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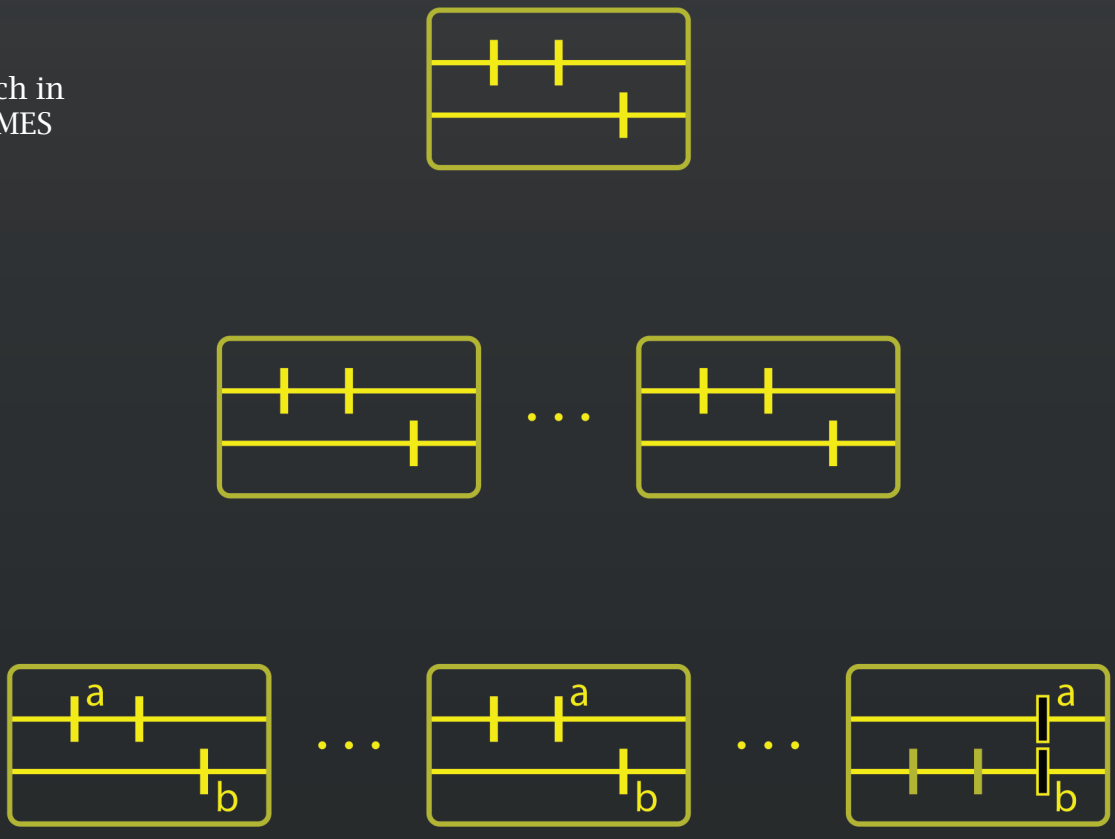

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About the cover:
Simple but Effective: Van der Waerden's Tick Diagrams (see page 967)

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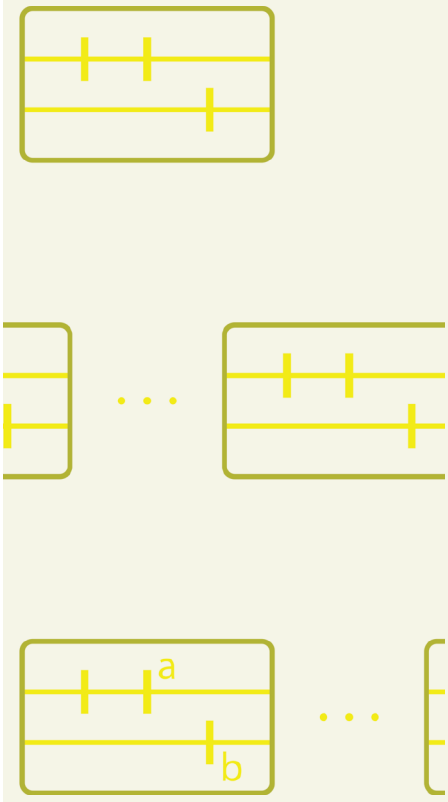
of the American Mathematical Society
September 2015

As we return to our teaching duties, it is both comforting and edifying to have a new issue of the *Notices* to turn to.

The September issue contains an interview with the creators of PRIMES, an MIT research-based program for high school students. September also offers a compelling piece on the question of diversity for women in the STEM disciplines. There is a piece on Gauss's hidden menagerie of dazzling visuals. And the September issue features a memorial to eminent Swedish mathematician Lars Hörmander.

—Steven G. Krantz, Editor



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Notices

of the American Mathematical Society

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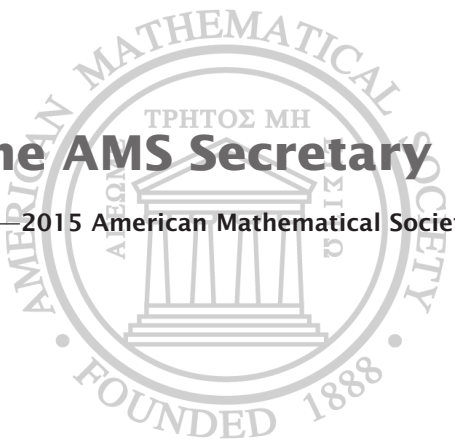

From the AMS Secretary

AMERICAN MATHEMATICAL SOCIETY

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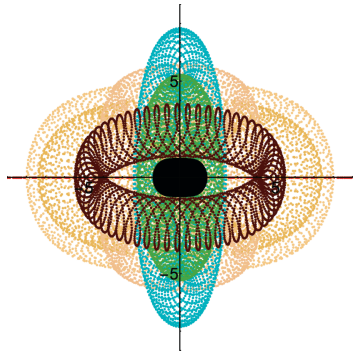
Gauss's Hidden Menagerie:
From Cyclotomy to Supercharacters

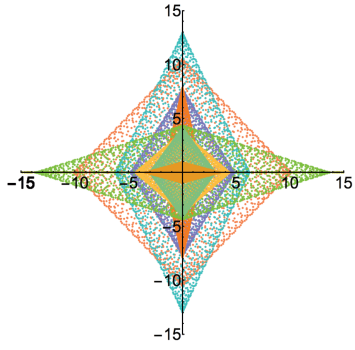
Stephan Ramon Garcia, Trevor Hyde, and Bob Lutz

At the age of eighteen, Gauss established the constructibility of the 17-gon, a result that had eluded mathematicians for two millennia. At the heart of his argument was a keen study of certain sums of complex exponentials, known now as *Gaussian periods*. These sums play starring roles in applications both classical and modern, including Kummer's development of arithmetic in the cyclotomic integers [28] and the optimized AKS primality test of H. W. Lenstra and C. Pomerance [1, 32]. In a poetic twist, this recent application of Gaussian periods realizes "Gauss's dream" of an efficient algorithm for distinguishing prime numbers from composites [24].

We seek here to study Gaussian periods from a graphical perspective. It turns out that these classical objects, when viewed appropriately, exhibit a dazzling and eclectic host of visual qualities. Some images contain discretized versions of familiar shapes, while others resemble natural phenomena. Many can be colorized to isolate certain features; for details, see "Cyclic Supercharacters."



(A) $n = 29 \cdot 109 \cdot 113$, $\omega = 8862$, $c = 113$



(B) $n = 37 \cdot 97 \cdot 113$, $\omega = 5507$, $c = 113$

Figure 1. Eye and jewel—images of *cyclic supercharacters* correspond to sets of Gaussian periods. For notation and terminology, see "Cyclic Supercharacters."

Historical Context

The problem of constructing a regular polygon with compass and straight-edge dates back to ancient times. Descartes and others knew that with only these tools on hand, the motivated geometer could draw, in principle, any segment whose length could be written as a finite composition of sums, products, and square roots of rational numbers [18]. Gauss's construction of the 17-gon relied on showing that

$$16\cos\left(\frac{2\pi}{17}\right) = -1 + \sqrt{17} + \sqrt{34 - 2\sqrt{17}} + 2\sqrt{17 + 3\sqrt{17} - \sqrt{34 - 2\sqrt{17}} - 2\sqrt{34 + 2\sqrt{17}}}$$

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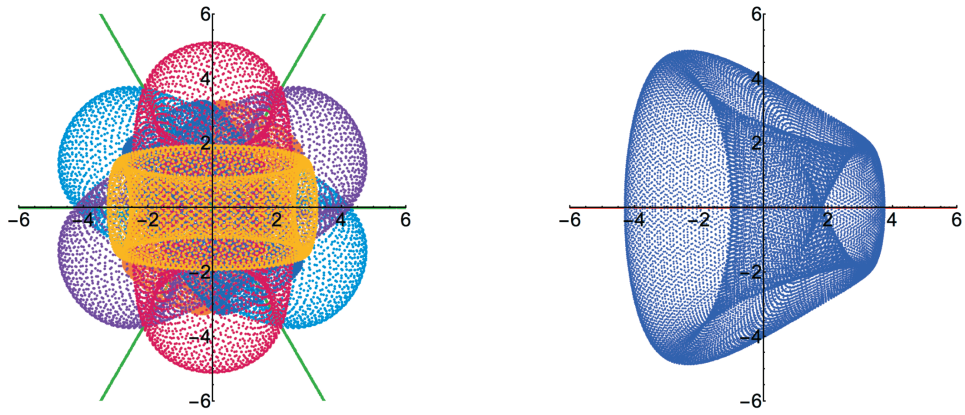


(A) $n = 3 \cdot 5 \cdot 17 \cdot 29 \cdot 37]$, $\omega = 184747$, $c = 3 \cdot 17$

(B) $n = 13 \cdot 127 \cdot 199$, $\omega = 6077$, $c = 13$

Figure 2. Disco ball and loudspeaker—images of *cyclic supercharacters* correspond to sets of Gaussian periods. For notation and terminology, see "Cyclic Supercharacters."

was such a length. After reducing the constructibility of the n-gon to drawing the length $\cos\left(\frac{2\pi}{n}\right)$, his result followed easily. So proud was Gauss of this discovery that he wrote about it throughout his career, purportedly requesting a 17-gon in place of his epitaph.[1] While this appeal went unfulfilled, sculptor Fritz Schaper did include a 17-pointed star at the base of a monument to Gauss in Brunswick, where the latter was born [31].

Gauss went on to demonstrate that a regular n-gon is constructible if Euler's totient $\varphi(n)$ is a power of 2. He stopped short of proving that these are the only cases of constructibility; this remained unsettled until J. Petersen completed a largely neglected argument of P. Wantzel nearly three quarters of a century later [33]. Nonetheless, the chapter containing Gauss's proof has persisted deservedly as perhaps the most well-known section of his *Disquisitiones Arithmeticae*. Without the language of abstract algebra, Gauss initiated the study of *cyclotomy*, literally "circle cutting," from an algebraic point of view.

The main ingredient in Gauss's argument is an exponential sum known as a *Gaussian period*. Denoting the cardinality of a set S by $|S|$, if p is an odd prime number and ω has order d in the unit group $(\mathbb{Z}/p\mathbb{Z})^\times$, then the *$d$-nomial* Gaussian periods modulo p are the complex numbers

$$\sum_{j=0}^{d-1} e\left(\frac{\omega^j y}{p}\right),$$

where y belongs to $\mathbb{Z}/p\mathbb{Z}$ and $e(\theta)$ denotes $\exp(2\pi i\theta)$ for real θ. Following its appearance in *Disquisitiones*, Gauss's cyclotomy drew the attention of other mathematicians who saw its potential use in their own work. In 1879, J. J. Sylvester wrote that "[c]yclotomy is to be regarded … as the natural and inherent centre and core of the arithmetic of the future" [39]. Two of Kummer's most significant achievements depended critically on his study of Gaussian periods: Gauss's work laid the foundation for the proof of Fermat's Last Theorem in the case of regular primes and later for Kummer's celebrated reciprocity law.

This success inspired Kummer to generalize Gaussian periods in [30] to the case of composite moduli. Essential to his work was a study of the polynomial $x^d - 1$ by his former student, L. Kronecker, whom Kummer continued to mentor for the better part of both men's careers [27]. Just as Gaussian periods for prime moduli had given rise to various families of difference sets [7], Kummer's composite cyclotomy has been used to explain certain difference sets arising in finite projective geometry [14]. Shortly after Kummer's publication, L. Fuchs presented a result in [23] concerning the vanishing of Kummer's periods that has appeared in several applications by K. Mahler [34], [35]. A modern treatment of Fuchs's result and a further generalization of Gaussian periods can be found in [21].

For a positive integer n and positive divisor d of $\varphi(n)$, Kummer "defined" a d-nomial period modulo n to be the sum

$$\sum_{j=0}^{d-1} e\left(\frac{\omega^j y}{n}\right), \tag{1}$$

where ω has order d in the unit group $(\mathbb{Z}/n\mathbb{Z})^\times$ and y ranges over $\mathbb{Z}/n\mathbb{Z}$. Unlike the case of prime moduli, however, there is no guarantee that a generator ω of order d will exist or that a subgroup of order d will be unique. For example, consider $(\mathbb{Z}/8\mathbb{Z})^\times$, which contains no element of order 4, as well as three distinct subgroups of order 2. A similar lack of specificity pervaded some of Kummer's other

[1] *H. Weber makes a footnote of this anecdote in* [43, p. 362], *but omits it curiously from later editions.*

definitions, including his introduction of ideal prime factors, used to prove a weak form of prime factorization for cyclotomic integers. According to H. M. Edwards, instead of revealing deficiencies in Kummer's work, these examples suggest "the mathematical culture…as Kummer saw it" [19].

Fortunately, the ambiguity in Kummer's definition is easily resolved. For n as above and an element ω of $(\mathbb{Z}/n\mathbb{Z})^\times$, we define the Gaussian periods generated by ω modulo n to be the sums in (1), where d is the order of ω and y ranges over $\mathbb{Z}/n\mathbb{Z}$, as before. These periods are closely related to Gauss sums, another type of exponential sum [9].

Cyclic Supercharacters

In 2008, P. Diaconis and I. M. Isaacs introduced the theory of supercharacters axiomatically [15], building upon seminal work of C. André on the representation theory of unipotent matrix groups [3], [4]. Supercharacter techniques have been used to study the Hopf algebra of symmetric functions of noncommuting variables [2], random walks on upper triangular matrices [5], combinatorial properties of Schur rings [16], [40], [41], and Ramanujan sums [22].

To make an important definition, we divert briefly to the character theory of finite groups. Let G be a finite group with identity 0, $\mathcal{K}$ a partition of G, and $\mathcal{X}$ a partition of the set of irreducible characters of G. The ordered pair $(\mathcal{X}, \mathcal{K})$ is called a *supercharacter theory* for G if $\{0\} \in \mathcal{K}$, $|\mathcal{X}| = |\mathcal{K}|$, and for each $X \in \mathcal{X}$, the function

$$\sigma_X = \sum_{\chi \in X} \chi(0)\chi$$

is constant on each $K \in \mathcal{K}$. The functions $\sigma_X : G \to \mathbb{C}$ are called *supercharacters*, and the elements of $\mathcal{K}$ are called *superclasses*.

Since $\mathbb{Z}/n\mathbb{Z}$ is abelian, its irreducible characters are group homomorphisms $\mathbb{Z}/n\mathbb{Z} \to \mathbb{C}^\times$. Namely, for each x in $\mathbb{Z}/n\mathbb{Z}$, there is an irreducible character χ_x of $\mathbb{Z}/n\mathbb{Z}$ given by $\chi_x(y) = e(\frac{xy}{n})$. For a subgroup Γ of $(\mathbb{Z}/n\mathbb{Z})^\times$, let $\mathcal{K}$ denote the partition of $\mathbb{Z}/n\mathbb{Z}$ arising from the action $a \cdot x = ax$ of Γ. The action $a \cdot \chi_x = \chi_{a^{-1}x}$ of Γ on the irreducible characters of $\mathbb{Z}/n\mathbb{Z}$ yields a compatible partition $\mathcal{X}$ making $(\mathcal{X}, \mathcal{K})$ a supercharacter theory on $\mathbb{Z}/n\mathbb{Z}$. The corresponding supercharacters are

$$\sigma_X(y) = \sum_{x \in X} e\left(\frac{xy}{n}\right). \tag{2}$$

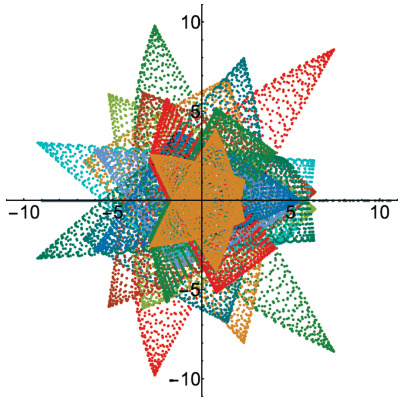
For a positive integer n and an orbit X of $\mathbb{Z}/n\mathbb{Z}$ under the multiplication action of a cyclic subgroup $\langle\omega\rangle$ of $(\mathbb{Z}/n\mathbb{Z})^\times$, we define the *cyclic supercharacter* $\sigma_X : \mathbb{Z}/n\mathbb{Z} \to \mathbb{C}$ by (2). The values of these functions are Gaussian periods in the sense of Kummer [17]. For applications of supercharacter theory to other exponential sums, see [11], [12], [22].

We are now in a position to clarify the captions and colorizations of the numerous figures. Unless specified otherwise, the image appearing in each figure is the image in $\mathbb{C}$ of the cyclic supercharacter $\sigma_{\langle\omega\rangle} : \mathbb{Z}/n\mathbb{Z} \to \mathbb{C}$, where ω belongs to $(\mathbb{Z}/n\mathbb{Z})^\times$, and $\langle\omega\rangle = \langle\omega\rangle 1$ denotes the orbit of 1 under the action of the subgroup generated by ω. Conveniently, the image of *any* cyclic supercharacter is a scaled subset of the image of one having the form $\sigma_{\langle\omega\rangle}$ [17, Proposition 2.2], so a restriction of our attention to orbits of 1 is natural. Moreover, the image of $\sigma_{\langle\omega\rangle}$ is the set of Gaussian periods generated by ω modulo n, bringing classical relevance to these figures.

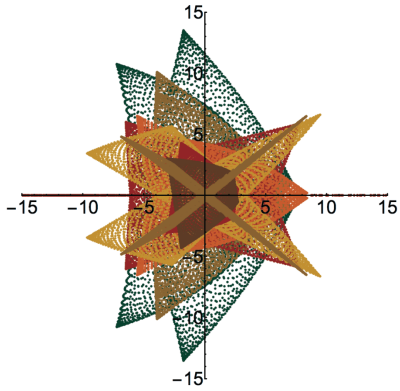
To colorize each image, we fix a proper divisor c of n and assign a color to each of the *layers*,

$$\{\sigma_{\langle\omega\rangle 1}(y) \mid y \equiv j \pmod{c}\},$$

for $j = 0, 1, \ldots, c-1$. Different choices of c result in different "layerings." For many images, certain values of c yield colorizations that separate distinct graphical components.

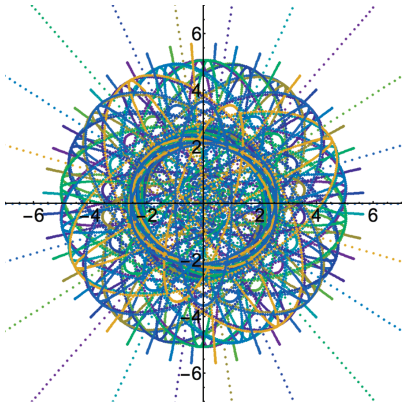


(A) $n = 13 \cdot 127 \cdot 199$, $X = \omega = 9247$, $c = 127$

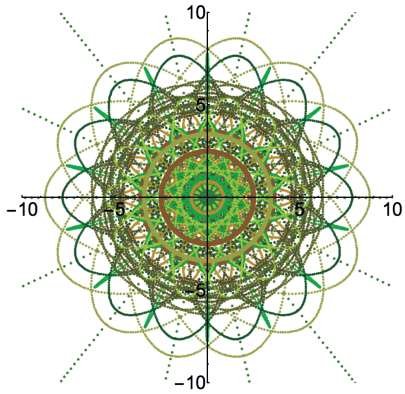


(B) $n = 3 \cdot 7 \cdot 211 \cdot 223$, $\omega = 710216$, $c = 211$

Figure 3. Mite and moth—images of *cyclic supercharacters* correspond to sets of Gaussian periods. For notation and terminology, see "Cyclic Supercharacters."



(A) $n = 3 \cdot 5 \cdot 7 \cdot 11 \cdot 13 \cdot 17$, $\omega = 254$, $c = 11$



(B) $n = 3^2 \cdot 5^2 \cdot 7 \cdot 17^2$, $\omega = 3599$, $c = 17^2$

Figure 4. Atoms—images of *cyclic supercharacters* correspond to sets of Gaussian periods. For notation and terminology, see "Cyclic Supercharacters."

Predictable layering occurs when the image of a cyclic supercharacter contains several rotated copies of a proper subset. We say that a subset of $\mathbb{C}$ has *k-fold dihedral symmetry* if it is invariant under complex conjugation and rotation by $\frac{2\pi}{k}$ about the origin. For example, the image pictured in Figure 4(A) has 11-fold dihedral symmetry, while the symmetry in Figure 4(B) is 7-fold. The image of a cyclic supercharacter $\sigma_{\langle\omega\rangle} : \mathbb{Z}/n\mathbb{Z} \to \mathbb{C}$ has k-fold dihedral symmetry, where $k = \gcd(n, \omega - 1)$ [17, Proposition 3.1]. In this situation, taking $c = k$ results in exactly k layers that are rotated copies of one another.

In addition to the behaviors above, certain cyclic supercharacters enjoy a multiplicative property [17, Theorem 2.1]. Specifically, if $\gcd(m, n) = 1$ and $\omega \mapsto (\omega_m, \omega_n)$ under the isomorphism $(\mathbb{Z}/mn\mathbb{Z})^\times \to (\mathbb{Z}/m\mathbb{Z})^\times \times (\mathbb{Z}/n\mathbb{Z})^\times$ afforded by the Chinese Remainder Theorem, where the multiplicative orders of ω_m and ω_n are coprime, then

$$\sigma_{\langle\omega\rangle}(\mathbb{Z}/mn\mathbb{Z}) = \{wz \in \mathbb{C} : (w, z) \in \sigma_{\langle\omega_m\rangle}(\mathbb{Z}/m\mathbb{Z}) \times \sigma_{\langle\omega_n\rangle}(\mathbb{Z}/n\mathbb{Z})\}. \tag{3}$$

This can be used to explain the images of cyclic supercharacters featuring "nested" copies of a given shape. For examples of this phenomenon, see Figures 6 and 7.

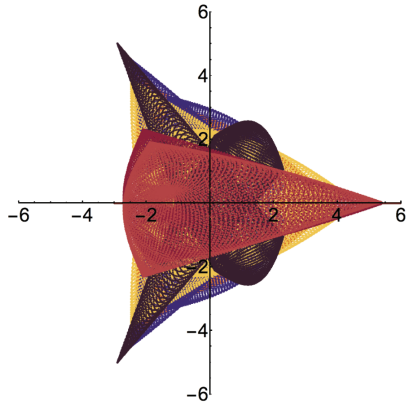
Asymptotic Behavior

In this section, we restrict our attention to cyclic supercharacters $\sigma_X : \mathbb{Z}/q\mathbb{Z} \to \mathbb{C}$, where q is a power of an odd prime and $X = \langle\omega\rangle$ is an orbit of 1. The Gaussian periods attained as values of these supercharacters have been applied in various settings [6], [8], [26]. Plotting the functions σ_X in this case reveals asymptotic patterns that have, until recently, gone unseen. Before proceeding, we recall several definitions and results.

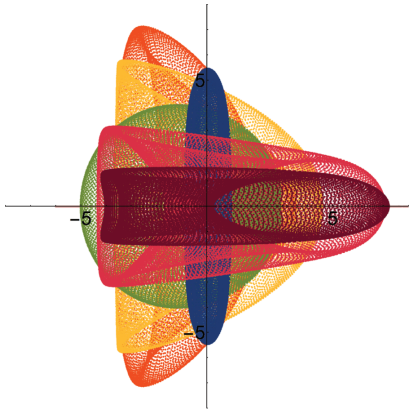
Uniform Distribution mod 1

Let m be a positive integer and Λ a finite subset of $\mathbb{R}^m$. We write

$$\widehat{\Lambda} = \{(\lambda_1 - \lfloor\lambda_1\rfloor, \ldots, \lambda_m - \lfloor\lambda_m\rfloor) \in [0, 1)^m : (\lambda_1, \ldots, \lambda_m) \in \Lambda\},$$

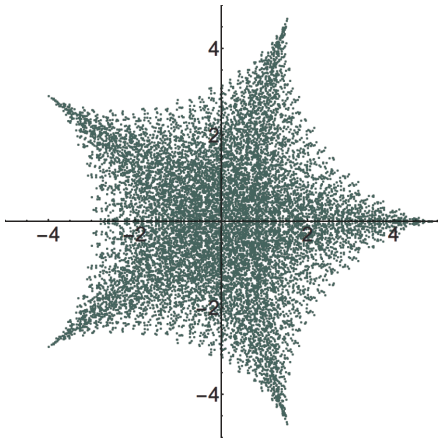


(A) $n = 31 \cdot 73 \cdot 211$, $\omega = 2547$, $c = 31$

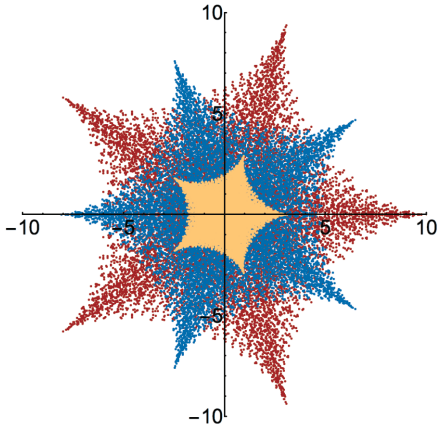


(B) $n = 3 \cdot 31 \cdot 73 \cdot 211$, $\omega = 1463$, $c = 73$

Figure 5. Bird and spacecraft—images of cyclic supercharacters.



(A) $m = 251 \cdot 281$, $\omega_m = 54184$



(B) $m = 251 \cdot 281$, $\omega_m = 54184$

Figure 6. The image on the top is the product set of the image on the bottom and the image $\{2, \frac{1}{2}(\pm\sqrt{5}-1)\}$, as in (3).

where $\lfloor \cdot \rfloor$ denotes the greatest integer function. The *discrepancy* of the set Λ is

$$\sup_B \left| \frac{|B \cap \hat{\Lambda}|}{|\hat{\Lambda}|} - \mathrm{vol}(B) \right|,$$

where the supremum is taken over all boxes $B = [a_1, b_1) \times \cdots \times [a_m, b_m) \subset [0,1)^m$ and $\mathrm{vol}(B)$ denotes the volume of B. We say that a sequence $(\Lambda_n)_{n=1}^{\infty}$ of finite subsets of $\mathbb{R}^m$ is *uniformly distributed mod* 1 if the discrepancy of Λ_n tends to zero as $n \to \infty$.

Many accessible examples exist in the case $m = 1$. For instance, a well-known theorem of Weyl states that if α is an irrational number, then the sequence

$$(4) \qquad (\{k\alpha \in \mathbb{R} : k = 0, 1, \ldots, n-1\})_{n=1}^{\infty}$$

is uniformly distributed mod 1 [44]. A lovely result of Vinogradov is that the same holds when k above is replaced by the kth prime number [42]. While it is known that the sequence

$$(\{\theta, \theta^2, \ldots, \theta^n\})_{n=1}^{\infty}$$

is uniformly distributed mod 1 for almost every $\theta > 1$, specific cases such as $\theta = \frac{3}{2}$ are not well understood [20]. Surprisingly perhaps, the sequence

$$(\{\log 1, \log 2, \ldots, \log n\})_{n=1}^{\infty}$$

is not uniformly distributed mod 1. This example and several others are elaborated in [29] using the following crucial characterization, also due to Weyl [45].

Lemma 1 (Weyl's criterion)**.** *A sequence $(\Lambda_n)_{n=1}^{\infty}$ of finite subsets of $\mathbb{R}^m$ is uniformly distributed mod* 1 *if and only if for each $\mathbf{v}$ in $\mathbb{Z}^m$ we have*

$$\lim_{n\to\infty} \frac{1}{|\Lambda_n|} \sum_{\mathbf{u}\in\Lambda_n} e(\mathbf{u}\cdot\mathbf{v}) = 0.$$

For example, let $(\Lambda_n)_{n=1}^{\infty}$ be the sequence in (4). Since α is irrational,

$$\frac{1}{|\Lambda_n|} \sum_{u\in\Lambda_n} e(uv) = \frac{1}{n} \sum_{k=0}^{n-1} e(v\alpha)^k = \frac{1}{n}\left(\frac{1-e(v\alpha)^n}{1-e(v\alpha)}\right)$$

for each nonzero $v \in \mathbb{Z}$. Consequently,

$$\left|\frac{1}{n}\left(\frac{1-e(v\alpha)^n}{1-e(v\alpha)}\right)\right| \le \frac{1}{n}\frac{2}{|1-e(v\alpha)|} \to 0$$

as $n \to \infty$, so Lemma 1 confirms that (4) is uniformly distributed mod 1.

Cyclotomic Polynomials

For a positive integer d, the *dth cyclotomic polynomial* $\Phi_d(x)$ is defined by the formula

$$\Phi_d(x) = \prod_{\substack{k=1,2,\ldots,d \\ \gcd(k,d)=1}} \left(x - e\left(\frac{k}{d}\right)\right).$$

It can be shown that $\Phi_d(x)$ is of degree $\varphi(d)$ and belongs to $\mathbb{Z}[x]$. In *Disquisitiones*, Gauss showed that $\Phi_d(x)$ is irreducible, hence the minimal polynomial of any primitive dth root of unity, over $\mathbb{Q}$. The first several cyclotomic polynomials are

$$\begin{aligned}
\Phi_1(t) &= x - 1, \\
\Phi_2(t) &= x + 1, \\
\Phi_3(t) &= x^2 + x + 1, \\
\Phi_4(t) &= x^2 + 1, \\
\Phi_5(t) &= x^4 + x^3 + x^2 + x + 1.
\end{aligned}$$

In these examples, the coefficients have absolute value at most 1. In 1938, N. G. Chebotarëv asked

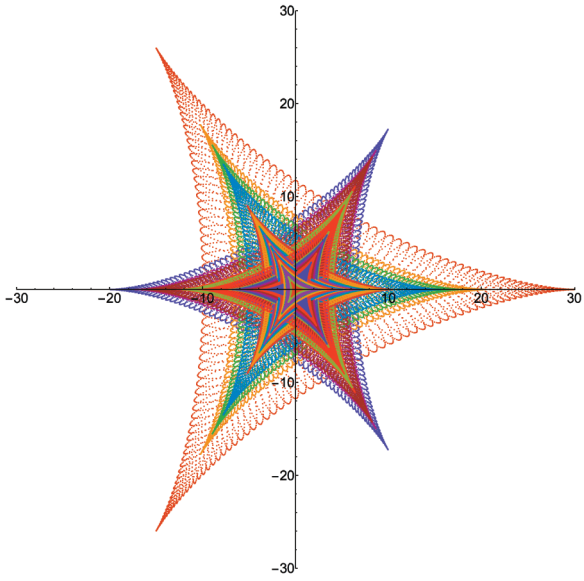


Figure 7. $n = 127^2 \cdot 401$, $\omega = 6085605$, $c = 401$

whether this phenomenon continues for all factors of $x^d - 1$ and all values of d [25]. Three years later, V. Ivanov showed that while the pattern holds for $d < 105$, one coefficient of $\Phi_{105}(x)$ is -2. Unbeknownst to either mathematician, A. S. Bang had solved Chebotarëv's challenge more than forty years earlier [10].

Main Theorem

We require a lemma essentially due to G. Myerson. The original aim of the result was to count the number of ways to write an arbitrary element of $(\mathbb{Z}/q\mathbb{Z})^\times$ as a sum of elements, one in each coset of a fixed subgroup of $(\mathbb{Z}/q\mathbb{Z})^\times$. For our purposes, Myerson's lemma will be critical in discussing the asymptotic behavior of the images of cyclic supercharacters. Throughout, we let ω_q denote a primitive dth root of unity in $\mathbb{Z}/q\mathbb{Z}$, in which $q = p^a$ is a power of an odd prime p, and

(5)
$$\Lambda_q = \left\{ \frac{\ell}{q} \left(1, \omega_q, \omega_q^2, \ldots, \omega_q^{\varphi(d)-1}\right) \in [0,1)^{\varphi(d)} : \ell = 0, 1, \ldots, q-1 \right\}.$$

Lemma 2 (Myerson [36])**.** *The sequence* $(\Lambda_q)_{q \equiv 1 \pmod d}$ *is uniformly distributed mod* 1.

Proof. Let $\mathbf{v} = (v_0, \ldots, v_{\varphi(d)-1})$ be nonzero in $\mathbb{Z}^{\varphi(d)}$ and let $f \in \mathbb{Z}[x]$ be given by

$$f(x) = v_0 + v_1 x + \cdots + v_{\varphi(d)-1} x^{\varphi(d)-1}.$$

Writing $r = \frac{q}{\gcd(q, f(\omega_q))}$, we notice that

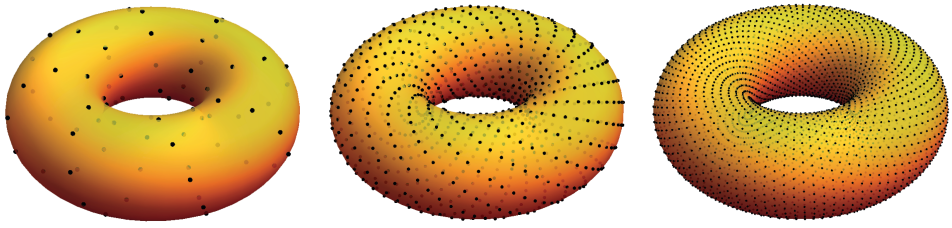
$$\begin{aligned}
\sum_{\mathbf{u} \in \Lambda_q} e(\mathbf{u} \cdot \mathbf{v}) &= \sum_{\ell=0}^{q-1} e\left(\frac{\ell f(\omega_q)}{q}\right) \\
&= \sum_{k=0}^{q/r-1} \sum_{j=0}^{r-1} e\left(\frac{(kr+j) f(\omega_q)}{q}\right) \\
&= \sum_{k=0}^{q/r-1} \sum_{j=0}^{r-1} e\left(\frac{k f(\omega_q)}{\gcd(q, f(\omega_q))} + \frac{j f(\omega_q)}{q}\right) \\
&= \sum_{k=0}^{q/r-1} \sum_{j=0}^{r-1} e\left(\frac{j f(\omega_q)}{q}\right) \\
&= \frac{q}{r} \sum_{j=0}^{r-1} e\left(\frac{j f(\omega_q)}{q}\right) \\
&= \begin{cases} q & \text{if } q \mid f(\omega_q), \\ 0 & \text{otherwise.} \end{cases} \qquad (6)
\end{aligned}$$

Since $\Phi_d(x)$ is irreducible over $\mathbb{Q}$ and of greater degree than $f(x)$, we see that $\gcd(f(x), \Phi_d(x)) = 1$ in $\mathbb{Q}[x]$. From this we obtain $a(x)$ and $b(x)$ in $\mathbb{Z}[x]$ such that $a(x)f(x) + b(x)\Phi_d(x) = s$ for some $s \in \mathbb{Z}$. Evaluating at $x = \omega_q$ reveals that $a(\omega_q)f(\omega_q) \equiv s \pmod q$, so $q \mid s$ whenever $q \mid f(\omega_q)$. Hence $q \mid f(\omega_q)$ for at most finitely many odd prime powers $q \equiv 1 \pmod d$. It follows from (6) that

$$\lim_{\substack{q \to \infty \\ q \equiv 1 \pmod d}} \frac{1}{|\Lambda_q|} \sum_{\mathbf{u} \in \Lambda_q} e(\mathbf{u} \cdot \mathbf{v}) = 0.$$

Appealing to Lemma 1 completes the proof. □

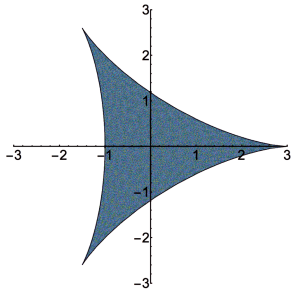
The following theorem summarizes our current understanding of the asymptotic behavior of cyclic supercharacters. A special case supplies a



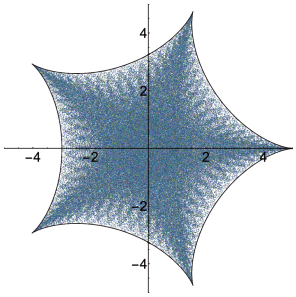
(A) $q = 73$ (B) $q = 31^2$ (C) $q = 3571$

Figure 8. The sequence $(\Lambda_q)_{q\equiv 1 \pmod 3}$, defined in (5), is uniformly distributed mod 1. Here we plot several of the sets $\Lambda_q \subset [0,1)^2$, identifying $[0,1)^2$ with a torus.

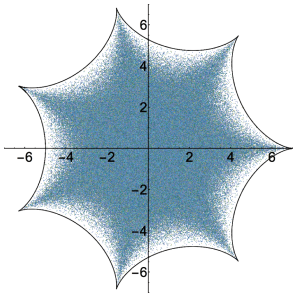
geometric description of the set of $|X|$-nomial periods modulo p considered by Gauss, shedding new light on these classical objects. We let $\mathbb{T}$ denote the unit circle in $\mathbb{C}$.



(A) $n = 97^3$, $\omega = 61074$, $d = 3$



(B) $n = 31^4$, $\omega = 62996$, $d = 5$



(C) $n = 1933^2$, $\omega = 537832$, $d = 7$

Figure 9. Certain cyclic supercharacters fill out regions bounded by *hypocycloids*, outlined in black (see Proposition 1).

Theorem 1 (Duke-Garcia-Lutz)**.** *If $\sigma_X : \mathbb{Z}/q\mathbb{Z} \to \mathbb{C}$ is a cyclic supercharacter, where $q = p^a$ is a power of an odd prime, X is an orbit of 1, and $|X| = d$ divides $p-1$, then the image of σ_X is contained in the image of the Laurent polynomial function $g_d : \mathbb{T}^{\varphi(d)} \to \mathbb{C}$ defined by*

$$g_d(z_1, z_2, \ldots, z_{\varphi(d)}) = \sum_{k=0}^{d-1} \prod_{j=0}^{\varphi(d)-1} z_{j+1}^{c_{jk}}, \tag{7}$$

where the c_{jk} are given by the relation

$$x^k \equiv \sum_{j=0}^{\varphi(d)-1} c_{jk} x^j \pmod{\Phi_d(x)}. \tag{8}$$

Moreover, for a fixed $|X| = d$, as $q \equiv 1 \pmod d$ tends to infinity, every nonempty open disk in the image of g eventually contains points in the image $\sigma_X(\mathbb{Z}/q\mathbb{Z})$.

Proof. Since the elements $1, \omega_q, \ldots, \omega_q^{\varphi(d)-1}$ form a $\mathbb{Z}$-basis for $\mathbb{Z}[\omega_q]$ [37, p. 60], for $k = 0, 1, \ldots, d-1$ we can write

$$\omega_q^k \equiv \sum_{j=0}^{\varphi(d)-1} c_{jk} \omega_p^j \pmod q,$$

where the integers c_{jk} are given by (8). Letting $X = \langle \omega_q \rangle$, we see that

$$\begin{aligned} \sigma_X(y) &= \sum_{x\in X} e\left(\frac{xy}{q}\right) = \sum_{k=0}^{d-1} e\left(\frac{\omega_q^k y}{q}\right) \\ &= \sum_{k=0}^{d-1} e\left(\sum_{j=0}^{\varphi(d)-1} c_{jk} \frac{\omega_q^j y}{q}\right) \\ &= \sum_{k=0}^{d-1} \prod_{j=0}^{\varphi(d)-1} e\left(\frac{\omega_q^j y}{q}\right)^{c_{jk}}, \end{aligned}$$

whence the image of σ_X is contained in the image of the function $g_d : \mathbb{T}^{\varphi(d)} \to \mathbb{C}$ defined in (7). The claim about open disks follows immediately from Lemma 2. □

Several remarks are in order. First, when the hypotheses of Theorem 1 are satisfied, we say that σ_X *fills out* the image of g_d, as illustrated by Figure 9. The corresponding values of d are

given in captions. Second, since every divisor of $\varphi(q) = p^{a-1}(p-1)$ is the cardinality of some orbit X under the action of a cyclic subgroup of $(\mathbb{Z}/p^a\mathbb{Z})^\times$, the requirement that $|X|$ divide $p-1$ might seem restrictive. However, it turns out that if p divides $|X|$, then the image of σ_X is equal to a scaled copy of the image of a supercharacter that satisfies the hypotheses of the theorem, except for a single point at the origin [17, Proposition 2.4].

Examples

As a consequence of Theorem 1, the functions g_d are instrumental in understanding the asymptotic behavior of cyclic supercharacters $\sigma_X : \mathbb{Z}/q\mathbb{Z} \to \mathbb{C}$, where q is a power of an odd prime. Fortunately, whenever the coefficients of $\Phi_d(x)$ are relatively accessible, we can obtain a convenient formula for g_d. For example, it is not difficult to show that

$$\Phi_{2^b}(x) = x^{2^{b-1}} + 1,$$

for any positive integer b. With this, we can compute the integers c_{jk} in (8) to see that

$$g_{2^b}(z_1, z_2, \ldots, z_{2^{b-1}}) = 2\sum_{j=1}^{2^{b-1}} \Re(z_j),$$

where $\Re(z)$ denotes the real part of z. Hence the image of g_{2^b} is the real interval $[-2^b, 2^b]$. Alternatively, if r is an odd prime, then

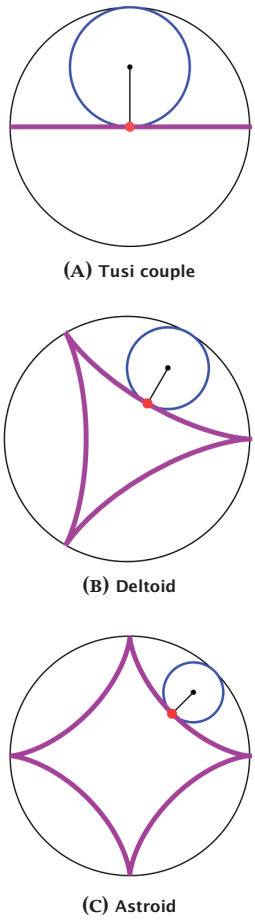
$$\Phi_{2r}(x) = \sum_{j=0}^{r-1} (-x)^j,$$

giving

$$g_{2r}(z_1, z_2, \ldots, z_{r-1}) = 2\Re\left(\frac{z_2 z_4 \cdots z_{r-1}}{z_1 z_3 \cdots z_{r-2}}\right) + 2\sum_{j=1}^{r-1} \Re(z_j).$$

More generally, g_d is real valued whenever d is even.

A novel and particularly accessible behavior occurs when $d = r$ is an odd prime. The reader might recall that a *hypocycloid* is a planar curve obtained by tracing a fixed point on a circle of integral radius as it "rolls" within a larger circle of integral radius. Figure 10 illustrates this construction. We are interested in the hypocycloid that is centered at the origin and has r cusps, one of which is at r. This curve is obtained by rolling a circle of radius 1 within a circle of radius d; it has the parametrization $\theta \mapsto (r-1)e(\theta) + e((1-r)\theta)$. Let H_r denote the compact region bounded by this curve.



(A) Tusi couple

(B) Deltoid

(C) Astroid

Figure 10. Circles of radius 1 trace out hypocycloids as they roll within circles of radii (from top to bottom) 2, 3, and 4.

Proposition 1. *If r is an odd prime, then the image of g_r is H_r.*

Proof. Since

$$\Phi_r(x) = x^{r-1} + x^{r-2} + \cdots + x + 1,$$

we obtain the formula

$$g_r(z_1, z_2, \ldots, z_{r-1}) = z_1 + z_2 + \cdots + z_{r-1} + \frac{1}{z_1 z_2 \cdots z_{r-1}}.$$

The image of this map is the set of all traces of matrices in $SU(r)$, the group of $r \times r$ complex unitary matrices with determinant 1. This set is none other than H_r [13, Theorem 3.2.3]. In particular, the image under g_d of the diagonal $z_1 = z_2 = \cdots = z_{r-1}$ is the boundary of H_r. □

To expand on the previous example, suppose again that r is an odd prime and b is a positive integer. We have

$$\Phi_{r^b}(x) = \sum_{j=0}^{r-1} x^{jr^{b-1}},$$

whence

$$g_{r^b}(z_1, z_2, \ldots, z_{r^b - r^{b-1}}) = \sum_{j=1}^{r^b - r^{b-1}} z_j + \sum_{j=1}^{r^{b-1}} \prod_{\ell=0}^{r-2} z_{j+\ell r^{b-1}}^{-1}. \tag{9}$$

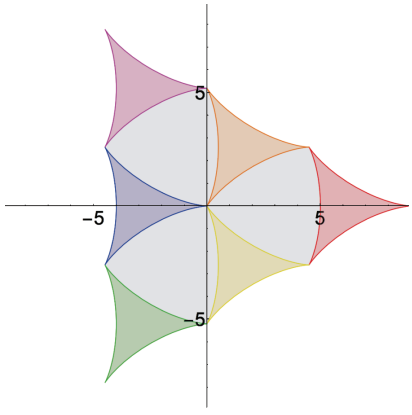
If $r = 3$ and $b = 2$, for instance, then the map is given by

$$g_9(z_1, z_2, z_3, z_4, z_5, z_6) = z_1 + z_4 + \frac{1}{z_1 z_4} + z_2 + z_5 + \frac{1}{z_2 z_5} + z_3 + z_6 + \frac{1}{z_3 z_6}.$$

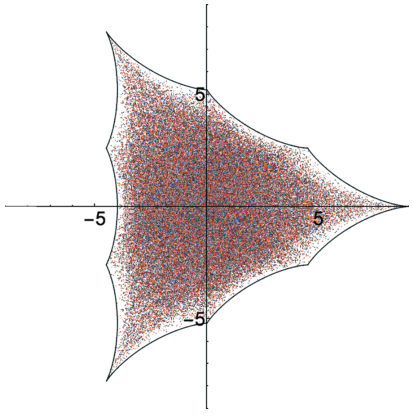
A definition will enable us to discuss the image in this situation. The *Minkowski sum* of two nonempty subsets S and T of $\mathbb{C}$, denoted by $S + T$, is the set

$$S + T = \{s + t \in \mathbb{C} : s \in S \text{ and } t \in T\}.$$

The Minkowski sum of an arbitrary finite collection is defined by induction. As a consequence of Proposition 1, we discover that the image of g_9 is none other than the Minkowski sum $H_3 + H_3 + H_3$, as illustrated in Figure 11. A close look at (9) reveals a more general phenomenon.



(A) A geometric interpretation of $H_3 + H_3 + H_3$



(B) $n = 1009^2$, $\omega = 84669$, $d = 3^2$

Figure 11. The supercharacter at the top fills out a Minkowski sum of filled deltoids.

Corollary 1. *If r^b is a power of an odd prime, then the image of g_{r^b} is the Minkowski sum*

$$\sum_{j=1}^{r^{b-1}} H_r.$$

The Shapley-Folkman-Starr Theorem, familiar to mathematical economists, gives an explicit upper bound on the distance between points in a Minkowski sum and its convex hull [38]. In the context of Corollary 1, we obtain the bound

$$\min\{|w - z| : w \in \sum_{j=1}^{r^{b-1}} H_r\} \le 2\sqrt{2} r \sin\left(\frac{\pi}{r}\right),$$

for any z in the filled r-gon with vertices at $r^b e(\frac{j}{r})$ for $j = 1, 2, \ldots, r$. It follows easily that as $b \to \infty$, any point in the filled r-gon whose vertices are the rth roots of unity becomes arbitrarily close to points in the scaled Minkowski sum

$$\frac{1}{r^{b-1}} \sum_{j=1}^{r^{b-1}} H_r.$$

Concluding Remarks

There is work to be done toward understanding the images of cyclic supercharacters. If we are to stay the course of inquiry set in the Examples section, then a different approach is required; beyond the special cases discussed above, a general formula for the integers c_{jk} in (8) appears unobtainable, since there is no known simple closed-form expression for the coefficients of an arbitrary cyclotomic polynomial $\Phi_d(x)$.

There is, however, a remedy. To minimize headache, suppose that $d = rs$ is a product of distinct odd primes and that $\omega_q \mapsto (\gamma_r, \gamma_s)$ under the standard isomorphism $(\mathbb{Z}/d\mathbb{Z})^\times \to (\mathbb{Z}/r\mathbb{Z})^\times \times (\mathbb{Z}/s\mathbb{Z})^\times$. Instead of wielding the elements $1, \omega_q, \ldots, \omega_q^{\varphi(d)-1}$ as a $\mathbb{Z}$-basis for $\mathbb{Z}[\omega_q]$, we can use an analogous basis for $\mathbb{Z}[\gamma_r, \gamma_s]$. After some computation, we see that the image of the function g_d, formerly quite mysterious, is equal to the image of the function $h_d : \mathbb{T}^{\varphi(d)} \to \mathbb{C}$ given by

$$h((z_{ij})_{0 \le i < r-1, 0 \le j < s-1}) = \sum_{i=0}^{r-2} \sum_{j=1}^{s-2} z_{ij} + \sum_{i=0}^{r-2} \prod_{j=0}^{s-2} \frac{1}{z_{ij}} + \sum_{j=0}^{s-2} \prod_{i=0}^{r-2} \frac{1}{z_{ij}} + \prod_{i=0}^{r-2} \prod_{j=0}^{s-2} z_{ij}. \tag{10}$$

This procedure, which amounts to a change of coordinates, can be used to obtain a closed formula for a Laurent polynomial map h_d having the same image as g_d, for any integer d. This brings us one step closer to understanding the

asymptotic behavior of the cyclic supercharacters in "Asymptotic Behavior." In practice, however, the functions h_d are still difficult to analyze, despite being considerably easier to write down than the g_d. Even the simplest cases, described in (10), resist the accessible geometric description provided in the preceding section.

While certain graphical features of cyclic supercharacters with composite moduli have been explained in [17], the mechanisms behind many of the striking patterns herein remain enigmatic. An important step toward deciphering the behavior of these supercharacters is to predict the layering constant c, discussed in "Cyclic Supercharacters," given only a modulus n and generator ω. As is apparent, these layerings betray an underlying geometric structure that allows us to decompose the images of σ_X into more manageable sets. We have been successful so far in finding appropriate values of c ad hoc; however, a general theory is necessary to formalize our intuition.

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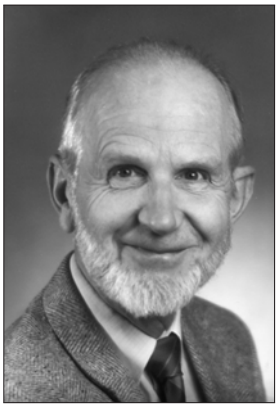
To the Memory of Lars Hörmander (1931–2012)

Jan Boman and Ragnar Sigurdsson, Coordinating Editors



Lars Hörmander 1996.

The eminent mathematician Lars Valter Hörmander passed away on November 25, 2012. He was the leading figure in the dramatic development of the theory of linear partial differential equations during the second half of the twentieth century, and his L^2 estimates for the $\bar{\partial}$ equation became a revolutionary tool in complex analysis of several variables. He was awarded the Fields Medal in 1962, the Wolf Prize in 1988, and the Leroy P. Steele Prize for Mathematical Exposition in 2006. He published 121 research articles and 9 books, which have had a profound impact on generations of analysts.

Student in Lund

Lars Hörmander was born on January 24, 1931, in Mjällby in southern Sweden. His talents became apparent very early. He skipped two years of elementary school and moved to Lund in 1946 to enter secondary school (gymnasium). He was one of the selected students who were offered the chance to cover three years' material in two years by staying only three hours per day in school and devoting the rest of the day to individual studies, a scheme he found ideal. His mathematics teacher, Nils Erik Fremberg (1908–52), was also docent at Lund University and in charge of the undergraduate program there. When graduating from gymnasium in the spring of 1948 Lars had already completed the first-semester university courses in mathematics.

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Unless otherwise noted, all photographs are from Lars Hörmander's personal collection, courtesy of Sofia Broström (Hörmander).

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Lars entered Lund University in the fall of 1948 to study mathematics and physics. Marcel Riesz (1886–1969) became his mentor. Lars studied most of the courses on his own, but followed the lectures on analysis given by Riesz during 1948–50. In the early fall of 1949 he completed a bachelor's degree and a master's degree in the spring of 1950, which could have allowed him to earn his living as a secondary school teacher at the age of only nineteen.

In October 1951 Lars completed the licentiate degree with a thesis entitled "Applications of Helly's theorem to estimates of Tchebycheff type", written under the supervision of Riesz. Shortly afterwards Riesz retired from his professorship and moved to the US to remain there during most of the coming ten years. We have often been asked who was the PhD thesis advisor of Lars Hörmander. The correct answer is no one and it needs a little bit of explanation. As a young man Marcel Riesz worked mainly on complex and harmonic analysis, but later in life he became interested in partial differential equations and mathematical physics, so partial differential equations were certainly studied in Lund in the early 1950s. Moreover, Lars Gårding (1919–2014) and Åke Pleijel (1913–89) were appointed professors in mathematics in Lund during this period. They had good international contacts, and the young Lars concluded that partial differential equations would give him the best opportunities in Lund.

Lars defended his doctorate thesis, "On the theory of general partial differential operators," on October 22, 1955, with Jacques-Louis Lions as opponent, and it was published in *Acta Mathematica* the same year. His work was highly independent. Lars chose his problems himself and solved them. Gårding was often mentioned as the thesis advisor of Hörmander, but the fact is that he was no more than a formal advisor, in the sense that he was an important source of inspiration and that he served as a chairman at Lars's thesis defense. It is no exaggeration to say that the thesis opened a new era of the subject of partial differential equations.

Some of the most important results were quite original and had not even been envisioned before.

Professor in Stockholm, Stanford, and Princeton

Lars spent the year 1956 in the United States. In January 1957 he became professor at Stockholm University. Since there was no activity in partial differential equations at Stockholm University at this time, he had to start from the beginning and lecture on distribution theory, Fourier analysis, and functional analysis. In 1961–62 he lectured on the material that was to become his 1963 book, *Linear Partial Differential Operators*. He quickly gathered a large group of students around him. Among them were Christer Kiselman and Vidar Thomée. One of us (JB) had the privilege to be a member of that group. Lars's lectures were wonderful, and there was excitement and enthusiasm around him. His vast knowledge, fast thinking, and overwhelming capacity for work inspired all of us, but also sometimes scared his students. The clattering from his typewriter, which was constantly heard through his door, is famous.

Lars spent the summer of 1960 in Stanford and the following academic year at the Institute for Advanced Study (IAS) in Princeton. The summer of 1960 was both pleasant and productive for Lars, and both he and the members of the department in Stanford were interested in a continuation on a more permanent basis, but Lars was not ready to leave Sweden at that time. An arrangement was made so that he would be on leave from Stockholm for April and May and combine the position in Stockholm with a permanent professorship at Stanford, where he would work for the spring and summer quarters. In Stockholm 1962–63 he gave a lecture series on complex analysis which he developed further in Stanford, 1964 and published as *An Introduction to Complex Analysis in Several Variables* in 1966. Revised editions were published in 1973 and 1990. It is remarkable that this book has kept its position as one of the main references on the subject for almost fifty years.

At Stanford in the summer of 1963 Lars received a letter which would change his life. Robert Oppenheimer, the director of the IAS, made him an offer to become a professor and a permanent member of the institute. It took Lars some time to make up his mind. Attempts were made by Lennart Carleson (b. 1928), Otto Frostman (1907–77), and Lars Gårding to arrange for a research position in Lund, but when this was declined by the Swedish government, Lars decided to accept the offer. He spent the summer of 1964 at Stanford and started his work at the institute in September. He soon found that ongoing conflicts had created a bad climate at the institute. He also felt strong pressure to produce a steady stream of high-quality research, and this he found paralyzing. This appears especially paradoxical, since his accomplishments during his period in Princeton were truly remarkable. Already in early 1966 he had made up his mind to return to an ordinary professorship in Sweden as soon as an opportunity came up.

Back in Lund

Lars left Princeton in the spring of 1968 and became a professor in Lund, a position he held until his retirement in 1996. He always kept good contact with IAS and other universities in the US. In 1977–78 Lars was in charge of a special program on microlocal analysis at IAS. Among Lars's prominent students in Lund were Johannes Sjöstrand, Anders Melin, Nils Dencker, and Hans Lindblad.

Photograph by Nils Åslund

Student in Lund around 1950.

During the years 1979–84 Lars worked on the four volumes of *The Analysis of Partial Differential Operators* published in 1983 and 1985. This was the time of study of the younger of us (RS) in Lund. Lars gave a wonderful lecture series on various parts of the manuscript. The students corrected (rare) errors and in return got superb private lessons on the parts they did not understand. The four volumes, written in the well-known compact Hörmander style, contain enough material to fill eight volumes rather than four. The amount of work needed to complete the project was clearly formidable, and Lars later looked back at this period as six years of slave labor.

In the fall of 1984 Lars succeeded Lennart Carleson as director of the Institut Mittag-Leffler and became the managing editor for *Acta Mathematica*. He conducted a two-year program on nonlinear partial differential equations. Back in Lund in the fall of 1986 Lars started a series of lectures on nonlinear problems. His notes from 1988 were widely circulated and finally published in revised form as the book *Lectures on Nonlinear Hyperbolic Differential Equations* in 1997. In 1991–92 Lars gave lectures which he later developed into the book *Notions of Convexity*, published in 1994. In this book he shows again the depth and breadth of his knowledge of analysis.

Lars became emeritus on January 1, 1996. From the beginning of the 1990s his research was not as focused on partial differential equations as it had been before. He looked back on his career and took up the study of various problems that he had dealt with and continued publishing interesting papers. Lars was always interested in the Nordic cooperation of mathematicians. He published his first paper in the proceedings of the Scandinavian Congress of Mathematicians held

With John Forbes Nash, Jean Leray, and Lars Gårding in Paris, 1958.

Photograph by Vidar Thomée.

With Bogdan Bojarski and Vidar Thomée in Norway, 1965.

in Lund in 1953, the second one in *Mathematica Scandinavica* in 1954, and it is symbolic that his last paper was published there in 2008. In 1997 Mikael Passare (1959–2011) initiated the annual Nordan conferences, which is a platform for Nordic researchers in complex analysis and related topics. Lars participated the first few years. He gave his last conference talk in Reykjavik in 2002. The subject was unusual for him: he talked about his L^2 method from a historical perspective. It was published in *Journal of Geometric Analysis* in 2003.

Lars Hörmander had a huge influence on our development as mathematicians, first as a teacher and advisor and later as a colleague and friend. We always admired him for his great knowledge, his sharp mind, and his masterful way of communicating mathematics in speech and writing. Until his death, he kept his great spirit and memory. His interests in mathematics, science, nature, and history were always the same. We kept regular contact with him and it was always a pleasure to talk to him. We are very grateful for having had the opportunity to work with him.

In this series of memorial articles we have assembled nine contributions from Lars's colleagues, friends, students, and his daughter, Sofia. Nicolas Lerner writes on Lars's contributions to partial differential equations, and Jean-Pierre Demailly on his work in complex analysis.

Nicolas Lerner

On Lars Hörmander's Work on Partial Differential Equations

The Beginning

Lars Hörmander wrote a PhD thesis under the guidance of L. Gårding, and the publication of that thesis, "On the theory of general partial differential operators" [29], in *Acta Mathematica* in 1955 can be considered as the starting point of a new era for partial differential equations. Among other things, very general theorems of local existence were established without using an analyticity hypothesis of the coefficients. Hörmander's arguments relied on a priori inequalities combined with abstract functional analytic arguments. Let us cite L. Gårding in [26]: *It was pointed out very emphatically by Hadamard that it is not natural to consider only analytic solutions and source functions even for an operator with analytic coefficients. This reduces the interest of the Cauchy-Kowalevski theorem which …does not distinguish between classes of differential operators which have, in fact, very different properties such as the Laplace operator and the Wave operator.*

L. Ehrenpreis in [23] and B. Malgrange in [58] had proven a general theorem on the existence of a fundamental solution for any constant coefficients PDE, and the work [30] by Hörmander provided another proof along with some improvement on the regularity properties, whereas [29] gave a characterization of hypoelliptic constant coefficients PDE via properties of the algebraic variety

$$\mathrm{char}P = \{\zeta \in \mathbb{C}^n, P(\zeta) = 0\}.$$

The operator $P(D)$ is hypoelliptic if and only if $\{|\zeta| \to \infty \text{ on } \mathrm{char}P \implies |\mathrm{Im}\,\zeta| \to \infty.\}$ Here hypoellipticity means

$$\mathrm{singsupp}\, u = \mathrm{singsupp}\, Pu \tag{1}$$

for the C^∞ singular support. The characterization of hypoellipticity of the constant coefficient operator $P(D)$ by a simple algebraic property of the characteristic set is a tour de force, technically and conceptually: in the first place, nobody had conjectured such a result or even remotely suggested a link between the two properties, and next, the proof provided by Hörmander relies on a very subtle study of the characteristic set, requiring an extensive knowledge of real algebraic geometry.

In 1957, Hans Lewy made a stunning discovery [57]: the equation $\mathcal{L}u = f$ with

$$\mathcal{L} = \frac{\partial}{\partial x_1} + i\frac{\partial}{\partial x_2} + i(x_1 + ix_2)\frac{\partial}{\partial x_3} \tag{2}$$

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Photograph by Ragnar Sigurdsson.

With Lars Gårding and Tomas Claesson, 2008.

Receiving the Fields Medal from King Gustav VI Adolf.

Opening ceremony of ICM in Stockholm, 1962. From left: Lars Gårding, Lars Hörmander, John Milnor, Hassler Whitney, Åke Pleijel, Harald Cramér, Otto Frostman. Standing at the rostrum: Rolf Nevanlinna. Gårding and Whitney presented the work of the Fields Medalists Hörmander and Milnor, resp. The organizing committee consisted of Frostman (chair), Cramér, Gårding, and Pleijel. Nevanlinna was president of IMU and chairman of the Fields Medal Committee.

does not have local solutions for most right-hand sides f. The surprise came in particular from the fact that the operator $\mathcal{L}$ is a nonvanishing vector field with a very simple expression and also, as the Cauchy-Riemann operator on the boundary of a pseudo-convex domain, it is not a cooked-up example. Hörmander started working on the Lewy operator (2) with the goal to get a general geometric understanding of a class of operators displaying the same defect of local solvability. The two papers [34], [33], published in 1960, achieved that goal. Taking a complex-valued homogeneous symbol $p(x,\xi)$, the existence of a point (x,ξ) in the cotangent bundle such that

$$p(x,\xi) = 0, \quad \{\bar{p}, p\}(x,\xi) \neq 0 \tag{3}$$

ruins local solvability at x (here $\{\cdot,\cdot\}$ stands for the Poisson bracket). With this result, Hörmander nonetheless gave a generalization of the Lewy operator, but above all provided a geometric explanation for that nonsolvability phenomenon.

A.-P. Calderón's 1958 paper [17] on the uniqueness in the Cauchy problem was somehow the starting point for the renewal of singular integrals methods in local analysis. Calderón proved in [17] that an operator with real principal symbol with simple characteristics has the Cauchy uniqueness property; his method relied on a pseudodifferential factorization of the operator which can be handled thanks to the simple characteristic assumption. It appears somewhat paradoxical that Hörmander, who later became one of the architects of pseudodifferential analysis, found a generalization of Calderón's paper using only a local method, inventing a new notion to prove a Carleman estimate. He introduced in [32], [31] the notion of pseudoconvexity of a hypersurface with respect to an operator and was able to handle the case of tangent characteristics of order two. A large array of counterexamples, due to P. Cohen [18], A. Pliś [73], and later to S. Alinhac [1] and S. Alinhac and M. S. Baouendi [2], showed the relevance of the pseudoconvexity hypothesis for Cauchy uniqueness.

In 1962, at the age of thirty-one, Hörmander was awarded the Fields Medal. His impressive work on PDE, in particular his characterization of hypoellipticity for constant coefficients and his geometrical explanation of the Lewy nonsolvability phenomenon, were certainly very strong arguments for awarding him the medal. Also his new point of view on PDE, which combined functional analysis with a priori inequalities, had led to very general results on large classes of equations which had been out of reach in the early 1950s.

The Microlocal Revolution, Act I

Pseudodifferential Equations

The paper [17] of Calderón led to renewed interest in singular integrals, and the notion of pseudo-differential operators along with a symbolic calculus was introduced in the 1960s by several authors: J. J. Kohn and L. Nirenberg in [53], and A. Unterberger and J. Bokobza in [81]. Hörmander wrote in 1965 a synthetic account of the nascent pseudodifferential methods with the article [36]. A pseudodifferential operator $A = a(x,D)$ with

symbol a is defined by the formula

$$(4) \qquad (Au)(x) = \int_{\mathbb{R}^n} e^{ix\cdot\xi} a(x,\xi)\hat{u}(\xi)d\xi(2\pi)^{-n},$$

say for $u \in C_c^\infty(\mathbb{R}^n)$. The symbol a is a smooth function on the phase space which should satisfy some estimates, e.g., $\exists m, \forall \alpha, \beta$,

$$\sup_{x,\xi}(1+|\xi|)^{-m+|\beta|}|(\partial_x^\alpha \partial_\xi^\beta a)(x,\xi)| < \infty.$$

This type of operator, initially used to construct parametrices of elliptic operators, soon became a key tool in the analysis of PDE.

Hypoellipticity

In 1934, A. Kolmogorov introduced the operator in $\mathbb{R}^3_{t,x,v}$,

$$(5) \qquad \mathcal{K} = \partial_t + v\partial_x - \partial_v^2,$$

to provide a model for Brownian motion in one dimension. Hörmander took up the study of general operators

$$(6) \qquad \mathcal{H} = X_0 - \sum_{1\le j\le r} X_j^2,$$

where the $(X_j)_{0\le j\le r}$ are smooth real vector fields whose Lie algebra generates the tangent space at each point: the rank of the X_j and their iterated Poisson brackets is equal to the dimension of the ambient space (for $\mathcal{K}$, we have $X_0 = \partial_t + v\partial_x, X_1 = \partial_v, [X_1, X_0] = \partial_x$). These operators were proven to be hypoelliptic in the 1967 article [37]: (1) holds with $P = \mathcal{H}$ for the C^∞ singular support. This paper was the starting point of many studies, including numerous articles in probability theory, and the operators $\mathcal{H}$ soon became known as *Hörmander's sum of squares*. Their importance in probability came from the fact that these operators appeared as a generalization of the heat equation where the diffusion term $\sum_{1\le j\le r} X_j^2$ was no longer elliptic but had instead some hypoelliptic behavior. Chapter XXII in Hörmander's book [45] is concerned with hypoelliptic pseudodifferential operators: on the one hand, operators with a pseudodifferential parametrix, such as the hypoelliptic constant coefficient operators, and on the other hand generalizations of the Kolmogorov operators (6). Results on lower bounds for pseudodifferential operators due to A. Melin [60] are a key tool in this analysis. Results of L. Boutet de Monvel [13], J. Sjöstrand [76], L. Boutet de Monvel, and A. Grigis and B. Helffer [14] are also given in that chapter. Chapter XIX in [45] deals with elliptic operators on a manifold without boundary and the index theorem. In the Notes of Chapter XVIII, Hörmander writes: *It seems likely that it was the solution by Atiyah and Singer* [5] *of the index problem for elliptic operators which led to the revitalization of the theory of singular integral operators.*

Spectral Asymptotics

The article [38], published in 1968, provides the best possible estimates for the remainder term in the asymptotic formula for the spectral function of an arbitrary elliptic differential operator. This is achieved by means of a complete description of the singularities of the Fourier transform of the spectral function for low frequencies. The method of proof for a positive elliptic operator P of order m on a compact manifold is using the construction of a parametrix for the hyperbolic equation $i\partial_t + P^{1/m}$, which is formally $\exp itP^{1/m}$, an operator that can be realized as a *Fourier integral operator.*

The Microlocal Revolution, Act II

Propagation of Singularities

The fact that singularities should be classified according to their spectrum was recognized first in the early 1970s by three Japanese mathematicians: the Lecture Notes [75] by M. Sato, T. Kawai, and M. Kashiwara set the basis for the analysis in the phase space and microlocalization. The analytic wave-front set was defined in algebraic terms and elliptic regularity, and propagation theorems were proven in the analytic category. The paper [15] by J. Bros and D. Iagolnitzer gave a formulation of the analytic wave-front set that was more friendly to analysts. The definition of the C^∞ wave-front set was given by Hörmander in [40]. For Ω an open subset of $\mathbb{R}^n$, $u \in \mathcal{D}'(\Omega)$, $(x_0,\xi_0) \in \Omega \times \mathbb{S}^{n-1}$ belongs to the *complement of* WFu means that there exists a neighborhood $U \times V$ of (x_0,ξ_0) such that $\forall \chi \in C_c^\infty(U), \forall N \in \mathbb{N}$,

$$(7) \qquad \sup_{\lambda\ge 1, \xi\in V} |\widehat{\chi u}(\lambda\xi)|\lambda^N < \infty.$$

The propagation of singularities theorem for real principal-type operators (see [75] for the analytic wave-front set and Hörmander's [41] for the C^∞ wave-front set) represents certainly the apex of microlocal analysis. Since the seventeenth century, with the works of Huygens and Newton, the mathematical formulation for propagation of linear waves lacked correct definitions. The wave-front set provided the ideal framework: for P a real principal-type operator with smooth coefficients (e.g., the wave equation) and u a function such that $Pu \in C^\infty$, WFu is invariant by the flow of the Hamiltonian vector field of the principal symbol of P.

Fourier Integral Operators

The propagation results found new proofs via Hörmander's articles on Fourier integral operators [39] and [20] (joint work with J. Duistermaat). It is interesting to quote at this point the introduction of [39] (the reference numbers are those of our reference list): *The work of Egorov is actually an application of ideas from Maslov* [59] *who stated at*

the International Congress in Nice that his book actually contains the ideas attributed here to Egorov [22] *and Arnold* [4] *as well as a more general and precise operator calculus than ours. Since the book is highly inaccessible and does not appear to be quite rigorous we can only pass this information on to the reader, adding a reference to the explanations of Maslov's work given by Buslaev* [16]. *In this context we should also mention that the "Maslov index" which plays an essential role in Chapters III and IV was already considered quite explicitly by J. Keller* [51]. *It expresses the classical observation in geometrical optics that a phase shift of* $\pi/2$ *takes place at a caustic. The purpose of the present paper is not to extend the more or less formal methods used in geometrical optics but to extract from them a precise operator theory which can be applied to the theory of partial differential operators.*

The simplest example of a Fourier integral operator U is given by the formula

$$(8) \qquad (Uv)(x) = \int e^{i\phi(x,\eta)} c(x,\eta)\hat{v}(\eta) d\eta (2\pi)^{-n},$$

where the real phase ϕ is (positively) homogeneous with degree 1 in η such that

$$\det \partial^2\phi/\partial x\partial\eta \neq 0,$$

and c is some amplitude behaving like a symbol. Some operators of this type were already introduced in 1957 in P. Lax's paper [54] as parametrices of hyperbolic operators. A fundamental theorem due to Y. V. Egorov [22] is that FIO are quantizing asymptotically canonical transformations in the sense that

$$(9) \qquad U^* a(x,D)U \equiv (a\circ\chi)(y,D) \mod \mathcal{P}^{m-1},$$

for any symbol a of order m, where χ is the canonical transformation naturally attached to the phase ϕ and $\mathcal{P}^{m-1}$ stands for pseudodifferential operators with order $m-1$.

Local Solvability

After Lewy's example (2) and Hörmander's work on local solvability, L. Nirenberg and F. Treves in 1970 [68], [69], [70], after a study of complex vector fields in [67] (see also the S. Mizohata paper [65]), introduced the so-called condition (Ψ) and provided strong arguments suggesting that this geometric condition should be equivalent to local solvability. The necessity of condition (Ψ) for local solvability of principal-type pseudodifferential equations was proved in two dimensions by R. Moyer in [66] and in general by Hörmander [44] in 1981. The sufficiency of condition (Ψ) for local solvability of differential equations was proved by R. Beals and C. Fefferman [8] in 1973. They created a new type of pseudodifferential calculus, based on a Calderón-Zygmund decomposition, and were able to remove the analyticity assumption required by L. Nirenberg and F. Treves. The sufficiency of that geometric condition was proven in 1988 in two dimensions by N. Lerner [55]. Later in 1994, Hörmander, in his survey article [47], went back to local solvability questions, giving a generalization of Lerner's article [56]. In 2006, N. Dencker [19] proved that condition (Ψ) implies local solvability with a loss of two derivatives.

More on Pseudodifferential Calculus

A most striking fact in R. Beals and C. Fefferman's proof was the essential use of a nonhomogeneous pseudodifferential calculus which allowed a finer localization than what could be given by conic microlocalization. The efficiency and refinement of the pseudodifferential machinery was such that the very structure of this tool attracted the attention of several mathematicians, among them R. Beals and Fefferman [7], Beals [6], and A. Unterberger [80]. Hörmander's 1979 paper [43], "The Weyl calculus of pseudodifferential operators," represents an excellent synthesis of the main requirements for a pseudodifferential calculus to satisfy; that article was used by many authors in multiple circumstances, and the combination of the symplectically invariant Weyl quantization along with the datum of a metric on the phase space was proven to be a very efficient approach.

The thirty-page presentation of the *Basic Calculus* in Chapter XVIII of [45] is concerned with pseudodifferential calculus and is an excellent introduction to the topic. R. Melrose's totally characteristic calculus [62] and L. Boutet de Monvel's transmission condition [12] are given a detailed treatment in this chapter. The last sections are devoted in part to results on new lower bounds by C. Fefferman and D. H. Phong [25]. Chapter XX in [45] is entitled "Boundary Problems for Elliptic Differential Operators." It reproduces at the beginning elements of Chapter X in [35] and takes into account the developments on the index problem for elliptic boundary problems given by L. Boutet de Monvel [12], [11] and G. Grubb [27]. Chapter XXIV in [45] is devoted to the mixed Dirichlet-Cauchy problem for second-order operators. Singularities of solutions of the Dirichlet problem arriving at the boundary on a transversal bicharacteristic will leave again on the reflected bicharacteristic. The study of tangential bicharacteristics required a new analysis and attracted the attention of many mathematicians. Among these works: the papers by R. Melrose [61], M. Taylor [78], G. Eskin [24], V. Ivriĭ [50], R. Melrose and J. Sjöstrand [63], [64], K. Andersson and R. Melrose [3], J. Ralston [74], and J. Sjöstrand [77].

Subelliptic Operators

A pseudodifferential operator of order m is said to be subelliptic with a loss of δ derivatives whenever

$$(10) \qquad Pu \in H^s_{loc} \Longrightarrow u \in H^{s+m-\delta}_{loc}.$$

The elliptic case corresponds to $\delta = 0$, whereas the cases $\delta \in (0,1)$ are much more complicated to handle. The first complete proof for operators satisfying condition (P) was given by F. Treves in [79], using a coherent states method (see also Section 27.3 of Hörmander's [46]). Although it is far from an elementary proof, the simplifications allowed by condition (P) permit a rather compact exposition. The last three sections of Chapter XXVII in [46] are devoted to the much more involved case of subelliptic operators satisfying condition (Ψ), and one could say that the proof is extremely complicated. Let us cite Hörmander in [49]: *For the scalar case, Egorov* [21] *found necessary and sufficient conditions for subellipticity with loss of δ derivatives ($\delta \in [0,1)$); the proof of sufficiency was completed in* [42]. *The results prove that the best δ is always of the form $k/(k+1)$ where k is a positive integer.…A slight modification of the presentation of* [42] *is given in Chapter 27 of* [46], *but it is still very complicated technically. Another approach which covers also systems operating on scalars has been given by Nourrigat* [71], [72] *(see also the book* [28] *by Helffer and Nourrigat), but it is also far from simple so the study of subelliptic operators may not yet be in a final form.*

Nonlinear Hyperbolic Equations

In 1996, Hörmander's book appeared [48]. The first subject which is treated is the problem of long-time existence of small solutions for nonlinear waves. Hörmander uses the original method of S. Klainerman [52]. It relies on a weighted L^∞ Sobolev estimate for a smooth function in terms of L^2 norms of $Z^I u$, where Z^I stands for an iterate of homogeneous vector fields tangent to the wave cone. The chapter closes with a proof of global existence in 3D when the nonlinearity satisfies the so-called "null condition," i.e., a compatibility relation between the nonlinear terms and the wave operator.

The last part of the book is concerned with the use of microlocal analysis in the study of nonlinear equations. Chapter 9 is devoted to the study of pseudodifferential operators lying in the "bad class" $S^0_{1,1}$. The results of Chapter 9 are applied in Chapter 10 to construct Bony's paradifferential calculus [9], [10]. One associates to a symbol $a(x,\xi)$, with limited regularity in x, a paradifferential operator and proves the basic theorems on symbolic calculus, as well as "Bony's paraproduct formula." Next, Bony's paralinearization theorem is discussed: it asserts that if F is a smooth function and u belongs to $C^\rho(\rho > 0)$, $F(u)$ may be written as $Pu + Ru$, where P is a paradifferential operator with symbol $F'(u)$ and R is a ρ-regularizing operator. This is used to prove microlocal elliptic regularity for solutions to nonlinear differential equations. The last chapter is devoted to propagation of microlocal singularities, where the author proves Bony's theorem on propagation of weak singularities for solutions to nonlinear equations.

Final Comments

After this not-so-short review of Hörmander's works on PDE, we see in the first place that he was instrumental in the mathematical setting of Fourier integral operators (achieved in part with J. Duistermaat) and also in the elaboration of a comprehensive theory of pseudodifferential operators. Fourier integral operators had a long heuristic tradition, linked to quantum mechanics, but their mathematical theory is indeed a major lasting contribution of Lars Hörmander. He was also the first to study what's now called *Hörmander's sum of squares* of vector fields and their hypoellipticity properties. These operators are important in probability theory and geometry but also gained a renewed interest in the recent studies of regularization properties for Boltzmann's equation and other nonlinear equations.

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Jean-Pierre Demailly

Lars Hörmander and the Theory of L^2 Estimates for the $\bar\partial$ Operator

I met Lars Hörmander for the first time in the early 1980s on the occasion of one of the "Komplexe Analysis" conferences held in Oberwolfach under the direction of Hans Grauert and Michael Schneider. My early mathematical education had already been greatly influenced by Hörmander's work on L^2 estimates for the $\bar\partial$-operator in several complex variables. The most basic statement is that one can solve an equation of the form $\bar\partial u = v$ for any given (n,q)-form v on a complex manifold X such that $\bar\partial v = 0$, along with a fundamental L^2 estimate of the form $\int_X |u|^2 e^{-\varphi} dV_\omega \le \int_X \gamma_q^{-1} |v|^2 e^{-\varphi} dV_\omega$. This holds true whenever φ is a plurisubharmonic function such that the right-hand side is finite and X satisfies suitable convexity assumptions, e.g., when X possesses a weakly plurisubharmonic exhaustion function. Here dV_ω is the volume form of some Kähler metric ω on X, and $\gamma_q(x)$, at any point $x \in X$, is the sum of the q smallest eigenvalues of $i\partial\bar\partial\varphi(x)$ with respect to $\omega(x)$. This was in fact the main subject of a PhD course delivered by Henri Skoda in Paris during the year 1976–77, and, to a great extent, the theory of L^2 estimates was my entry point into complex analysis of several variables. At the same time, I followed a graduate course of Serge Alinhac on PDE theory, and Lars Hörmander appeared again as one of the main heroes. I was therefore extremely impressed to meet him in person a few years later—his tall stature and physical appearance did make for an even stronger impression. I still remember that on the occasion of the Wednesday afternoon walk in the Black Forest, Hörmander was in a group of two or three that essentially left all the rest behind when hiking on the somewhat steep slopes leading to the Glaswaldsee, a dozen kilometers north of the Mathematisches Forschungsinstitut Oberwolfach.

It seems that Lars Hörmander himself, at least in the mid 1960s, did not consider his work on $\bar\partial$-estimates [13] to stand out in a particular way among his other achievements; after all, these estimates appeared to him to be only a special case of Carleman's technique, which also applies to more general classes of differential operators. In his own words, *Apart from the results involving precise bounds, this paper does not give any new existence theorems for functions of several complex variables. However, we believe that it is justified by the methods of proof.* In spite of this rather modest statement, the paper already permitted

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one to bypass the difficult question of boundary regularity involved in the Morrey-Kohn approach [22], [18], [19], [20]. For this, Hörmander observes that the Friedrichs regularization lemma applies to the particular situation he considers. Also, and perhaps more importantly, Hörmander's technique gives a new proof of the existence of solutions of $\overline{\partial}$-equations on pseudoconvex or q-convex domains, thus recovering the results of Andreotti-Grauert [1] by a more direct analytic approach. We should mention here that Andreotti-Vesentini [2] independently obtained similar results in the context of complete Hermitian manifolds through a refinement of the Bochner-Kodaira technique [3], [16], [17]. One year after the publication of [13], Lars Hörmander published his tremendously influential book *An Introduction to Complex Analysis in Several Variables* [14], which is now considered to be one of the foundational texts in complex analysis and geometry.

It took only a few years to realize that the very precise L^2 estimates obtained by Hörmander for solutions of $\overline{\partial}$-equations had terrific applications to other domains of mathematics. Chapter VII of [14] already derives a deep existence theorem for solutions of PDE equations with constant coefficients. More surprisingly, there are also striking applications in number theory. In 1970, Enrico Bombieri extended in this way an earlier result of Serge Lang concerning algebraic values of meromorphic maps of finite order: if a system of such functions has transcendence degree larger than the dimension and satisfies algebraic differential equations, then the set of points where they simultaneously take values in an algebraic number field is contained in a certain algebraic hypersurface of bounded degree. The proof combines use of Lelong's theory of positive currents with L^2 estimates for arbitrary singular plurisubharmonic weights; cf. [4]. It is crucial here to allow φ to have poles, e.g., logarithmic poles of the form $\log \sum |g_j|^2$ where the g_j's are holomorphic functions sharing common zeroes (the degree bounds were later refined by Henri Skoda [30] and [21]). Using Hörmander's techniques in a fundamental way, Henri Skoda gave further major applications to complex analysis and geometry. In [28] it is shown that analytic subsets of $\mathbb{C}^n$ possessing a given growth of the area at infinity can be defined by holomorphic functions with a precise control of the growth; such quantitative versions of Cartan's theorems A and B had also been anticipated in [14] (see e.g., section 7.6, "Cohomology with bounds"). The article [29], on the other hand, gives an almost optimal L^2 estimate for the solutions of Bézout equations $\sum g_j h_j = f$ in the ring of holomorphic functions (if f and the g_j's are given so that a certain quotient $|f|^2|g|^{-2(n+1+\varepsilon)}e^{-\varphi}$ is integrable, then h can be found such that $|h|^2|g|^{-2(n+\varepsilon)}e^{-\varphi}$ is integrable). This result, in its turn, yields profound results of local algebra, e.g., in the form of a fine control of the integral closure of ideals in the ring of germs of holomorphic functions [5]; see also [31] for more related geometric statements. It is remarkable that algebraic proofs of such results were found only after the discovery of the analytic proof. About the same time, Yum-Tong Siu [26] gave a proof of the analyticity of sublevel sets of Lelong numbers of closed positive currents; Siu's main argument again involves the Hörmander-Bombieri technique.

But the story does not stop there; Hörmander's L^2 estimates also have intimate connections with fundamental questions of algebraic geometry. In fact, Takeo Ohsawa and Kensho Takegoshi discovered in 1987 a very deep L^2 extension theorem: every L^2 holomorphic function defined on a subvariety Y of a complex manifold X can be extended as a holomorphic function F on X satisfying an L^2 bound $\int_X |F|^2 e^{-\varphi} dV_X \le C \int_Y |f|^2 e^{-\varphi} dV_Y$. This holds true provided φ is plurisubharmonic and suitable curvature assumptions are satisfied [24]. The initial proof used a complicated, twisted Bochner-Kodaira-Nakano formula, but it was recently discovered by Bo-Yong Chen [6], [7] that the Morrey-Kohn-Hörmander estimates were in fact sufficient to prove it, while improving the estimates along the way. The Ohsawa-Takegoshi L^2 extension theorem itself has quite remarkable consequences in the theory of analytic singularities, for instance a basic regularization theorem for closed positive currents [9] or a proof of the semicontinuity of complex singularity exponents [11]. Finally, [24] can be used to confirm the conjecture on the invariance of plurigenera in a deformation of projective algebraic varieties [27], [25]: this basic statement of algebraic geometry still has no algebraic proof as of this date! Another very strong link with algebraic geometry occurs through the concept of multiplier ideal sheaves: if φ is an arbitrary plurisubharmonic function, then the ideal sheaf of germs of holomorphic functions such that $|f|^2 e^{-\varphi}$ is integrable is a coherent analytic sheaf; the proof is essentially a straightforward consequence of the Hörmander-Bombieri technique. In general, if $(L, e^{-\varphi})$ is a singular hermitian line bundle on a compact Kähler manifold X, one has $H^q(X, K_X \otimes L \otimes \mathcal{I}(\varphi)) = 0$ as soon as the curvature of φ is positive definite (a generalization of the Kawamata-Viehweg vanishing theorem [15], [32]; cf. [8], [23], [10]). In case $i\partial\overline{\partial}\varphi$ is merely semipositive, one gets instead a surjective Lefschetz morphism $\omega^q \wedge \bullet : H^0(X, \Omega_X^{n-q} \otimes L \otimes \mathcal{I}(\varphi)) \to H^q(X, K_X \otimes L \otimes \mathcal{I}(\varphi))$ [12]. All the arguments use Hörmander's theory of L^2 estimates in one way or the other. Contrary to the exceedingly modest words of Hörmander, the L^2 existence theorem for solutions of $\overline{\partial}$-equations appears to be one of the most powerful theorems of contemporary mathematics!

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Michael Atiyah

I must have met Lars Hörmander in the early 1960s, probably on one of many trips to Lund, where I also collaborated with the other Lars (Gårding). At various stages Hörmander and I discussed elliptic differential equations and index theory. From these discussions and from his book, with its excellent treatment of distributions, I got my education in modern analysis.

Later we overlapped for a year at the Institute for Advanced Study in Princeton. By the time I arrived he had already decided to return permanently to Lund. But before he left he instructed me in the art of log-splitting with wedges, something which every Swedish boy picks up and which I found

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useful later when I acquired a Scandinavian log cabin in the Scottish Highlands.

I think the transition from Princeton to Lund was not easy for Lars. He was at home in the Swedish countryside and culture, but mathematically he was somewhat isolated, despite his fame and his international connections.

Lars had one of the most penetrating intellects I have ever come across. I remember when I was struggling with the linear algebra of Novikov additivity for the signature of manifolds, Lars just disposed of the problem in minutes.

Lars and I met at numerous international conferences. but I remember particularly a joint trip to Japan, where the tall blond Scandinavian towered over all the Japanese (and me), attracting universal attention, particularly from parties of Japanese schoolgirls.

François Treves

This is much too short a space, for me, in which to condense a lifetime of complicated interaction with Lars Hörmander. We met for the first time in February 1958. I had finished the writing of my *thèse de Doctorat* and convinced a (nonmathematician) friend to drive us from Paris to Stockholm, where I was eager to meet Hörmander for a week of vacation in the northern snows. We arrived Saturday night and went directly to Drottninggatan (Queen Street, not pedestrian at the time), where the mathematics department was then located. I wanted to have a feel for the place, but what we saw was a not very wide, brightly lit street in downtown Stockholm with a surprising number of very drunk men ricocheting along the sidewalks, from the tightly parked cars to the walls. On Sunday morning Hörmander picked me up in his Volvo and drove us to the Mittag-Leffler Institute in Djursholm, where he was living. Unbeknownst to me I was the bearer of bad news from Paris: Lojasiewicz had just proved the divisibility of distributions by analytic functions (and much more), while Hörmander had just finished writing his paper on the division of distributions by polynomials (making use of the Seidenberg principle and implying the existence of a tempered fundamental solution for any PDE with constant coefficients).

At the time Hörmander was twenty-six, one year younger than I and already famous. Outside the circle of the participants in the Laurent Schwartz seminar at the Institut Henri Poincaré (a small circle indeed: Lions, Malgrange, Malliavin, Martineau, and a few others), nobody knew me—nobody, that is, except Hörmander. We had exchanged letters since 1956, and Schwartz had asked me to give a couple of lectures at the quarterly Bourbaki seminar on

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With Atiyah and three Japanese ladies in Japan, 1969.

Hörmander's PhD thesis, recently published in *Acta Mathematica*. Those lectures (my first) had been a revelation to me, mainly about the standing of analysis in the mathematical firmament: they had been preceded by lectures in algebra and topology. With my arrival at the podium there was a mass exodus from the large Hermite auditorium. A few people stayed; I remember Claude Chevalley and Henri Cartan among my sparse public—out of pity, I guess, for the novice at the blackboard.

In 1959 Hörmander visited Berkeley (where I had my first job, an assistant professor position), bringing his very novel explanation of Hans Lewy's counterexample to the local solvability of a smooth, nowhere null, complex vector field L—in modern language, the nonvanishing of the Levi form $\frac{1}{2i}\left[L,\overline{L}\right]$ at a characteristic point. This breakthrough was destined to have a determinative impact on my future research, more than I could have imagined at the time. More importantly, from about that date on Hörmander's work was to have an overarching influence on the development of the modern theories of several complex variables and of linear PDE (with ramifications in probability theory). Prior sections of this article by other authors describe the scope of Hörmander's oeuvre, so I will limit myself here to a couple of very personal recollections.

My relations with Hörmander were always courteous and often cordial, even warm, I would say, in the last decades. There was one exception: at a conference in Nice in 1972 on the topic of Fourier integral operators and symplectic geometry, his attitude towards me seemed uncharacteristically cold, and I asked friends what could be the cause. Hörmander had recently submitted a paper to the *Annals* in which he proved a necessary and sufficient condition for a PDE with constant coefficients to have an analytic solution for every analytic right-hand side. That the heat equation in 3D did not have this property had been discovered earlier by E. De Giorgi, who, incidentally, openly

refused to seek a necessary and sufficient condition, *so as not to discourage other mathematicians from getting interested in the problem.* Hörmander's paper had been returned to him for revision on the basis of some—rather mild I was told—objections by the referee. Apparently, Lars had convinced himself that I was the referee, which I was not, and he was showing to common friends a list of twenty points indicative of my personal style. I was never shown the list (nor the referee report!), but someone told me what point #1 was: that my correspondence was always typewritten, which was true. (I am, to this day, curious about the nineteen other "qualities" I shared with the culprit.) Nirenberg told Hörmander that *I had too much respect for him* to be the referee (a well-intentioned exaggeration, perhaps), while B. Malgrange put to me a sweet request: *May I tell Lars that the referee was not born in Europe?.* Bernard, I, and the others knew this to be true.

My last stay in Lund was part of a series of visits by mathematicians to celebrate the final settling, by N. Dencker, of the circle of solvability problems started fifty years earlier with the Lewy example (to which Nirenberg and I had made contributions, as well as R. Beals and Ch. Fefferman, R. Moyer, and, later, N. Lerner). During that visit, Lars took my wife and me on a day tour by car of Skåne: first to Ystad, which I had wished to visit because of Wallander's travails and which turned out to be an old, lovely small town, nothing like what I expected from reading Mankel's novels, and afterwards to Trelleborg, where my wife had worked in her early twenties. She left us to revisit old places. As in every one of my not-so-rare stays in Lund, the weather was splendid. We sat under the trees, two old professors indulging in a bit of nostalgia. That is when I learned that Hörmander had written a number of historical essays on the twentieth-century mathematical developments in which he had participated; they were in the safekeeping of Lund University for publication after his death. One of them, devoted to the $\bar{\partial}$ Neumann problem, had already circulated. Having read it, I was pretty confident that the unpublished ones would be as severely impartial and as valuable to interested historians and mathematicians.

Lars insisted on taking us to the train to Copenhagen the next morning. We both knew that this was the last time, for, though he appeared to be well, it was the tenth year of his illness and he had decided to terminate all medication.

During lunch in Ystad I had mentioned that in the diet to which celiac disease confined me, what I missed most was beer. A few weeks after our return home I received an email from his daughter with a list of gluten-free beers; I have been enjoying one of the brands ever since, for which I am very grateful to both him and his daughter. A minor, but still pleasurable, addition to my mathematical debt to Lars Hörmander.

Sigurdur Helgason

My contact with Hörmander started with my use of his 1963 book, which I used several times in a course on distributions. Already his work was having major impact on the large field of partial differential equations. At that time I was involved in the study of differential equations on a homogeneous space G/K invariant under the natural action of G. Constant coefficient differential operators are the first natural example. While invariant operators in the above sense are plentiful in nature, one's optimism is quickly dampened by Levy's example,

$$\delta_x + i\delta_y - 2i(x+iy)\delta_z,$$

of an operator which is not locally solvable yet closely related to an operator which is left invariant on the Heisenberg group.

At the Institute for Advanced Study in 1964 I had the opportunity of discussing these matters with Hörmander. The same afternoon he came up with the result that if G is a Lie group for which every first-order invariant operator is locally solvable, then G is either abelian or has a normal abelian subgroup of codimension one. This he derived quickly from his necessary condition of local solvability, specialized to first-order operators. The result was also proved by Cerezo and Rouvière with further explicit details.

This was typical of my experience with Hörmander. When asking him a mathematical question, one got back much more than just the answer. Another example of this is my questioning him about the property of a constant coefficient differential operator being a homeomorphism of the space of test functions onto its image. Ehrenpreis's treatment of this question did not convince me. Since I needed this result in my research, I consulted Hörmander. He was optimistic, but the full proof did not emerge until the second volume of his magnificent four-volume opus *The Analysis of Linear Partial Differential Operators*. Theorem 15.4.2 there gives an explicit intrinsic description of the topology of the Fourier transform space $\tilde{\mathcal{D}}$. Since Schwartz's topology of $\mathcal{D}$ is rather complicated, the topology of $\tilde{\mathcal{D}}$ is fairly complicated too. However, the result is powerful and the proof shows the touch of a master, also in the analysis of several complex variables. Since the proof can be reduced so as to need Cauchy's theorem in just one variable, I have found it ideally suited to a course on distribution theory. For example, it leads very quickly to the

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existence theorem $L\mathcal{D}' = \mathcal{D}'$ for any constant coefficient differential operator L.

Gerd Grubb

It was during my PhD studies at Stanford University (completed in 1966) when I first met Lars Hörmander. I did not follow his lectures then, but did so later during summer visits to Stanford in 1967 and 1971. The first time I asked him a question was on the Calderón projector put forward by Robert Seeley in [6], where he kindly explained to me the essentially equivalent construction in his *Annals* paper [3].

Back in Denmark around 1970 I organized an interuniversity study group with the aim of understanding the new results on hypoellipticity; it culminated with Lars's participation in a workshop we organized in Århus in spring 1972 (where some French colleagues also came: A. and J. Unterberger, C. Zuily, M. Derridj). That spring I was also occupied with an honorable task Lars had given me: to be the faculty opponent on the thesis [7] of Johannes Sjöstrand in Lund. (Here he kidded me with the fact that the part I found most strange was the one he had insisted on.)

Besides producing wonderful mathematics himself, Lars had a great influence on the work of all with whom he had contact. He inspired everyone around him to sharpen their efforts and formulations in research questions in analysis, to make simplifications by use of functional analysis such that one would reach the really hard questions that demanded original tricks or new theories. But being in his vicinity did not increase one's feeling of self-importance.

The Danish "hypoelliptic study group" was revived later when we were invited to read preliminary versions of his four-volume treatise [4]. I was allowed a small influence on the chapter on elliptic boundary problems. A particular effort was made by Niels J. Kokholm (who also received special thanks) at the same time as he was working on a thesis under Lars's guidance in Lund. Kokholm and I later carried a large project through [2], but he quit mathematics for more concrete IT jobs after this.

In 1985 we started the Danish-Swedish Analysis Seminar, where Lars and I, together with Anders Melin, organized one-day meetings, alternating between Lund and Copenhagen, once or twice per semester. This made it possible to have a sufficiently large audience for a lot of interesting guests, and it served the whole PDE community in Denmark.

In the 1980s it became possible to write manuscripts in TEX; Richard Melrose brought macros from MIT, and Lars passed them on to me, introducing me to this clever way to master mathematical formulation.

I have consulted Lars on many details in my ongoing research and refereeing jobs and have learned enormously from him; I have also given comments on some of his writings. We made one joint publication [1], on pseudodifferential operators satisfying the transmission condition (preserving smoothness up to a boundary) with symbols in $S^m_{\varrho,\delta}$-spaces, including results on Poisson operators of this type. The work was quite difficult; whenever I wrote something, a formulation or deduction by Lars would usually win over it, but after a lot of work back and forth it ended as a nice informative piece, I think.

A bit uncommonly, Lars detested being the center of a celebration. Therefore he often fled from his home in Lund when a special birthday was approaching. On the other hand, to organize a meeting gives one the chance to invite people in return for their hospitalities. In 1995, when Lars's retirement was approaching, he and I, jointly with Anders Melin and Johannes Sjöstrand, used the framework of the Danish-Swedish analysis seminar to arrange two 3-day meetings [5], where we fit in as many of his good international colleagues as possible, having feasts in Copenhagen and Lund each time. In 2006 (a birthday year) again many visitors came informally to Lund.

On the private side, we shared an interest in the wild flowers of Skåne and Blekinge, in particular rare Nordic orchids. This is a very sad occasion to think back on those years.

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Jean-Michel Bony

I first met Lars Hörmander at the International Congress of Mathematicians (Nice, 1970), but I was already quite familiar with his work. One of my first papers, devoted to sums of squares of vector fields, relied on his result of hypoellipticity. Above all, it is in his book *Linear Partial Differential Operators* that I learned the theory of PDE when I was a student in École Normale Supérieure. I could appreciate then the precision and the concision of his style: a complete exposition in eighteen pages of the theory of distributions, which was at that time the subject of a one-semester course in Paris.

Even though the words were not spoken, one can say that *microlocal analysis* was born at this ICM, with the lectures of Mikio Sato and Youri Egorov, and the plenary lecture of Lars Hörmander. For the first time, Hörmander defined the wave-front set, stated and proved his fundamental theorem on the propagation of singularities, and announced his monumental work (partly with J. J. Duistermaat) on Fourier integral operators.

A few months later I had the surprise of receiving a preprint of L. Hörmander, giving another proof, and an improvement, of my own contribution to the congress (an extension of Holmgren's theorem). I should not have been surprised. If L. Hörmander had been for forty years the foremost contributor to the theory of linear PDE, I think that it is due to three reasons: many outstanding theorems, of course, but also the fact that he gave us fundamental tools such as Fourier integral operators or his successive extensions of the pseudodifferential calculus. The third reason is that quite frequently he rewrote the results of other mathematicians, trying to extend their generality and above all to give proofs which link them to a small number of fundamental concepts and results. All this was converging towards a new treatise on the subject, which he had in mind as early as in the beginning of the 1970s.

I met L. Hörmander rather frequently after that, particularly during two long stays at the Mittag-Leffler Institute, where he organized two one-year thematic programs on PDE. During the first one, in 1974, he looked quite interested in hyperfunction theory, and I can find traces of our talks on this topic in Chapter 9 of his treatise. The manuscript was already quite advanced, carefully stored in three binders (the last volume was divided later), and I remember the clatter of his typewriter between the seminars. Ten years later the second program was mainly devoted to nonlinear PDE, the treatise was completed, and the typewriter was replaced by a noiseless computer.

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My talks with Lars Hörmander were not limited to mathematics. He was fond of French literature, reading in French, for instance, novels by Stendhal and more recently *A la recherche du temps perdu*. He did not like to speak French, probably because his French, though quite good, was not perfect. However, he made an exception for his answer when he was made *Doctor Honoris Causa* of the University of Paris-Sud at Orsay.

The development of the theory of PDE has been and still is a wonderful journey. Without Lars Hörmander, this development would have been certainly much slower, and it could have produced a messy and tangled heap of results and specific methods. We are all indebted to him and will remain so for a long time.

Christer O. Kiselman

Lars Hörmander was appointed professor at Stockholm University College effective January 1, 1957, not yet twenty-six years old. I started my studies there in the fall of 1957 and soon became aware of his existence. The student newspaper *Gaudeamus* published a report from the installation ceremony with the heading "Twenty-six-year-old mathematics machine solemnly installed."

During my first years I had no contact with Hörmander, but I had several teachers who were students of his: Benny Brodda, Vidar Thomée, Göran Björck, Stephan Schwarz, and Lars Nystedt. In October 1960 I talked with Olof Hanner about a possible continuation of my studies, and I mentioned that I would like to have Lars Hörmander as my advisor. Olof was not surprised; he just remarked that the reputation of his young colleague had spread efficiently.

Lars was always available for consultations. One knocked at his door—he could answer any question immediately. I never experienced any difficulty in talking mathematics with him. Most often he was typing articles or chapters of his book, the one which was to appear in 1963. The clattering was intense. He also typed lecture notes, which were mimeographed using the technology of the time. When I left his office the clattering resumed after zero seconds.

Lars lectured on partial differential equations during the academic year 1961–62. These lectures foreshadowed the Springer book that came out in 1963. We, his students, read the manuscript and commented on it. I wrote a licentiate thesis on a problem proposed by him concerning approximation of solutions to partial differential equations with constant coefficients.

During the academic year 1962–63, Lars gave a series of lectures on analysis in several complex

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variables. In this way he started the creation of his book that came out with Van Nostrand in 1966 and which is now one of the most quoted in the area. The organization of the lectures was exactly the one we now see in the book. Holomorphic functions were considered as solutions to differential equations, which was then a new approach for me and which gave powerful construction methods and made generalizations possible. It was a great experience to witness the birth of this book.

During the fall semester of 1963, Lars gave a series of seminars on convex and subharmonic functions. More than thirty years later, in 1994, he published his book *Notions of Convexity*, which takes up these topics with a unified treatment of convex, subharmonic, and plurisubharmonic functions.

Most important were three seminars on L^2-methods for the $\bar{\partial}$ operator, which he gave in the fall of 1963. The results then appeared in *Acta Mathematica* in 1965 in a groundbreaking article.

In 1964 Lars left Stockholm for Stanford and Princeton. He visited Stockholm in May 1965 and gave four lectures on pseudodifferential operators, an area that was then rather new.

Robert Oppenheimer offered me a membership in the Institute for Advanced Study in Princeton, NJ, for the academic year 1965–66. Lars was there then, and of course it was he who had arranged everything for me.

It became a most valuable year in every respect, both mathematically and culturally. I was there with my wife Astrid and our son Dan, who turned two during the fall. We arrived early on one of the first days in July while Lars and Viveka were in Sweden. They let us stay in their house during the summer. As a small service in return, we took care of their dog Shilly-Shally.

Lars gave a series of lectures at the institute with the title "Pseudo-differential operators and boundary problems." This was an elaboration and extension of the lectures he had given at Stockholm University in May 1965. Furthermore, Lars gave a seminar within the framework of the Current Literature Seminar on "The Lefschetz fixed point formula for elliptic complexes." I was in constant contact with Lars during that year and wrote a paper on the growth of entire functions and on analytic functionals. Another valuable contact was Miguel Herrera (1938–84), with whom I studied residue theory.

After that year I had many contacts with Lars concerning complex convexity and fundamental solutions as well as many other topics, especially after his return to Lund in 1968. I was the faculty opponent when his students Arne Enqvist and Ragnar Sigurdsson presented their PhD theses. On the last day of 2010, he sent me a new, strong theorem on the regularity of fundamental solutions, an excellent addition to the results in his four-volume book.

Photograph by Vidar Thomée.

With wife, Viveka, and Airedale terrier Shilly at their house in Princeton, 1965.

Nobody has been so important for my intellectual and scientific development as Lars.

Sofia Broström

My father was born on January 24, 1931, in a small fishing village in southern Sweden as the youngest of five children. His father was a school teacher—originally trained as a painter, he had paid his own way to a teaching degree at twenty-one—who had married a bright farmer's daughter who recalled her few years in school as a highlight of her life. Together they created an atmosphere characterized by a strong thirst for knowledge and education, and all five children graduated quickly from secondary school and then continued with higher education.

My father went through school even quicker than the others: he skipped two years of elementary school, with the result that he graduated with the usual interval of two years between the siblings, although in reality he was four years younger than his youngest sister. Thanks to an enthusiastic teacher in secondary school, Nils-Erik Fremberg, he had also finished the first semester of university mathematics when graduating at seventeen. Despite previous plans to become an engineer like his older brother, this made him decide to continue with more mathematics and physics, receiving his master's degree at nineteen

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With daughter Gisela in Princeton, 1960.

and his licentiate degree (PhD) a year and a half later in October 1951 at age twenty.

At the department Christmas party of that year he met my mother, Viveka. They married while my father was in military service and had their first daughter, Gisela, in October 1954. One year later my father received his doctorate through the dissertation that made him famous. Since my mother had only been able to stay at home to take care of Gisela for the first few months, much of the dissertation was actually written with my sister in his (pulled-out) desk drawer (which was just the right size for the carriage insert). He apparently didn't find this distracting, which was typical of my father—the only effect an interruption seemed to have on his work was the few minutes lost to the actual distraction, nothing more.

It is not for me, however, to give a full biography of my father's life, so let me skip to my own memories of him. I was born in 1965, almost eleven years after my sister, during the Princeton years. I adored my father as a child, and we spent countless hours together building with Legos, doing jigsaw puzzles, playing backgammon and Scrabble (for the latter my mother would also join), or doing carpentry. My father loved to work with his hands, especially with wood, having contemplated a future as a carpenter as a child.

Photograph by Eva Enderlein.

With daughter Sofia, 1971.

Among other things he built a Barbie dollhouse for me with four rooms, each fitted with electricity and completely furnished—my sister also helping with some of the smaller details, like textiles or earthenware. And I loved the weeks before Christmas when he would spend long hours in the basement crafting presents for me—it was frustrating that I couldn't join, but at the same time exciting. One year I was deeply intrigued by screeching sounds coming from the basement. It turned out that he had built the kitchen for the doll house, complete with refrigerator, stove, sink, cupboards, drawers, even a broom closet, and that the strange sounds came from sanding down four coins to make them into stove plates.

I was very fortunate that my father always had a lot of spare time, so much so that my mother used to complain that she couldn't keep up with him, and this was even more so in the summers when he would take long periods away from work. On the island of Askerön off the west coast of Sweden my parents had bought a summer house by the sea, and there we spent much time outdoors together. Either in the forest—a highlight was an osprey nest that we would visit every day for years—or on the sea—my father loved sailing. When I was very young we had a SeaCat, which, to my great chagrin, was later traded in for a much smaller boat for day trips only. We also fished for plaice, with nets, together with a friend and his children.

When not actively engaged with the family or the house, my father would spend his spare time reading. He always read a lot, fiction as well as fact, mostly history or science. He had a very inquisitive mind and loved to learn new things up until the last days of his life. In all this he was much aided by his excellent memory; he seemed unable to forget anything he had learned and, unfortunately, unable to realize that other people did not have quite his powers of memory…he could be quite impatient with me. And I had to be careful when asking him a question: there was always the risk of a long and enthusiastic lecture, containing a lot more information than I wanted. For better or for worse, this seems to have been a heritable trait—my son complains about the same behavior in me.

My father set exceptionally high standards not only for himself but for everyone around him, including of course his children. Needless to say, this was difficult for us, especially until I was

With grandson Sander, 2003.

old enough to realize that he himself was the primary victim of his drive for perfection, not anyone else. He never felt that anything he did was quite good enough and was devastated if he made a mistake. Despite his demands for excellence, he did not, however, have career ambitions for us, just as he lacked such ambitions himself. His first goal when studying mathematics had been to become a teacher in secondary school (something he famously said to my mother on the evening they met), and the promotions and prizes he received in his career were never what he strived for—on the contrary, they weighed him down. He truly wanted us to do whatever we fancied, as long as we did what we did well and were able to support ourselves. He had chosen mathematics solely out of love for the subject and wanted us to do the same in our lives.

He was also a very loyal father. Many times I chose to do things he advised me not to do, but once my mind was made up he was always completely loyal with my decision. For example, my former husband and I bought a rundown house with a large garden despite his warnings. But once he realized that we were really going ahead, he quickly arranged for a generous loan and from day one was a faithful caretaker of the house and garden, effectively sheltering me from realizing what a crazy decision I had made. When he was no longer able to help, the house of course became impossible to keep and has now been sold.

In 1996 my son, Sander, was born, and Lars became a grandfather, something which delighted him no end. I think even more so since my sister had decided to end her life in 1978 at the age of twenty-three. When my son was born he could again see a continuation, a path into the future, and I think that this at least partially restored his peace of mind. And he was overjoyed that he was able to follow Sander all the way to sixteen, even to the publication of his first book (Sander is a photo artist). Before his death my father often said to me that he was content with his life, that it had been a good life. I do believe he died a happy man.

Mathematical Research in High School: The PRIMES Experience

Pavel Etingof, Slava Gerovitch, and Tanya Khovanova

Consider a finite set of lines in 3-space. A *joint* is a point where three of these lines (not lying in the same plane) intersect. If there are L lines, what is the largest possible number of joints? Well, let's try our luck and randomly choose k planes. Any pair of planes produces a line, and any triple of planes, a joint. Thus, they produce $L := k(k-1)/2$ lines and $J := k(k-1)(k-2)/6$ joints. If k is large, J is about $\frac{\sqrt{2}}{3}L^{3/2}$. For many years it was conjectured that one cannot do much better than that, in the sense that if L is large, then $J \le CL^{3/2}$, where C is a constant (clearly, $C \ge \frac{\sqrt{2}}{3}$). This was proved by Larry Guth and Nets Katz in 2007 and was a breakthrough in incidence geometry. Guth also showed that one can take $C = 10$. Can you do better? Yes! The best known result is that any number $C > 4/3$ will do. This was proved in 2014 by Joseph Zurier, an eleventh-grader from Rhode Island [Z].

Here is another problem. Let K and L be convex bodies in space, and suppose that we can hide K behind L no matter from where we look (we are allowed to translate the bodies but may not rotate them). Is it true that the volume of K is at most the volume of L? Curiously, no! Christina Chen, a tenth-grader from Massachusetts, showed in 2011 that the volume ratio can be about 1.16,

Figure 1. PRIMES student Christina Chen is showing a picture of a convex body which can hide behind a tetrahedron of smaller volume (PRIMES Conference, 2011).

the best currently known value ([Ch]; see Figure 1). So, can it be arbitrarily large? No! Christina, Tanya Khovanova, and Dan Klain showed that the volume ratio is less than 3 in any dimension [CKK].

Seriously? Is it really possible for tenth- and eleventh-graders to do original mathematical research?

Yes! Christina and Joseph, as well as over a hundred other students, have done their research at PRIMES (Program for Research In Mathematics, Engineering, and Science; `web.mit.edu/primes`), which we've been running in the MIT mathematics department since January 2011. Every year we receive numerous questions about our program from prospective students and their parents and also from academics who want to organize a similar program. Here we'd like to answer some of these questions, to share our experience, and to tell a wider mathematical community how such a seemingly impossible thing as mathematical research in high school can actually be done.

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What kind of students do you look for? My son was wondering—should he even bother to apply if he doesn't have a perfect score at the IMO and hasn't yet mastered Wiles's proof of Fermat's Last Theorem?

P.E.: If he is in love with math, yes, by all means! Some background (such as calculus) is needed, but generally he will learn along the way under his mentor's guidance. Also, many gifted high-schoolers do well at math competitions, but good researchers are not always quick problem-solvers. It takes time, effort, and perseverance to learn the background and try different approaches, many of which are doomed to fail. We look for students with a talent for mathematical research and a stamina to carry it through, for avid learners, hard workers, and imaginative explorers. And, above all, for those who are crazy about mathematics!

How do you select students? My daughter asks: to get accepted, does she need to be a machine that makes coffee into theorems?

P.E.: Mathematicians are mere humans who make coffee into theorems 10 percent of the time, and into unsuccessful attempts to prove theorems the rest of their lives—and we welcome your daughter to the club!

S.G.: We carefully consider Olympiad scores, statements of purpose, recommendations, and grades, but the pivotal part of the application is the entrance problem set. We post it in mid-September, due in two months.

T.K.: These are not the kinds of problems that one can crack quickly: at first glance, some of them may puzzle even a math professor. Students are expected to think about a problem, consult books and online sources, think again the next day, then again and again, until one day they finally get it and then write a full solution with detailed proofs. This protracted engagement with mathematical problems resembles a research process.

P.E.: In fact, this is similar to my favorite hobby, picking mushrooms. You may run around the woods for hours seeing nothing, and then all of a sudden you find a real treasure. You need patience and ability to enjoy the process and forget about everything else. There is a lot in common between a good mushroom hunter and a good mathematician.

Do PRIMES students work individually or in groups?

S.G.: Most projects are individual and involve one-on-one mentoring. Freshmen and sophomores, however, usually work in groups of two on joint projects. Group discussions make research more exciting and stimulating for younger students and give them a gentler entry into the world of mathematics. Even in individual projects the students are not alone: they collaborate with their mentors and faculty who suggested projects. They form a team in which mathematicians of different levels of experience and seniority become equal collaborators. This way PRIMES students learn the art of collaboration and teamwork.

P.E.: In short, we do have options for both introverted mathematicians (who like to look at their shoes while doing research) and extroverted ones (who prefer to look at the shoes of their collaborator). And, of course, all PRIMES students are encouraged to look at the shoes of their mentors as often as they like!

How do you select projects? Can my student be told to prove the Twin Primes Conjecture in PRIMES?

P.E.: Famous open problems don't usually make good projects, but we don't assign "toy projects" with known solutions either. Students delve into real research, with all its uncertainties, disappointments, and surprises. Finding cutting-edge projects requiring a minimal background is one of the trickiest tasks in running PRIMES. Here are some features we want to see in a PRIMES project:

1. *Accessible beginning.* Presence of simple initial steps to get started.

2. *Flexibility.* A possibility to think about several related questions, switching from one to another if stuck, and to tweak the questions if they are too hard or insufficiently interesting.

3. *Computer (experimental) component.* A possibility of computer-assisted exploration aimed at finding patterns and making conjectures. This way students, who often have strong programming skills, can contribute to the project early, when they don't yet have a working knowledge of the theoretical tools. It is also easier to learn new mathematical concepts, e.g., those from algebra and representation theory, through a hands-on experience with a computer algebra system.

4. *Adviser involvement.* Availability of a research mathematician other than the mentor (usually the professor or researcher who suggested the project) to advise the project through email and occasional meetings. Such meetings make a big difference.

5. *Big picture/motivation.* Connection, at least at the level of ideas, to a wider context and to other people's work.

6. *Learning component.* The project should encourage the student to study advanced mathematics on a regular basis.

7. *Doability.* A reasonable expectation that a good student would obtain some new results in several months to present at the annual PRIMES conference in mid-May and produce publishable results in one year.

8. *Relation to the mentor's research program or area.*

T.K.: A crucial part of research is the art of asking your own questions, not just solving other people's problems. When the students realize that it is in their power to move the project in a new direction, they get very excited and start feeling ownership of the project. The ability to trust

themselves and ask their own questions is very important in their future lives, independent of their career choices. That's why we try to choose projects that develop this ability.

P.E.: Sounds easy? Well, if you have a bit of free time or have nothing better to do (e.g., during an excruciatingly boring math lecture that you can't sneak out of), just try to come up with a project satisfying most of these conditions. And when you do, please send it to us!

Is it true that in PRIMES mathematics equals elementary combinatorics? Do PRIMES students work on elaborate Olympiad problems instead of learning about algebra, topology, geometry, analysis, number theory?

P.E.: Not really. We've had many projects in these fields, especially in noncommutative algebra and representation theory. Also, PRIMES students get exposed to these areas in PRIMES reading groups.

This said, it's true that many PRIMES projects are in discrete math. This is because in this field, it's easier to find interesting projects requiring relatively little initial background. However, they are not just elaborate Olympiad problems. Many of them are designed to touch upon fundamental questions and to encourage learning about other areas with which discrete math has many deep connections. In short, we try to show our students both the breadth and the unity of mathematics.

Noncommutative algebra and representation theory in high school? Touch upon fundamental questions? No kidding? Can you give some examples?

P.E.: You want me to get technical? All right, here you go.

One group of projects concerns representations of rational Cherednik algebras. Let G be a finite group and V be its finite-dimensional representation over a field k. Then one can define the rational Cherednik algebra $H(G,V)$, which is a certain remarkable deformation of the algebra $kG \ltimes D(V)$, the semidirect product of the group algebra of G with the algebra of differential operators on V. For example, if $G = \mathbb{Z}/2\mathbb{Z}$, $V = k$, and the generator $s \in \mathbb{Z}/2\mathbb{Z}$ acts on the coordinate x on V by $s(x) = -x$, then $H(G,V)$ is generated by s, x and the *Dunkl operator* $\partial_x - \frac{k}{x}s$. Representations of $H(G,V)$ are currently a subject of active research.

In [DS] Sheela Devadas and her mentor, Steven Sam, studied lowest-weight irreducible representations of $H(G,V)$ for G being the complex reflection group $G(m,r,n)$ and $V = k^n$ (where $\mathrm{char}k = p$) using methods of commutative algebra. They gave conjectural character formulas for some of them and proved these formulas in a number of cases. In general, this is a difficult open problem. It is not easy even in the case $n = 2$ and $m = r$ (groups of symmetries of a regular polygon); in this case, more definitive results were obtained by PRIMES student Carl Lian [Li].

In [DT] Fengning Ding and his mentor, Sasha Tsymbaliuk, considered representations of continuous Cherednik algebras, which are generalizations of $H(G,V)$ to the case when G is a reductive algebraic group (rather than a finite group). Namely, they considered the case when $G = GL(n,\mathbb{C})$ and $V = \mathbb{C}^n$. They computed the center of $H(G,V)$, classified its finite-dimensional irreducible representations, and computed their characters.

In [KL] Shashwat Kishore and his mentor, Gus Lonergan, studied signature of the canonical Hermitian form on the space $\mathrm{Hom}(M_\lambda, M_{\lambda_1} \otimes \cdots \otimes M_{\lambda_n})$, where $\lambda, \lambda_1, \ldots, \lambda_n \in \mathbb{R}$ and M_λ is the Verma module for the Lie algebra $\mathfrak{sl}_2$. They classified the cases when this form is definite and also applied the signature formula to solve a topological problem: give lower bounds for the number of real critical points of the Gaudin model master function

$$F(t_1,\ldots,t_m,z_1,\ldots,z_n) = \prod_{1\le i<j\le m}(t_i-t_j)^2 \prod_{i=1}^{m}\prod_{k=1}^{n}(t_i-z_k)^{-\lambda_k},$$

where $m = \frac{1}{2}(\lambda_1 + \cdots + \lambda_n - \lambda)$. They also generalized their results to the case of quantum group $U_q(\mathfrak{sl}_2)$ (where $|q| = 1$).

We've also had some other algebraic projects. With Yongyi Chen, Michael Zhang, and their mentor, David Jordan, we studied trace functions on the algebra $A_P := k[x,y,z]/(P)$, where P is a generic homogeneous polynomial of degree d and k is a field of characteristic p [CEJZ]. By definition, a trace function is a linear function on A_P which vanishes on Poisson brackets

$$\{f,g\} := \frac{\partial(P,f,g)}{\partial(x,y,z)}.$$

The problem was to compute the Hilbert series of the space of trace functions, i.e., $h(z) := \sum_{n\ge 0} h_n z^n$, where h_n is the dimension of the space of trace functions of degree n. It turns out that for large enough p, the function $h(z)$ is given by the following peculiar formula:

$$h(z) = \frac{(1-z^{d-1})^3}{(1-z)^3} + z^{d-3}\left(\frac{1-z^{pd}}{(1-z^p)^3} + \frac{d(d-3)z^p}{1-z^p} - 1\right).$$

We found this formula empirically on a computer and then proved it (and generalized to the quasi-homogeneous case) using some algebraic geometry and the theory of D-modules.

Another algebraic project concerned the lower central series of an associative algebra A: $L_1 = A$, $L_2 = [A, L_1]$, $L_3 = [A, L_2]$, and so on. Feigin and Shoikhet showed in 2006 that if A is free in n generators over $\mathbb{Q}$, then $B_2 = L_2/L_3$ is the space of closed differential forms of positive even degree in n variables. With Surya Bhupatiraju, Bill Kuszmaul,

Jason Li, and their mentor, David Jordan, we generalized this result to the case of integer coefficients, expressing B_2 in terms of the de Rham cohomology over the integers [BEJKL]. In another project, Isaac Xia and his mentor, Yael Fregier, studied quotients $N_i := AL_i/AL_{i+1}$ and showed that if A is a free algebra in $x_1, \dots, x_n$ over a field of characteristic p modulo relations written in terms of $x_1^{p^{m_1}}, \dots, x_n^{p^{m_n}}$ and if the abelianization of A is finite-dimensional, then N_i have dimensions divisible by $p^{\sum m_i}$ [FX]. The proof is based on the representation theory of algebras of differential operators with divided powers.

Tired of algebra? Here is a project in combinatorics. A linear equation is r-regular if for every r-coloring of the positive integers, there exist positive integers of the same color which satisfy the equation. In 2005 Fox and Radoicic conjectured that the equation

$$x_0 + 2x_1 + \cdots + 2^{n-1}x_{n-1} - 2^n x_n = 0,$$

for any $n \geq 1$, has a degree of regularity of n, which would verify a conjecture of Rado from 1933. While Rado's conjecture was later verified with a different family of equations, the Fox-Radoicic conjecture remained open. This conjecture (in a generalized form) was proved by Noah Golowich [Go] under the mentorship of László Lovász.

S.G.: This is beautiful math, but sounds like the "prior results" section of our grant proposal. Did you copy-paste it here? This will put the readers to sleep! Tell them what our students do in the form of an exciting game or an engaging story.

P.E.: OK, let me try my best. Every day each Martian gives each of his friends one Martian peso if he is sufficiently rich to do so. What will happen?

This process is called "the parallel chip-firing game" (see Figure 2) and is an important model of dynamics on graphs. Clearly, it is eventually periodic, but as it is nonlinear, one could a priori expect complicated behavior. Yet, Ziv Scully with his mentors, Damien Jiang and Yan Zhang, were able to completely characterize the possible periodic patterns [JSZ]. This is a truly beautiful result!

S.G.: Perhaps this is a good model for funding PRIMES? I suppose this model applies not only to Martian pesos but equally to earthly hundred-dollar bills? Then we just need to make sure that PRIMES has enough sufficiently rich friends.…

P.E.: Well, there is a small catch: according to this model, PRIMES would also have to give out hundred-dollar bills. The total amount of money in the system is preserved, so the salary of the program director would unfortunately have to be zero!

But surely not all your projects are at this high level. I saw that one of them is about "dessins d'enfants." Unless I am forgetting my French, this means "child's drawings." Can this possibly involve serious mathematics?

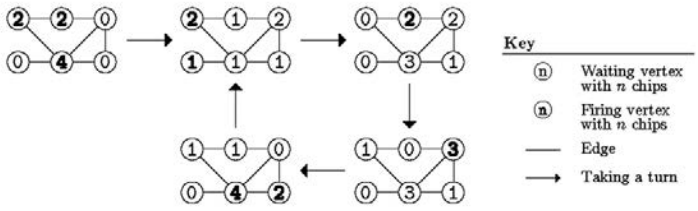

Figure 2. PRIMES project, 2011.

P.E.: In fact, this is one of our more advanced projects! The child here is Alexandre Grothendieck (1928–2014), one of the greatest mathematicians of the twentieth century. In 1984 in his famous "Esquisse d'un Programme," he proposed to study the Galois group $\mathrm{Gal}(\overline{\mathbb{Q}}/\mathbb{Q})$ through its action on the set of finite covers of the complex plane that branch at $0, 1, \infty$. He represented such covers by certain planar graphs which he called "dessins d'enfants." An important problem is to find invariants of covers (or, equivalently, Grothendieck's dessins) that allow one to show that two given covers are not equivalent under the action of $\mathrm{Gal}(\overline{\mathbb{Q}}/\mathbb{Q})$. Ravi Jagadeesan (mentored by Akhil Mathew) found a new invariant of covers which is more powerful than the previous invariants and used it to prove a new lower bound on the number of Galois orbits of a certain type [Ja]. Even though it is about "dessins d'enfants" and the author was in eleventh grade, this result is of real interest to grown-up mathematicians!

How do you match students to projects? Is the matching theory relevant here?

P.E.: Yes. We always manage to find a good matching, all thanks to the counterintuitive mathematical fact that good matchings exist and are easy to find: the Gale-Shapley Stable Marriage Theorem, which says that in the ideal world all marriages are stable. In fact, the only reason the real world is short of ideal is that people don't know enough mathematics!

T.K.: However bright, PRIMES students rarely have an idea of what a suitable project would look like. Many applicants, for example, declare on their application that they want to work on the Riemann hypothesis. Most list number theory as their top interest, which could be the result of PROMYS, Canada-USA MathCamp, Ross, and other programs teaching students advanced number theory. Yet state-of-the-art projects in number theory are usually too advanced for high school students. For this reason, it does not always make sense to follow the applicant's preferences literally.

But we try to glean from the application the true inclinations and strengths of the student and find a project that would let us play on those as much as we can.

Also, an average PRIMES student is a better programmer than an average MIT math professor. And many of our projects have a computational component. So we look at the programming background in addition to the math background when matching projects.

S.G.: Most students end up working in areas they've never heard of before, because that's where the good projects are. Also, we adjust the difficulty of each project along the way, depending on the student's abilities, preparation, and progress. This way every student discovers the joy of proving a new theorem.

How do you find mentors and match them to projects and students? Does PRIMES distract mentors from their research and ruin their careers?

S.G.: PRIMES mentors are typically math graduate students and sometimes postdocs or faculty who show desire and ability to work with high school students. We look for mentors with a knack for teaching and an inspiring personality who can be effective role models. We also try to match projects and students with the mentor's research style, whether conceptual or oriented toward problem solving.

Finally, to make sure that PRIMES does not take a toll on the mentor's career and research, we encourage mentors to suggest projects related to their own work. This not only improves the quality of mentoring but also allows mentors to combine mentoring with research, often leading to joint papers with students. Thus mentors not only receive a supplement to their stipend and acquire valuable advising experience but also add joint papers to their publication record, strengthening their position in the job market.

T.K.: Some mentors say that after teaching high school students how to do research, they finally understand it themselves!

Do you admit students from other states? Other countries? Other planets, planetary systems, galaxies?

S.G.: For the first two years, PRIMES operated as a program for local students. In 2013 we decided to do an experiment. We selected five students in a nationwide search and mentored their research projects over the Internet, using software and hardware tools for online collaboration. The experiment proved to be a success, and the following year we expanded the PRIMES-USA section to thirteen students, including two supervised by faculty from the University of Illinois at Urbana-Champaign. This year the number of out-of-state students rose to fifteen, and to meet the demand we collaborate with faculty from several universities, including CUNY and SUNY at Stony Brook.

The PRIMES-USA section not only provides research opportunities to talented math students across the nation but also serves as a laboratory for testing new methods of distance research mentoring, as well as helps spread the PRIMES approach to other universities in the United States and beyond. Arrangements to open a section of PRIMES in Europe are currently under way.

P.E.: And, yes, PRIMES-Extraterrestrial is presently under construction. Originally our down-to-earth program director was reluctant, but I've convinced him to go ahead. However, alien high school students may well turn out to know more math than MIT professors. So I envision working on proving the Riemann hypothesis under the guidance of a high school mentor from the far end of the Milky Way.…

Is it good for a math student to start research so early? Isn't it better to spend time reading and learning new mathematics?

P.E.: In many cases, it is better, yes. Reading mathematical literature and learning are vital parts of the professional life of every mathematician. They are of key importance at all ages. In fact, one of the greatest mathematicians of the twentieth century, I. M. Gelfand, said at his ninetieth birthday celebration: "I am a student of mathematics."

It is a tautology that learning is especially vital for students. For many students, guided reading is more intellectually stimulating and beneficial than an immediate plunge into research. We carefully evaluate PRIMES applicants and recommend research only for those who are ready. For most younger students we set up reading groups of 2–3 students who study an advanced mathematical book with a mentor. Devoting the first year of PRIMES to guided reading helps students build a foundation for attacking research problems in the following years.

PRIMES research projects are also designed to require learning new mathematics. Before the project starts, students devote one month to background reading, and they continue reading along with research. A research problem provides excellent motivation and environment for learning a new area of math.

S.G.: We also recommend reading groups to seniors, who spend only half a year in PRIMES before going to college. After doing a research project in junior year, PRIMES students often stay in reading groups to expand their mathematical knowledge. We encourage them to explore areas beyond the topic of their research project. This year, 40 percent of local math students at PRIMES are in reading groups, while 60 percent work on research projects.

What's the timeline of your program? Isn't a whole year too long? Do PRIMES students ever get a life?

P.E.: A year is too short! We all know it takes months and sometimes years to prove a good theorem and to write a good paper. And you get a life by getting to do math all this time! One famous mathematician said that to come up with a theorem that's any good, you have to become a sleepwalker for at least several weeks. That's what I've been trying to explain to my wife, admittedly without much success.…

S.G.: The PRIMES cycle runs through a calendar year.

January is the **reading period**: mentors give their students background reading and exercises via email or Skype. In early February we invite all local students and their parents to campus for an orientation meeting, where students meet their mentors and mingle with other students. At this meeting, Pavel shares his tips on doing mathematical research, also available at the PRIMES website.

P.E. This is a really exciting speech, especially for continuing students (given that the tips don't change from year to year, as they have eternal value).

S.G.: The spring semester is the **active research period**. At weekly meetings students and mentors discuss progress and set goals for next week. Meetings nominally last one and a half hours, but often run longer, as students and mentors get excited about new ideas. Students are encouraged to get in touch with their mentors over email midweek or any time they have a question or get stuck.

T.K.: During this period, I periodically check on every project, suggesting adjustments if necessary.

S.G.: The active research period culminates with a presentation at an annual PRIMES conference, held at MIT in May on the last weekend before Memorial Day (Figure 1, Figure 3). Prior to the conference, students prepare a research report, which includes preliminaries, previous results, statement of the problem, and new results. Since the conference comes in the middle of the annual cycle, the students present work in progress. They incorporate feedback received at the conference into their future work. The conference lasts for two days, with talks on mathematics, computer science, and computational biology before a lively audience that includes grad students, postdocs, and faculty. PRIMES students' parents, many of whom are academics or industry researchers, are also invited; they often ask interesting questions and invariably end up thoroughly impressed.

The summer break is the **independent study period**. The student and the mentor coordinate their schedules, meeting when in town, communicating by email when away, or taking a beach break when the weather is good. We also encourage PRIMES students to take advantage of other opportunities, such as attending summer math camps, which allows them to expand their scope and take a break from their project, only to return to it with renewed vigor in the fall.

Figure 3. Pavel Etingof and Tanya Khovanova with PRIMES Conference 2013 participants.

Fall is the **write-up period**. Students meet with their mentors as needed, finalize their project, and write a final paper summarizing their results. This is the time when we can teach our students to write mathematics, which is one of the important goals of PRIMES. Many PRIMES papers are submitted to national science competitions and the MAA-AMS undergraduate student poster session at the Joint Meetings in January.

T.K.: Sometimes by the end of the project the student and the mentor see a big, beautiful conjecture that generalizes their results. This conjecture is like a star shining ahead of them. When the PRIMES year is over, they can't stop, and continue working until they prove their conjecture.

Can students stay for a second year?

S.G.: Yes, every year a number of students stay for another year. This allows younger students to mature as researchers.

An example: Bill Kuszmaul was in PRIMES for four years. Having entered PRIMES in ninth grade, he did two joint projects in years 1 and 2, an individual project in year 3, and a reading group in year 4. Bill authored four papers posted on arXiv.org (two of them published in the *Journal of Algebra* and the *Electronic Journal of Combinatorics*), was a Siemens regional finalist in 2011 and 2012, a 2013 Davidson Fellow, and won Third Prize in the 2014 Intel STS. He is now a sophomore at Stanford.

P.E.: In fact, besides proving many cool theorems, Bill introduced a new English word. In his testimonial, he wrote: "It gave me an incredible feeling to have the paper come together in the final days of it being written, and I came to cherish the feeling of just putting everything in life aside and "primesing" for the rest of a day."

Is high school math research possible outside of PRIMES?

P.E.: Sure. One option is for students to work by themselves, supervised by mentors active in research. Also, there are summer programs offering such opportunities: RSI (for individual projects), PROMYS, Canada-USA MathCamp, and others (for group projects).

Sounds like you have competitors. Is your goal to put them out of business?

P.E.: In fact, our goal is to put as many of them as possible **into** business, and that's exactly why we are answering these questions here. Each year we have to turn down a growing number of strong applicants, which is a pity. We hope that soon there will be more opportunities like PRIMES. These students ought to have a chance to achieve their dream!

How is your program different from RSI, PROMYS, Canada-USA MathCamp, Ross, and other summer programs? Which one should my child choose?

S.G.: The main difference is that summer programs are compressed into a few weeks, while PRIMES operates for an entire year. This allows research at a natural pace, with sufficient time for trial and error, gaining additional background, and writing a detailed text according to professional standards.

T.K.: A few weeks are not enough. My best ideas come to me in the shower. I wouldn't be able to finish research in a summer program, as there aren't enough showers!

P.E.: Exactly. And there isn't enough hot water in the boiler. My wife complains that I leave none for anyone else, and this is expensive and environmentally unhealthy. Perhaps we should figure out a way to balance family and ecological needs with the need to do good mathematics!

S.G.: Well, Archimedes's example clearly shows that a bath, while much less wasteful, can be equally stimulating for a mathematician.

But bathroom issues aside, summer programs give students an excellent experience. They take a variety of short courses and are exposed to a wide range of mathematical topics, useful for further research. And your child doesn't really have to choose! PRIMES has a flexible schedule in the summer, which allows our students to attend summer programs, and we strongly encourage them to do so, as the two experiences reinforce each other. For instance, PRIMES students attending RSI often work there on projects related to their PRIMES projects, which magnifies the effects of both programs and often results in much stronger final papers.

How do you measure success?

S.G.: Every year PRIMES students win many prizes at national science competitions, including the very top ones. For example, in four years PRIMES has claimed twenty-four Siemens and fifteen Intel STS finalist awards. The first and second prizes at Siemens 2014, as well as the first, second, and third prizes for basic research at Intel STS 2015, went to PRIMES. Yet this is not our main criterion of success. A more important one is publications: our students have completed seventy-one papers, posted forty of them on `arXiv.org`, and published fifteen in high-level academic journals. Another criterion is matriculation record: virtually all our graduates go to top universities, where they are among the best students. Finally, the number of applications: in PRIMES-USA, it has tripled in the last two years. But above all, we feel that our mission is accomplished when our students get a taste of genuine mathematical research and fall in love with mathematics.

T.K.: The ultimate measure of success will come in a few years when these kids grow up. They are just amazing! I feel honored to work with the best mathematicians of the future generation.

Is your goal to win the largest possible number of prizes?

P.E.: Not really. We tell our students not to hyperfocus on winning science competitions and explain that mathematical research is about collaboration rather than competition. Yet, competitions are useful as an organizing and motivating factor. They need to write a paper which will be read by judges by a certain deadline, and this makes a difference. Also the Siemens and Intel STS competitions do a great job organizing activities for finalists. They meet and discuss their work with very competent judges, some of them top-level professional researchers in the field of their project. They also learn a lot from each other. And, last but not least, they have a lot of fun!

Do you expect all PRIMES math students to become research mathematicians? If they don't, do you view this as failure?

T.K.: Not necessarily. Some of them may want to do computer science, law, business, medicine, and so on. They come to us because they want to challenge their minds and try to see what math research is like, and this experience is valuable to them whatever career they choose. We had cases when students enjoyed math research so much that they changed their life plans and decided to become mathematicians. And we had other students who realized that they do not want to be mathematicians. They have a gift for mathematics, but their hearts are not there. And it is very useful to discover this before college.

So being sure that one wants to become a mathematician is not a requirement for our program. Intellectual curiosity and willingness to explore are way more important.

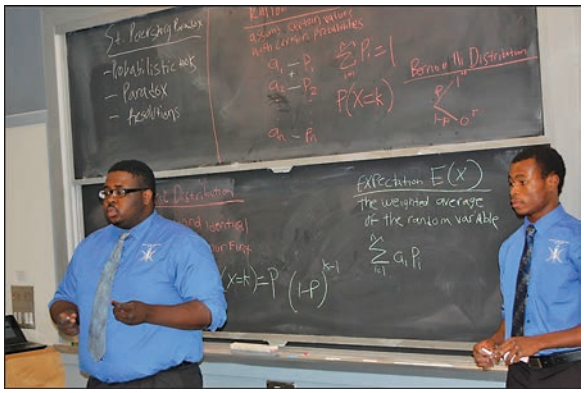

Figure 4. Primes Circle Conference 2013: PRIMES Circle students Omotoyosi Oyedeji and Tyreik Silva are giving a talk about probability theory.

Figure 5. MathROOTS students: (l to r) Josue Sican, Ben Bennington-Brandon, Trajan Hammonds, Adedoyin Olateru-Olagbegi.

What do you do to help diversify the mathematical community?

S.G.: In 2013 we set up PRIMES Circle, a math enrichment program for talented sophomores and juniors from local urban public high schools. Working in small groups under the guidance of MIT undergraduate students, PRIMES Circle participants discover the beauty of the mathematical way of thinking and the thrill of solving a challenging problem. Circle students study advanced topics in geometry, probability, combinatorics, knot theory, and so on; prepare expository papers; and make presentations at a miniconference at MIT. PRIMES Circle has expanded from eight students in 2013 to fifteen in 2015. Of current Circle students 60 percent are female, 27 percent are Hispanic, and 13 percent are African-American (see Figure 4).

In 2015 we organized a new section, MathROOTS, a twelve-day summer camp hosted by MIT for nationally selected promising high school students from underrepresented backgrounds interested in creative mathematical experiences. At MathROOTS students discover new mathematical ideas and learn problem-solving skills through a series of classes, group activities, and invited lectures led by a team of instructors with diverse experiences doing and teaching both research and competition math. (See Figure 5).

The mission of PRIMES Circle and MathROOTS is to increase diversity in the mathematical community by helping strong students from underrepresented backgrounds develop their interest in mathematics and to set them on a path toward pursuing a math-based major in college.

Do students enjoy your program?

S.G.: Every year we collect student impressions of the program and post them on the PRIMES website on the "Testimonials" page. Here are a couple of excerpts:

> "At the beginning of the PRIMES program in January last year, I was mildly nervous that I would not be able to discover anything new. However, such fears were certainly unmerited. During the first few meetings, my mentor provided my partner and me with background readings to become familiar with the common techniques. Within two months, we were formulating some of our own conjectures based on computer simulations, and before long, we were even able to find proofs of some of these conjectures."
>
> "I loved the feeling of being able to sit and think about problems without having anything else in my mind. It was a stress-free environment, and I thrived here. PRIMES is an excellent program—it's a remarkable way to start research at a young age with the help of incredible professionals and mentors who love the math and science that you do and will help you learn more and more. I'm very glad I chose to come to PRIMES, and it has truly changed my life as a student and a mathematician."

T.K.: Many high schools are worried about failing students and do not worry about bright students being bored. In our program no one is bored.

S.G.: Not even the program director! PRIMES has grown almost four times since its creation and currently has well over a hundred affiliates. Its administration and accounting have become as challenging as a PRIMES project!

Who pays for PRIMES?

S.G.: PRIMES is free for students, which is why it is not at all free for MIT. But it is paid for by generous people with big hearts. The biggest hearts belong to the NSF Department of Mathematical Sciences and the MIT math department (personally, its former Head Mike Sipser, currently MIT's Dean of Science, and its current Head Tom Mrowka),

who have provided crucial support since the inception of PRIMES. NIH, Clay Mathematics Institute, Simons Foundation, Rosenbaum Foundation, some companies and private donors have also made major contributions. Notably, George Lusztig, MIT mathematics professor and the recipient of the 2014 Shaw Prize in mathematics, used part of his prize to make a very significant gift to PRIMES as the first contribution to its endowment. This made it possible to establish George Lusztig PRIMES mentorships. Several such mentorships are awarded each year to continuing mathematics mentors for exceptional mentor service in past years.

P.E.: In fact, while we all think hard about math, our program director has to think hard how to find more people with big hearts. And he will definitely appreciate your help!

One of the PRIMES research papers is called "Cookie Monster Plays Games." Is this a serious mathematical paper or is it really about cookies? Do you supply cookies for your research?

Figure 6. PRIMES student Leigh Marie Braswell with the Cookie Monster (PRIMES Conference, 2013).

T.K.: It is entirely serious! The Cookie Monster (Figure 6) is just a fun way to represent a certain class of combinatorial problems. Namely, there are several jars with cookies. In one move the Cookie Monster is allowed to choose some of the jars and take the same number of cookies from all of them. The question "Given the number of cookies in jars, what is the smallest number of moves needed to empty all the jars?" was studied by Leigh Marie Braswell, a PRIMES 2013 student ([BK1]; [BK2]: see Figure 6). With another student, Joshua Xiong (PRIMES 2014), we converted the Cookie Monster problem into a game and made some interesting discoveries [KX].

P.E.: After attending our conference, MIT mathematics professor Richard Stanley observed that a certain breed of Cookie Monster (the one that eats cookies only from consecutive jars) corresponds to the combinatorics of the root system A_{n-1} attached to the simple Lie algebra $\mathfrak{sl}(n)$. In fact, there are rumors that this breed was genetically engineered at my request at the MIT biology department to encourage students to learn about Lie algebras!

S.G.: Even though the Cookie Monster research does not really require cookies, we do supply them during the annual PRIMES conference in May, which you are welcome to attend. In fact, every year, the night before the conference Pavel drives to Costco and fills up his van with cookies for participants. This allows all of us to enjoy many kinds of delicious cookies. They serve as a catalyst for making coffee into theorems!

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Increasing Diversity and Inclusion for Women in STEM

Dandrielle C. Lewis

In Science, Technology, Engineering, and Mathematics (STEM), the representation of women and women of color (WOC) is low because institutions and industries throughout the nation are having difficulties attracting and retaining this specific audience. Contributing factors to the low representation include lack of positive and engaging STEM experiences, negative classroom experiences, lack of self-confidence in their mathematics skills, and "chilly" campus and office climates. For the University of Wisconsin Eau Claire (UWEC), a public undergraduate university, we are addressing these issues, and we are finding success in the recruitment of women and WOC through our Sonia Kovalevsky High School (HS) and Middle School (MS) Mathematics Days.

Sonia Kovalevsky (SK) days are designed primarily to encourage and motivate young girls to pursue higher education, careers, and opportunities in STEM. During this one-day event, we create a "safe-space" learning environment for HS and MS girls, their teachers, and their parents by engaging them in activities that demonstrate that mathematics is FIERCE: Fresh, Innovative, Exciting, Research, Creative, and Eccentric! The overarching goal is to provide our participants with great out-of-classroom mathematics experiences designed to pique their STEM interests and curiosities. This goal is achieved through HS and MS workshops, math geocaching, a "Math Challenges" competition, teacher workshops, a keynote speaker address, a panel of diverse phenomenal women who use mathematics in their careers, and a parent chat with UWEC's STEM admissions counselor.

SK days historically have been funded by the Association for Women in Mathematics (AWM) [6], but due to financial exigencies the AWM [1] `https://sites.google.com/site/awmmath/programs/kovalevsky-days` has not received grant funding to support SK days since 2013. At UWEC, we are sustaining our SK days through secured funding from the Provost, the UWEC Foundation, the UWEC Office of Research and Sponsored Programs, the Equity, Diversity, and Inclusivity fellows, and the Mathematics Department, while simultaneously seeking external support. Having an enthusiastic local organizing committee makes our SK days widely applicable to most public institutions. Our SK days differ from other local SK days in that we also use this venue to promote diversity and to broaden the participation of underrepresented groups and WOC in STEM.

Keys to Success

What makes our SK day unique is the challenge to engage students in their own learning by getting them to think outside the box and use mathematics in fun activities where they are challenged but not judged. Past student participants exclaimed "The workshops were challenging and had me learning all the time." "The workshops made math active and made me enjoy math more." "They give you new skills to take with you by relating skills to things I already understand." Many students particularly enjoyed being able to "listen to people from around the country." They learned that "math and science can be used (in) your daily life" and they learned about "wavelengths" from the Rubens's tube [3] demonstration. Parents responded that the teacher

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workshops impacted their views of math and science "greatly because they now have more resources to help their kids." Teachers said they liked "new information that they can use to find activities for their classroom."

The keys to our success are:

- Involving both UWEC and Eau Claire Area School District (ECASD) communities to create a network for the young girls to help them through critical education transition points.
- Involving colleagues and UWEC administration to ensure that the goals of the event align with the mission and purpose of our university.
- Having a team of organizers, passionate about creating opportunities for women in STEM.
- Involving mathematics and mathematics education majors in designing fun-filled enriching HS and MS workshops and activities.
- Building partnerships with local educators and schools.
- Providing professional development opportunities for teachers and parents. Workshops developed by colleagues in mathematics education.
- Creating an environment where young girls can network with prominent women in the mathematical sciences; and
- Continually seeking ways to assess, improve, and expand recruitment by promoting diversity in mathematics and science.

Each year two mathematics/mathematics education undergraduate majors are selected to work with me on designing mathematics-themed workshops and activities suitable for HS and MS girls. The two students conduct background research on instructional design, research methods to learn the importance of getting participant feedback, and effective methods for underrepresented student recruitment and retention. The designed activities are planned by the students, tested by me, and then pilot-tested in a math methods course with fellow mathematics and mathematics education majors. The activities have been focused on topics in calculus, algebra, geometry, trigonometry, probability, statistics, and permutations/combinations.

Math Challenges Competition

Each SK day we created eight engaging and hands-on math challenges for the girls to complete in groups. The girls were grouped in such a way that there would be at least several girls from each parallel student workshop in the group and an undergraduate volunteer with each group. The undergraduate volunteers were given a bag with a math challenge packet, the solutions to the challenge packet, and the materials needed for the eight challenges. Having volunteers for this activity made it run efficiently, and this allowed us to make sure that each group was given the materials at the same time. Because research shows that girls learn more from hands-on activities, we designed a math competition where the girls would have to use their skills and knowledge of permutations and combinations. After each challenge, the student organizer briefly reviewed the solution to the challenge. If each girl successfully solved their Thinkfun [4] brain teaser (`www.thinkfun.com/rectangle`) before the competition, they earned their team 2 bonus points! The brain teasers were given to each participant at the start of the day.

Keynote, Diverse Panel, and STEM Colloquium

The keynote speaker for each of our SK days has been a WOC in mathematics. The strategy in choosing our keynote speaker is twofold: to expose student participants to people who they may not be exposed to otherwise because of the demographics in Eau Claire **and** to have WOC serve as conspicuous role models for a STEM population that is increasing. In 2014, Dr. Candice Price, an Assistant Professor at the United States Military Academy at West Point and co-founder of the Underrepresented Students in Topology and Algebra Research Symposium USTARS [5] (`www.ustars.org`), discussed her fascination with the way that numbers interacted, cool math tricks, and her journey to a doctorate in mathematics during her keynote address titled "My 'Tricky' Mathematical Journey."

The diverse panel and STEM colloquium, organized by Dr. Carolyn Otto, is made up of five women, including two to three WOC; these women are mathematicians or use mathematics in their careers. The panel is an essential component of our event because our participants are given the opportunity to network with and ask questions of our panelists, who travel from all over the country to share their experiences during the panel discussion. Relevant discussion topics have been: *increasing diversity in STEM* **and** *ways in which HS and MS girls can make contributions* **and** *representation of women in STEM and STEM opportunities for HS and MS girls*. Since participating in our event, two keynote speakers and one panelist have started SK days at their own institutions.

A special STEM colloquium is held for the UWEC community on the evening before the SK day, and during this colloquium, each panelist gives a twenty-minute presentation on his/her research. All students and faculty are: invited to attend, given the opportunity to network with these women, and exposed to research topics being studied across the country. Names of panelists from each year are listed on my web-page [2] `people.uwec.edu/lewisdc/SK_Day_webpage/SK_Day_2015/skday_index.htm`.

Data and Recruitment

Since starting in 2013, significant progress has been made in recruiting for our yearly SK day. This progress is attributed to assessing methods yearly and targeting schools to broaden participation. The most effective methods of recruiting have been through:

- advertisement in school newsletters via partnership coordinators in the ECASD;
- the STEM admissions office, who invited HSs and MSs within a fifty-mile radius of Eau Claire; and
- collaborations with UWEC offices such as the News Bureau, and local organizers appearing on local TV shows.

This year our organizing effort broadened to more effective recruiting of underrepresented groups. Through the UWEC Somali Immersion program, an ongoing partnership and Immersion Experience (IE) between UWEC and two predominately Somali schools in Minneapolis/St. Paul (MSP) Minnesota that has existed for five years, I met with teachers at a Somali community MS. The teachers of the Somali students brought a bus of twenty young girls to participate in our event. For many of the girls who attended from MSP, it was their first trip to a UW school and Eau Claire, Wisconsin. The teachers were excited about making this SK day a regular event for their students. The funding for this trip was supported by UWEC.

To reach underrepresented groups for participation, explore various avenues depending on the demographics in your community. For example, many universities have IEs to promote understanding of diversity, and contacts with other schools and communities are essential to successful IEs. I suggest contacting the facilitators of the IEs and asking them to connect you with their contacts; participating in IEs to broaden participation; recruiting in areas with large underrepresented groups; and working with advocates who desire to increase diversity in STEM. These suggestions made our recruiting efforts more effective.

The number of participants who registered and attended our event each year is given in Table 1. All participants in 2013 were Caucasian, and the ethnicities of the participants in 2014 were Asian, Caucasian, Hispanic, and Native American. In 2015, our recruiting was expanded to MSP, and the ethnicities of the participants were African-American, Asian, Caucasian, and Hispanic. Many students commented that they enjoyed "meeting new people and working in teams and groups with different kids." These comments show that we are positively impacting these young girls by equipping them with collaboration, problem-solving, and networking skills that allow them to experience, first-hand, the power of mathematics and its limitless possibilities. Tables 2 and 3 demonstrate ethnicity participation for SK days 2014 and 2015.

Table 1. Sonia Kovalevsky Day Participation.

Year	Registered	Attended
2013	24	12
2014	89	64
2015	116	80

Table 2. Ethnicity for Sonia Kovalevsky Day 2014.

Ethnicity	Percentage
Asian	2 percent
Caucasian/White	93 percent
Hispanic	3 percent
Native American	2 percent

Table 3. Ethnicity for Sonia Kovalevsky Day 2015.

Ethnicity	Percentage
African American/Black	20 percent
Asian	4 percent
Caucasian/White	66 percent
Hispanic	4 percent
Other	2 percent
Prefer not to answer	4 percent

Conclusion

UWEC SK days are doing much more than teaching young girls that mathematics is fun and accessible. We are changing the cultures at our schools, and we are exposing young girls to people they would not have had a chance to interact with otherwise because of the demographics of Eau Claire. Participation of women and WOC in STEM is being broadened by teaching girls and young women that diversity in mathematics **does** exist and that gender, appearance, and ethnicity should play no part in dampening their educational or their career goals; they **can** be the next prominent female mathematicians, the next women in STEM.

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Book Review

Van der Waerden in the Third Reich

Reinhard Siegmund-Schultze

The Scholar and the State. In Search of Van der Waerden
Alexander Soifer with forewords by Dirk van Dalen, James W. Fernandez, Branko Grünbaum, Peter D. Johnson, Jr., and Harold W. Kuhn
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Bartel L. van der Waerden (1903–1996), the Dutch mathematician best known for his textbook *Moderne Algebra*, was a professor in Germany during the entire period of the Third Reich (1933–1945). Later, he was heavily criticized for not leaving Germany. What exactly was his attitude toward the Nazi regime, and after the war, how did he explain his decision to stay? Seeking an answer to such questions requires deep understanding not only of Van der Waerden the man, but also of the history of the turbulent times in which he lived and of the social and mathematical milieu in which he worked.

It is exactly these questions that Alexander Soifer addresses in his book *The Scholar and the State. In Search of Van der Waerden*. While the book is in many ways an admirable effort, it is also deeply flawed, exhibiting insufficient understanding of the historical and political era of Van der Waerden and of the languages he spoke, and lacking proper attribution to other work on which the book depends. The topic clearly resonates with Soifer, both politically and emotionally, driving him to amass a tremendous amount of material and to endow the book with great passion. Unfortunately, that same passion has compromised his objectivity and judgment.

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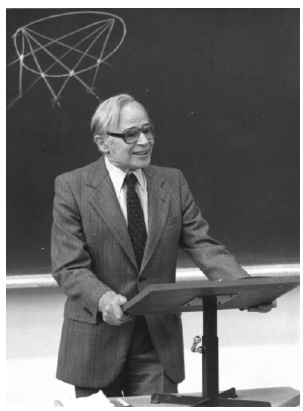
Van der Waerden, Post–1933



Author: Gerd Fischer, Source: Archives of the Mathematisches Forschungsinstitut Oberwolfach.

Bartel L. van der Waerden

Starting in 1933, thousands of Germans, many of whom had been arbitrarily defined by the Nazis as "Jews" and thus excluded from society, had to leave their country. They saved their lives, but they lost their positions and their homeland. Most of the émigrés were closely attached to the German language and culture, and only a few of them spoke English. If one seriously recognizes the hardships they endured through emigration, one should also acknowledge that the "non-Jewish" Germans, even if they despised the Nazis and even if they had alternatives abroad, had good reasons to stay. In fact, very few of the latter left unless expelled by force.

Van der Waerden (henceforth VdW) was not German, but he had long connections to Germany, particularly Göttingen. His wife was Austrian, he became a professor in Leipzig in 1931, and the book that made him famous—his *Moderne Algebra* (1930/31)—was written in German. Although he had offers from America, VdW decided to stay in his adopted country of Germany. The exciting scientific atmosphere in Leipzig, with Werner Heisenberg and later Eberhard Hopf, plus a low teaching load, contributed to this decision.

In a quagmire of denunciation, careerism, and terror, increasingly directed not only against Jews but also against political dissenters, VdW tried to keep his moral values. Traces of resistance against the Nazi regime not only are documented by VdW's warm and courageous obituary for his Jewish teacher Emmy Noether, published in 1935 in the *Mathematische Annalen*, but can also be found in his less public protest against the dismissal of Jewish colleagues in Leipzig, discussed in

chapter 15, "One Faculty Meeting at Leipzig" (pp. 113–139) of the book under review.

After the collapse of the Hitler regime in 1945, embittered émigrés and traumatized Dutch compatriots, mostly politicians and students rather than colleagues, attacked VdW for having stayed in Nazi Germany. Absurd alternatives were presented to him, such as that he should have gone into the Dutch underground and left his family behind. VdW reacted with indignation, as well as with tactlessness and naiveté. He misrepresented his nonemigration retrospectively as a deliberate decision aimed at protecting German culture against the Nazis.

Predictably, this confrontation did not prepare the ground for VdW to be self-critical about his behavior in the Third Reich. By turning down the offer of a full professorship in Baltimore (USA) in 1948 (a fact discovered by Soifer), where he had stayed for one year, and returning to the politicized and socially insecure atmosphere of Amsterdam, VdW confirmed his strong emotional attachment to Europe and to the two languages he knew best. No doubt this attachment had also influenced his decision in 1933 to turn down an offer from Princeton, a decision that thus appears more understandable in hindsight. After returning to Amsterdam in 1948, VdW and his family still had to cope with attacks by compatriots. So it did not come as a surprise that VdW seized the first opportunity of an offer, in 1950, of a professorship in the relatively apolitical, German-speaking city of Zürich, where he and his family were protected from further attacks.

Moral Impulse and Historical Judgment

The facts just described were basically known when, in 2004, Alexander Soifer, Professor of Mathematics, Art & Film History at the University of Colorado at Colorado Springs, began to publish about VdW's political biography. Soifer's writings appeared initially in his own journal *Geombinatorics*, which was largely protected against professional historical criticism.

Soifer has strong political and emotional motivations. He writes in a direct, easy-to-read style, at times becoming patronizing and at times including fictitious dialogues with the readers and with the mathematicians described. With no less than five enthusiastic prefaces, written by (mostly not historically trained) colleagues, the book receives much credit in advance. A tendency of self-congratulation can be found everywhere in the book.

In his book Soifer rarely goes into VdW's mathematical accomplishments. His previous book (2009), from which he reproduces much material in the book under review, intertwines more closely both aspects, the social-political and the mathematical (for a rather critical review in English see Ziegler (2014)). The title of Soifer's book is very apt, because it stresses the political dependence of publicly financed science both under dictatorships (Germany) and under democracies (Netherlands) and thus gives the book a broader focus.

Soifer is disgusted by apologetic biographical accounts and self-representations of Nazi mathematicians such as Helmut Hasse (pp. 190–194) who said, in a 1939 letter circulated widely among mathematicians in the US, that there was "war between the Germans and the Jews." In his book Soifer repeatedly criticizes the "Mathematik über Alles" (mathematics above all) ideology, which denies the moral responsibility of mathematicians in modern society. Soifer frequently alludes to his own experiences as an émigré from another dictatorship, the Soviet Union. He is also critical of the post-WWII McCarthy-era witch-hunts in the US. The reviewer sympathizes with this moral impulse and deems political positions and actions of scientists as legitimate themes of historical research.

Because VdW was obviously not a Nazi, one needs a great ability for nuanced historiographic analysis in order to understand his behavior in the Third Reich and to come to critical, but nevertheless just, conclusions. Soifer adopts this task enthusiastically and claims the attitudes of a professional historian (p. 255 "my first allegiance as historian"). He is less than satisfied with the work of many contemporary historians of mathematics (p. 48 "a thorough historian of mathematics (if such an endangered species exists)").

Soifer therefore has to be critically judged according to his own standards. On the positive side, he has shown great perseverance in searching for biographical material on VdW, inducing various historians to share with him their partly unpublished research and to provide him with translations of texts written in languages (Dutch and German) that he can read only partly, and encouraging various archives to send him copies of unknown material. The most impressive and newest material the book has to offer are Dutch documents, several from VdW's family, that shed light on his early life before he went to Germany in 1925, on his contacts with his Dutch compatriot Peter Debye during the 1930s, and on the aftermath of the war. Although known in general terms, this part of VdW's life has never been documented in detail before (except in Soifer's own previous publications). VdW's rejection of an offer of a chair in Utrecht in 1944 is aptly described by Soifer as missing "the last chance to distance himself from Nazi Germany" (p. 178). The "dialog in letters" in chapter 26 (233ff.) between VdW and Johannes van der Corput, who had a leading role in the re-organization of Dutch mathematics after liberation, gives fascinating insight into the post-war psychology of Dutch mathematicians and of VdW. Throughout, the book carries attractive illustrations including facsimiles and documents

from the family's possession. The most impressive may be the two juxtaposed pictures of the Van der Waerden family of five in exactly the same position around the table in their living room in Amsterdam in 1916 and in 1925 (pp.18/19).

Despite these positive aspects, the reviewer cannot hide his impression that the book is not, and could not be, fully successful. The main reason is that the author has never been immersed in the two cultures most important for the book, the Dutch and the German, and he does not know the history and the languages of the two countries well enough. While modern mathematicians usually cannot be expected to read languages other than English or their native tongue, and probably do not need to, the historian should be held responsible to read his sources or at least to get dependable help from native speakers. As is clear from the very restricted bibliography, which contains exceedingly many emails from correspondents who supported his research, Soifer bases his work on very little secondary historical literature.

The main problem with Soifer's historical judgments lies in the fact that he reads the history of the Third Reich very much from its end, from Auschwitz, insinuating knowledge of the Holocaust in individuals who, in reality, were gradually drawn into a criminal system. He thus falls back into some clichés about the Third Reich long thought to be overcome in the historical literature. Formerly, acts such as signing declarations of loyalty to the "Führer" Hitler (see facsimile p. 105 in VdW's case) had been considered as important markers of "collaboration". However, starting in 1933, such declarations had to be signed even by Jews, such as the mathematician Issai Schur, if they wished to (at least temporarily) keep their positions—and they did sign. It goes without saying that people under the Nazis who were not willing or not flexible enough to adapt to these rituals (for instance the mathematician Ernst Zermelo in Freiburg) and who suffered as a result deserve our respect and sympathy. Like everybody else, VdW was forced by the Nazis to provide proof that he was "Aryan". Soifer calls VdW's compliance "not noble" (p. 89). But how about all the Jewish Germans who desperately tried to hide their Jewish ancestry in order to evade dismissal? Not noble? Or the political dissenters (Liberals, Social Democrats, Communists) who tried to downplay their political role during the Weimar Republic? Not noble, too? This borders on blaming the victims. Instead Soifer should have referred to the fact that these devilish Nazi stipulations would draw even anti-Nazis such as VdW gradually into the system, and that these measures were bound to produce feelings of privilege and of guilt and led to compromise.

It seems surprising that this lack of sensitivity should be found in a person brought up under the Soviet regime. Or perhaps not so surprising: Historians agree that the latter regime became much less repressive after Stalin and certainly much less terrorist than the Nazi regime. The reviewer, who lived in East Germany until 1989, can confirm this from his own experience. But this shows the dangers of judging from one's own experience alone and not studying conscientiously the historical period under investigation. Deeply disturbing for a German reader is when Soifer unfavorably compares VdW's wish to be cleared from the suspicion of being Jewish with the alleged behavior of the eighteenth century historical figure Jud Süss. The latter became the main character both in a 1925 novel by Lion Feuchtwanger (who was forced into emigration in 1933) and in the infamous Nazi propaganda film by Veit Harlan made during the war. Soifer attaches Nazi terminology to Jud Süss ("in reality he is Aryan", p. 89) and betrays that he is unaware of the differences between religious and racist persecution of Jews and the role of conversion to Christianity before the Nazis came. Soifer manages not to mention the Harlan film at all.

Problems with Historiographic Methodology

Throughout the book the level of accuracy of documentation leaves a great deal to be desired, which may be partly explained by poor editing on the part of the publisher. I will now present some examples from the book that illustrate these problems. After brief remarks about VdW's youth and study in Amsterdam, the book goes very quickly to his time in Hamburg, where he attended Emil Artin's algebraic lectures in 1926. Soifer's chapter "The Story of The Book" raises the interesting question of why the original plan that Artin and VdW would co-author *Moderne Algebra* was not realized. As is well known, VdW became in the end the sole author of this influential book, duly acknowledging on the title page that in writing the book he used lectures by Artin and Emmy Noether. This acknowledgment also appears in the second edition, which was published in 1937 during the Nazi years and during Artin's emigration. Soifer is justified in expressing doubt about VdW's explanation in hindsight (1975) that Artin was "perfectly satisfied" with VdW's draft and that he had asked VdW, "Why don't you write the whole book?" (p. 39). But Soifer now begins to fabulate and claims without evidence that Artin was "dissatisfied" with VdW's draft (p. 40), that there was even an "explosion" on Artin's side and a "refusal to write *his* [Soifer's emphasis] book with this student." (p. 43). It does not help that Soifer mistranslates a letter written by Richard Courant to VdW in 1927, which could have given some basis for cautious interpretation. In this letter, Courant reports about a message received from Artin, which is not specified but seems to refer to a conflict between

the two prospective authors, Artin and VdW. Soifer publishes the letter in German facsimile (p. 41), but he mistranslates "Hoffentlich haben Sie sich nicht geärgert" as "I hope you have not angered him"; the correct translation is "Hopefully this did not anger you." Soifer interprets this as being in accordance with a remark that VdW made much later in 1993, namely that VdW expected Artin to contribute in equal measure to the manuscript (p. 43). Soifer now brings in his own experience as a mathematical author and seems to be critical of VdW's alleged pushiness that finally led to him being the sole author.

What is not mentioned in Soifer's discussion is that VdW, at least in his later years, had second thoughts about having become famous only for this influential textbook while his real research in algebraic geometry had comparatively less impact on mathematics (Schappacher 2007, p. 249). This sheds a possible light—in the opinion of the reviewer—on the question of why Artin finally did not become a co-author: it might have been that he was simply more interested in his research than in writing textbooks. Soifer draws a comparison between the Artin-VdW "affair" and the often-discussed and criticized Göttingen mathematicians' habit of "nostrification", or of using mathematical results by others (foreigners, assistants, etc.) and publishing them under their own names. Basing his discussion on Constance Reid's biography of Courant, Soifer criticizes Courant for supporting "nostrification" by exploiting students for his publications. But this leaves open the question of why Courant then did not support Artin's rights vis-à-vis VdW, who was the "underdog" in that relationship. Was VdW himself already sufficiently "nostrified" that he could count in Courant's eyes as a Göttinger?

Soifer uses the occasion to criticize Courant for continuing his bad habits of nostrification during his American exile. Here one can notice that Soifer's enthusiastic and suggestive style has its dangers. In a typical manner, he writes about the book by Courant and Herbert Robbins *What is Mathematics?*: "I hold in front of me a copy of its first 1941 edition.… The preface is signed by Courant alone and nowhere even mentions Robbins." (p. 45). Persuaded by the emphatic writing style, the reader is unlikely to check the veracity of this upsetting claim. But such a check reveals that almost an entire paragraph is devoted to Robbins. A few lines below, on the same page, Soifer writes, again using Reid as a source, that Courant handed Robbins for his collaboration "from time to time…a modest check." In fact, Reid, based on an interview with Robbins, had talked about a "personal check" without any mention of an amount. Criticism of Courant is surely justified but it is not the task of the historian to further embellish or (in this case) darken the facts.

In many cases Soifer reproduces material that was previously published in German without mentioning the source. For example, he devotes chapter 10 to a topic discussed in my 1998 book, namely, VdW's opposition to Richard Brauer's publication of an algebra textbook, which as a consequence failed. Unfortunately, the new discussion remains incomplete because Soifer does not emphasize that VdW and the Jewish émigré Brauer belonged to distinct and somewhat opposed algebraic schools. Exploring this dimension would have enabled the author to look more broadly at the effects of Nazi rule on mathematics and how VdW partially benefited from staying in Germany. In connection with VdW's decision of 1933 to turn down an offer from Princeton, Soifer tells the reader that he had heard about it only "from the grapevine…but no evidence has ever been published." (p. 97). Then he presents his interesting additional findings from the Princeton mathematical institute, but he also republishes (p. 104), without mentioning the source, part of an undated 1933 letter by VdW to Courant, which appeared in my 1998 book and of which I sent him a copy as well. In Soifer's English translation, the passage that contradicts Soifer's claim about the "grapevine" is: "I believe I will suggest to the Americans that this time they could spend their money better than to get me out because I still have a position that I can keep." The reader does not see the original letter and therefore has no way of knowing that Soifer has mistranslated "in dieser Zeit" as "this time"; the correct translation is "in these times". The mistranslation obviously distorts the meaning.

Quite often the author quotes already published work by archival call numbers without mentioning previous publication or specifically acknowledging help from colleagues. Maybe he thought he had covered himself by the general acknowledgement of help at the beginning of the book. Soifer thus creates the impression that, as a historian would usually have done, he has made systematic studies in these archives and selected the material from extensive sources. This is not only unfair toward colleagues who earlier published the material but it also deprives the reader of seeing the quoted passages in their original languages and thus checking the translations. The most benevolent interpretation here is that Soifer, in trying to cope with masses of material, somehow lost track of their origins.

The transcription by the author of the archival material at his disposal is not always reliable either. On p. 253, Soifer magisterially corrects passages from VdW's clearly faulty English letter to Courant from December 29, 1945. Soifer does this from a copy that I gave him, a fact he does not mention. In the original is VdW's important and clearly legible admission: "I have made some mistakes. But I have never pactified with the Nazis."

The German reader would immediately recognize from the German word "paktieren" that VdW wanted to say: "I never made a pact with the Nazis." Instead of simply quoting the original (maybe with a question mark beside the obvious mistake in the English) Soifer writes: "I have never pacified the Nazis."

German secondary literature is often treated carelessly by Soifer, if not ignored altogether. He took the central document of his chapter 27 from Martina Schneider's important book on VdW's work on quantum mechanics (2011). The document is a revealing undated letter that VdW wrote shortly after the war to his compatriot and historian E. J. Dijksterhuis. Here one finds the most self-critical statement that VdW seems ever to have made: "There still remains this one complaint, that I have assisted the Germans through my lectures. I know in the bottom of my heart that this complaint is just." (p. 257)

Soifer mentions Schneider's book, but he does not give a page number where the above-mentioned letter appears and does not include the book in the bibliography. He does not inform his readers that, unlike in his own book, Schneider's book reproduces the Dutch original of the letter as well. (In general, this reviewer would liked to have seen the originals behind Soifer's translations from Dutch too, after having seen his translations of German quotes.) It hurts the serious historian to see Soifer treat such meticulous work so carelessly. Instead, he uses this occasion, while making only passing reference to Schneider's fine and scholarly book, to boast about his own historiographic methodology, pointing to the fact that he included in his translation of VdW's letter a few (in fact not very important) passages that VdW had struck out in the draft. Soifer could have learned much more from Schneider's book, for instance (Schneider p. 161) that VdW in 1933 signed a petition against Courant's dismissal, a fact that escaped Soifer (p. 89). Schneider refers to Soifer's publications on VdW since 2004 in detail. She is partly critical of them but recognizes Soifer's findings of new sources. While Schneider's book concentrates on the mathematical theory of quantum mechanics and group representations, she uses for the more political passages much scholarly literature. For instance, she uses literature on the general history of Dutch science and society, mostly written in Dutch, such as works by Alberts, Berkel, Bertin, Fühner, Harmsen, Heijmans, Hirschfeld, de Keizer, Klomp, Knegtmans, Maas, Meertens, Willink. It was no trivial effort for Schneider, who is German, to read the Dutch. All literature of this kind is missing from Soifer's account, with the exception of two books in Dutch by Peter J. Knegtmans, a historian at Amsterdam University, who has apparently explained the content of these books to Soifer in English in six emails that are in the bibliography. However, Soifer's popular and opinionated account would have very much benefited from secondary literature of exactly that kind, which would have provided broader historical background.

Relevant Publications Overlooked

A reviewer should judge a book above all for the intentions of the author and not for what it should contain. Toward the end of his book Soifer points rightly to the fact that a (political) biography of VdW has to remain a "report on research in progress" and cannot treat all possible topics completely (p. 435). However, it seems legitimate for the reviewer to point to published sources that the author could have used for his investigation and that would have served him in answering his questions. One important source that Soifer does not use, although its topic is crucial for his inquiry, is the German collection with the telling title '*Foreign*' *Scientists in the Third Reich*, by Dieter Hoffmann and Mark Walker (2011). This collection would have aided Soifer's discussion of the role of VdW's compatriot, the physicist Paul Debye (chapter 11). It also contains my extensive paper on VdW's role in the Third Reich. From it Soifer could have gathered, among other things, the following information: An analysis of the text of VdW's obituary of Emmy Noether in the *Mathematische Annalen* (1935); the correct transcription of VdW's English letter to Courant from 1945; the changing conditions of reception of *Moderne Algebra* during the Third Reich and thus reasons for the differences in the various editions of that book, noticed but not analyzed by Soifer; VdW's second thoughts about his textbook as mentioned above; and several crude utterances by VdW from 1967 concerning mathematical talent in Jews as opposed to non-Jews. On the latter two, Soifer could have found information already in publications by Norbert Schappacher, among them an article in English from 2007 on VdW's work in algebraic geometry, which are not mentioned in Soifer's book.

To his credit, Soifer occasionally quotes alternative, counterbalancing views, as expressed for instance in testimonies by VdW's son Hans. In a letter to Soifer that Hans van der Waerden wrote about his Austrian mother and grandmother, it clearly transpires that the two were much more prone to falling into the traps of Nazi propaganda than was VdW himself (p. 427). If, however, one takes seriously feminist criticism according to which many prominent scholars rely totally on their wives for their physical and mental well-being, for their careers, and for the up-bringing of their children, it should not astonish that these same prominent scholars, in turn, have to take into consideration their wives' political feelings (and possibly their ignorance), including their preferences for where to live. Don't get me wrong: criticism of VdW's be-

havior in the Third Reich and, in particular, of his post-war apologia is legitimate. It is, however, the historian's task to discover the deep and nuanced reasons both for adaptation under the regime and for apologia afterward.

Conclusion: Merits and Limits Again

Soifer has collected, with substantial help from colleagues, a great deal of new and interesting material. He has seriously tried to give a convincing description of VdW's political behavior in the Third Reich and in the years before and after the regime. However, for someone who has not been immersed in the cultures in which VdW lived, who does not know the languages well and who has no training as a historian, it would have required superhuman abilities to succeed. Deficiencies in the immersion in foreign cultures create dependencies on other people's work that at the very least should result in clearly acknowledging that work. I am not sure Soifer was able to cope with this latter problem—or that he drew the proper conclusions from his discussion of Courant's "nostrification." In the end, VdW comes out of the book neither as a hero nor as a villain, which is not wrong as a rough estimate. But this is not necessarily a nuanced picture.

For all the criticism I have felt obliged to express I still have to admit that I am glad to have the book, which contains much interesting and hitherto unknown material. As a German, I am probably in a somewhat better position to understand the material than are non-Germans. I am not sure this book works for the general readership for which it is no doubt meant.

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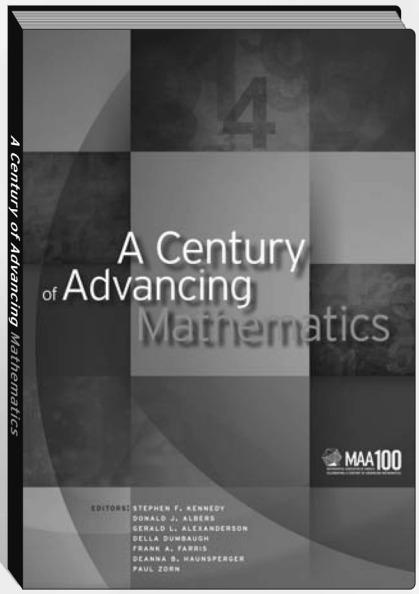
Revel in a 100 Years of Mathematics



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SPECIAL SECTION

2015 American Mathematical Society Elections

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2015 AMS Elections

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Ballots

AMS members will receive email with instructions for voting online by August 17, or a paper ballot by September 17. If you do not receive this information by that date, please contact the AMS (preferably before October 1) to request a ballot. Send email to `ballot@ams.org` or call the AMS at 800-321-4267 (within the U.S. or Canada) or 401-455-4000 (worldwide). The deadline for receipt of ballots is November 6, 2015.

Write-in Votes

It is suggested that names for write-in votes be given in exactly the form that the name occurs in the *Combined Membership List* (`www.ams.org/cml`). Otherwise the identity of the individual for whom the vote is cast may be in doubt and the vote may not be properly credited.

Replacement Ballots

For a paper ballot, the following replacement procedure has been devised: A member who has not received a ballot by September 17, 2015, or who has received a ballot but has accidentally spoiled it, may write to `ballot@ams.org` or Secretary of the AMS, 201 Charles Street, Providence, RI 02904-2294, USA, asking for a second ballot. The request should include the individual's member code and the address to which the replacement ballot should be sent. Immediately upon receipt of the request in the Providence office, a second ballot, which will be indistinguishable from the original, will be sent by first class or airmail. Although a second ballot will be supplied on request and will be sent by first class or airmail, the deadline for receipt of ballots cannot be extended to accommodate these special cases.

Biographies of Candidates

The next several pages contain biographical information about all candidates. All candidates were given the opportunity to provide a statement of not more than 200 words (400 for presidential candidates) to appear at the end of their biographical information. Photos were supplied by the candidates; if uncredited, the candidate owns the rights to the photo.

Description of Offices

The **president** of the Society serves one year as president elect, two years as president, and one year as immediate past president. The president strongly influences, either directly or indirectly, most of the scientific policies of the Society. A direct effect comes through the president's personal interactions with both members of the Society and with outside organizations. In addition, the president sits as member of all five policy committees (Education, Meetings and Conferences, Profession, Publications, and Science Policy), is the chair of the Council's Executive Committee, and serves ex officio as a trustee. Indirect influence occurs as the president appoints chairs and members of almost all committees of the Society, including the policy committees. The president works closely with all officers and administrators of the Society, especially the executive director and the secretary. Finally, the president nominates candidates for the Nominating Committee and the Editorial

Boards Committee. Consequently, the president also has a long-term effect on Society affairs.

The **vice president** and the **members at large of the AMS Council** serve for three years on the Council. That body determines all scientific policy of the Society, creates and oversees numerous committees, appoints the treasurers and members of the Secretariat, makes nominations of candidates for future elections, and determines the chief editors of several key editorial boards. Typically, each of these new members of the Council also will serve on one of the Society's five policy committees. Current members of the Council may be found here: www.ams.org/council.

The **Board of Trustees**, of whom you will be electing one member for a five-year term, has complete fiduciary responsibility for the Society. Among other activities, the trustees determine the annual budget of the Society, prices of journals, salaries of employees, dues (in cooperation with the Council), registration fees for meetings, and investment policy for the Society's reserves. The person you select will serve as chair of the Board of Trustees during the fourth year of the term. Current members of the Board may be found here: www.ams.org/bt.

The candidates for **president** were suggested to the Council by the Nominating Committee. The candidates for **vice president**, **members at large**, and **trustee** were suggested to the Council either by the Nominating Committee or by petition from members. While the Council has the final nominating responsibility, the groundwork is laid by the **Nominating Committee**. The candidates for election to the Nominating Committee were nominated by the current President, Robert L. Bryant. The three elected will serve three-year terms. The main work of the Nominating Committee takes place during the annual meeting of the Society, during which it has four sessions of face-to-face meetings, each lasting about three hours. The Committee then reports its suggestions to the spring Council, which makes the final nominations. Current members of the Nominating Committee may be found here: www.ams.org/nomcom.

The **Editorial Boards Committee** is responsible for the staffing of the editorial boards of the Society. Members are elected for three-year terms from a list of candidates named by the president. The Editorial Boards Committee makes recommendations for almost all editorial boards of the Society. Managing editors of *Journal of the AMS*, *Mathematics of Computation*, *Proceedings of the AMS*, and *Transactions of the AMS*; and Chairs of the *Colloquium*, *Mathematical Surveys and Monographs*, and *Mathematical Reviews* editorial committees are officially appointed by the Council upon recommendation by the Editorial Boards Committee. In virtually all other cases, the editors are appointed by the president, again upon recommendation by the Editorial Boards Committee. Current members of the Editorial Boards Committee may be found here:
www.ams.org/ebc.

Elections to the **Nominating Committee** and the **Editorial Boards Committee** are conducted by the method of approval voting. In the approval voting method, you can vote for as many or as few of the candidates as you wish. The candidates with the greatest number of the votes win the election.

A Note from AMS Secretary Carla D. Savage

The choices you make in these elections directly affect the direction the Society takes. If the past election serves as a reliable measure, about 13 percent of you will vote in the coming election, which is comparable with voter participation in other professional organizations which allow an online voting option. This is not mentioned as encouragement for you to throw the ballot in the trash; instead, the other officers and Council members join me in urging you to take a few minutes to review the election material, fill out your ballot, and submit it. The Society belongs to its members. You can influence the policy and direction it takes by voting.

Also, let me urge you to consider other ways of participating in Society activities. The Nominating Committee, the Editorial Boards Committee, and the Committee on Committees are always interested in learning of members who are willing to serve the Society in various capacities. Names are always welcome, particularly when accompanied by a few words detailing the person's background and interests. Self-nominations are probably the most useful. Recommendations can be transmitted through an online form (www.ams.org/committee-nominate) or sent directly to the secretary (secretary@ams.org) or Office of the Secretary, American Mathematical Society, Department of Computer Science, Box 8206, North Carolina State University, Raleigh, NC 27695-8206 USA.

PLEASE VOTE.

Nominations for President

Nomination of Mark Green

Phillip A. Griffiths and Jill Pipher

Mark Green is an absolutely superb choice for president of the American Mathematical Society. His scientific contributions to mathematics are at the highest level and he has a remarkable record of service to our community. He has taken on leadership roles in the profession with great success, combining a skill for administration with a true spirit of generosity. His accomplishments in the profession have been recognized by the AMS, as a Fellow, by the IMU, as the Chern Medal Plenary Lecturer in Seoul and an ICM invited speaker in Berlin, by the American Academy of Arts and Sciences, as a Fellow, and through many awards and honors too numerous to list here. Mark's selection as the 2013 AMS Congressional Lecturer demonstrates the confidence of the mathematical community in his ability to speak eloquently on their behalf. Finally, he has shown extraordinary dedication to the mathematics profession through his leadership in establishing and directing the Institute for Pure and Applied Mathematics, through his membership in the AMS Strategic Planning Group and as an AMS Trustee, and over many years as author, editor, educator, organizer, speaker, and reviewer.

It seems natural to begin with an overview of Mark Green's mathematical contributions. Over more than four decades, Mark has done fundamental research in geometry, algebra, and some areas of applications. His work has answered outstanding basic questions, and, especially, has opened up new areas of research by establishing initial results and formulating conjectures that have given rise to entire streams of productive activity. Mark's work is characterized by great originality and an unsurpassed ability to originate and apply techniques from commutative algebra to geometric questions.

To cite some examples, the modern subject of "hyperbolicity" originated with Picard's theorem and now involves the study of holomorphic maps of $\mathbb{C}^n$ into a quasi-projective algebraic variety X. Early in his career, Mark solved a problem posed by Chern at the 1970 ICM about holomorphic maps from $\mathbb{C}^n$ into X when X is the complement of hyperplanes in $\mathbb{P}^n$ and later studied maps from $\mathbb{C}$ into X when X is a surface of general type. In the latter work, jet differentials were introduced, and in an original and suggestive step, their connection to the surface being of general type was established. This led to a conjecture that is the subject of considerable interest and much current work; among other things it was the topic of a recent Bourbaki seminar. The Green-Griffiths conjecture on holomorphic curves motivated conjectures of Lang on rational points on varieties of general type. Also in his early work, and in a completely different area, Mark formulated and established a Lie algebra theoretic classification of the differential invariants that determine curves in homogeneous spaces. As these examples suggest, Mark's mathematical research is remarkably broad: it covers much of geometry.

Beginning with the early work of Serre, Grothendieck and others, commutative and homological algebra have been absolutely fundamental tools in algebraic geometry. In the 1980s, Mark brought an extremely fruitful, geometrically motivated, perspective to the field. He was able to solve outstanding classical questions, including a question of Riemann on quadrics of rank four through a canonical curve. He went on to establish fundamental new results and formulate new and highly original questions. The Green conjecture on syzygies of a canonical curve is one of the deepest and most tantalizing questions about the geometry of algebraic curves. The commutative/homological techniques that he introduced provided effective methods for addressing geometric questions arising from Hodge theory and paved the way for important ongoing work applying Hodge theory to questions in algebraic geometry. Mark's work with Rob Lazarsfeld on deformation theory of cohomology groups continues to play a role in the classification theory of algebraic varieties.

Mark's research in the last twenty years has focused on a wide range of geometrically motivated questions in Hodge theory. He and his collaborators have results pertaining to algebraic cycles, general Neron models, and Mumford-Tate groups and domains. This work has led to various mathematical generalizations and is currently being applied to questions in physics. The Mumford-Tate groups are the natural symmetry groups in Hodge theory, and the corresponding Mumford-Tate domains are special homogeneous complex manifolds that have a very rich geometry, relating to representation theory in addition to Hodge theory and complex algebraic geometry. Using techniques from Lie theory, Mark and his collaborators completely classified the ways in which a simple algebraic group may be realized as a Mumford-Tate group. All of the results we describe here have opened new areas of currently active research.

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DOI: http://dx.doi.org/10.1090/noti1268

We would now like to describe some of Mark's extraordinary service contributions to the profession. Over the years, these contributions range from specific service to AMS and SIAM to scientific and administrative leadership roles: the breadth of his service interests is striking. He has generously given time to support individuals and institutions that serve the mathematical community. His public presentations on policy and educational issues are noted for their focus and clarity.

He just completed a term (2010–2015) as a Trustee of the AMS and serves on its Strategic Planning Committee. Mark's perspective and advice on the profession has been widely sought: he has served as a consultant to many major scientific boards, societies and institutions, including the American Academy of Arts and Sciences Selection Panel, the American Council on Education, the National Research Council Board on Mathematical Sciences and Applications, (chair of) the 2013 NSF-DMS Committee of Visitors, the Simons Foundation, and numerous Canadian and US institute advisory boards.

One of the highlights in this extensive list is Mark's service as Vice-Chair of the National Research Council committee which produced the report, *The Mathematical Sciences in 2025*, known informally as *Math 2025*. Among the many excellent NRC reports in mathematics and other fields, *Math 2025* stands out in terms of its breadth and vision. Through concrete examples and cogent analysis, the mathematical sciences are portrayed in the report as having a role in the mathematical and scientific communities, and indeed in the larger society, that goes far beyond what could have been imagined even a few years ago. *Math 2025* is already receiving major attention from governmental, scientific and educational communities, and one might reasonably expect it to have a significant impact on the future of our field. Its companion volume, *Fueling Innovation and Discovery* has been distributed for uses that range from making the case for funding mathematics research to informing high school teachers about developments in mathematics. Mark's demonstrated leadership in communicating specific mathematical ideas, as well as the scope and impact of mathematics overall, is a tremendous resource for our community.

One milestone in Mark's service to the profession is his leadership at the Institute for Pure and Applied Mathematics (IPAM), an NSF Mathematics institute which he helped to found and served as co-director, and then director, for nearly a decade. Under his leadership, scientifically and administratively, IPAM went from the drawing board to its current unique place among math institutes, blending traditional areas of fundamental research in mathematics with synergistic opportunities for applications and impact in other scientific disciplines. Mark demonstrated a prescient vision for the impact of mathematical partnerships in science and technology, and it is his vision of this partnership to which IPAM owes its initial success.

Very recently, Mark's passion for communication and education has propelled him into a leadership role in finding funding for, and organizing meetings to promote the goals of, the broad initiative *Transforming Post-Secondary Education in Mathematics* or TPSE Math. Sponsored by the Carnegie Corporation of NY, the Sloan Foundation and four major mathematical societies, TPSE Math had its kickoff meeting in Austin in 2014. Mark and other members of the organizing committee led working groups exploring a variety of urgent issues in the undergraduate mathematics curriculum.

On the personal side, Mark is an engaging and warm colleague and teacher. His leadership style reflects his personality: considerate, informed, thoughtful and persuasive. We believe that the AMS would be well served by the unique blend of experiences, talent and passion that Mark would bring to the Presidency.

Nomination of Kenneth Ribet

Benedict Gross and Barry Mazur

It is an honor to nominate Kenneth Ribet for the Presidency of the AMS. We have both known Ken for over forty years. He has made fundamental contributions to number theory, and has served our profession in a variety of ways.

Ken's Background

Ken attended Brown as an undergraduate, receiving his AB and AM degrees in 1969. He came to Harvard as a graduate student in 1969—and promptly became an AMS member. His thesis advisor was John Tate. After receiving his PhD in 1973, Ken spent three years teaching at Princeton University and two years doing research in Paris before joining the UC Berkeley mathematics department in 1978. Ken has been a key member of his department since, teaching critical courses and winning several teaching awards. He has served in three different vice chairmanships as supervisor of the graduate program, the undergraduate program and the department's development efforts.

Ken has a deep and varied background in mathematics book and journal publishing. He began serving as journal editor almost thirty years ago and is currently an editor for a handful of number theory and general mathematics journals. After a brief stint as a book series editor for Cambridge University Press, he joined the New York-based Springer editorial board that looks after four book series, including the Graduate Texts in Mathematics series. Ken has served on the scientific advisor board of IPAM and is currently a member of the scientific board of the Simons Institute for the Theory of Computing.

Ken has been honored repeatedly over the course of his career. He won the Fermat Prize in 1989 and received an honorary doctorate from Brown University in 1998. Ken was elected to the American Academy of Arts and Sciences in 1997 and to the National Academy of Sciences in 2000. At the National Academy, he served on the US National Committee

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Barry Mazur is Gerhard Gade University Professor at Harvard University. His email address is mazur@math.harvard.edu.

for Mathematics, which represents the USA to the IMU. He also served three terms on the nominating committee, and chaired the mathematics section of the NAS for three years, beginning in 2009.

Ken is currently a member of the AMS Council. He serves on the Executive Committee of the Council, the Long Range Planning Committee, the Committee on Science Policy, and the committee that coordinates the collected works program. He is a much sought-after speaker, and with his varied professional experience would be an outstanding public face of the AMS.

Ken's Mathematics

Ken works in number theory and algebraic geometry. He is best known for his theorem in the 1980s that reduced the proof of Fermat's Last Theorem to the conjecture that all semi-stable elliptic curves over $\mathbb{Q}$ are modular (which was proved in the 1990s by Andrew Wiles and Richard Taylor). Ken was awarded the Fermat Prize for this contribution. But Ken's influence on number theory is more extensive than that single accomplishment: it spans four decades of important discoveries, during which Ken has been the inspiration for several generations of mathematicians. Many of his contributions are key to our understanding of the connections between the theory of modular forms and the ℓ-adic representations of the absolute Galois group of the field of rational numbers. We will briefly highlight three of them here. There are many other areas where Ken's work has been decisive, such as his construction with Deligne of p-adic L-functions for totally real fields [1].

To focus on a classical example in the theory of modular forms, consider the infinite product

$$\Delta(q) \;=\; q\prod_{n=1}^{\infty}(1-q^n)^{24} \;=\; \sum_{n=1}^{\infty}\tau(n)q^n.$$

The product $\Delta(q)$ can be thought of as a power series in the variable q; or putting $q = e^{2\pi iz}$ we may view it as an analytic function of the variable z in the upper half-plane, where it satisfies the additional symmetry $\Delta(-1/z) = z^{12}\Delta(z)$. As a consequence, Δ is a cuspidal modular form of level 1 and weight 12.

The Fourier coefficients, $\tau(n)$ of Δ have been studied by generations of mathematicians, starting with Ramanujan. Simple recurrence relations (first described by Mordell) allow one to retrieve the Ramanujan tau-function $n \mapsto \tau(n)$ from its values $\tau(p)$ for all prime numbers p. Serre conjectured, and Deligne proved, that the modular form $\Delta(q)$ has the following remarkable connection to Galois representations. Let $G_{\mathbb{Q}} := \mathrm{Gal}(\overline{\mathbf{Q}}/\mathbf{Q})$, the absolute Galois group of the field of rational numbers and let ℓ be a prime number. Then for every power ℓ^n there is a continuous representation

$$\rho_{\ell^n} : G_{\mathbb{Q}} \to \mathrm{GL}_2(\mathbb{Z}/\ell^n\mathbb{Z})$$

which is unramified at all primes $p \neq \ell$. Moreover, the image of a Frobenius element at p has trace congruent to the pth Fourier coefficient $\tau(p)$ of Δ and determinant congruent to p^{11} modulo ℓ^n. The same result holds not only for Δ, but for the Fourier expansions of general Hecke eigenforms. Many of Ken's earliest articles involve a study of the images of these Galois representations.

On the Size of the Image of Galois Representations

Swinnerton-Dyer and Serre showed that for ℓ different from $2, 3, 5, 7, 23$, and 691, the image of the representation ρ_{ℓ^n} associated with Δ is as large as possible. Specifically:

$$\mathrm{image}(\rho_{\ell^n}) = \{g \in \mathrm{GL}_2(\mathbb{Z}/\ell^n\mathbb{Z}) \mid \det(g) \text{ is an eleventh power in} (\mathbb{Z}/\ell^n\mathbb{Z})^*\}.$$

In one of Ken's first published papers [2] he established an analogous result for the Galois representations mod ℓ^n (where $\ell \gg 0$) attached to general Hecke eigenforms of level 1. His later work amplifies and generalizes this result in various important directions; for example, [4] establishes the Tate conjecture for Jacobians of modular curves.

On the Theorem of Herbrand and Ribet

Returning to the cuspidal modular form Δ, consider the representation

$$\rho_\ell : G_{\mathbb{Q}} \to \mathrm{GL}_2(\mathbb{Z}/\ell\mathbb{Z})$$

where $\ell = 691$, one of the primes for which the image of ρ_ℓ is *not* as large as possible; in fact it is contained in a Borel subgroup of $\mathrm{GL}_2(\mathbb{Z}/\ell\mathbb{Z})$. This is related to the Ramanujan congruence:

$$\tau(n) \;\equiv\; \sum_{d \mid n} d^{11} \mod 691$$

for every positive integer n. In particular,

$$\tau(p) \;\equiv\; 1 + p^{11} \mod 691$$

for every prime number $p \neq 691$. The number field fixed by the kernel of ρ_{691} is an *everywhere unramified* cyclic extension of degree 691 over the (cyclotomic) number field generated by 691th roots of unity. The existence of this unramified extension is related to the fact that 691 divides the numerator of the 12th Bernoulli number.

What one can take away from this example is that cuspidal modular forms such as Δ might be pressed into service to actually *construct* abelian everywhere unramified extensions of cyclotomic fields. That is precisely the approach that Ken took in his article [3], where he established the converse to a famous theorem of Herbrand. Specifically, Ken showed that for ℓ a prime number and k an integer with $2 < 2k < \ell - 1$, if the numerator of the $2k$th Bernoulli number is divisible by ℓ there is a cuspidal Hecke eigenform of weight $2k$ whose associated Galois representation mod ℓ has its image contained in a Borel subgroup, and the number field determined by the representation ρ_ℓ is an *everywhere unramified* cyclic extension of degree ℓ over the cyclotomic field generated by ℓth roots of unity. The extremely original viewpoint that Ken fashioned in his proof of 'Herbrand-Ribet', and the result itself, was seminal, and has been extraordinarily important for the later developments in the subject.

On Fermat's Last Theorem

The connection between automorphic forms and Galois representations can be run in either direction. An important conjecture of Serre (subsequently proved by Khare and Wintenberger) implies that any (irreducible) Galois representation

$$r : G_{\mathbb{Q}} \to \mathrm{GL}_2(\mathbb{Z}/\ell\mathbb{Z})$$

that has the property that complex conjugation, viewed as element of $G_{\mathbb{Q}}$, is not sent, under the representation r to $\pm 1 \in \mathrm{GL}_2(\mathbb{Z}/\ell\mathbb{Z})$, is associated to a cuspidal modular form modulo ℓ. Ken's remarkable contribution to Fermat's Last Theorem hinged on the (then conjectural) modularity theorem. (The modularity theorem is itself implied by Serre's conjecture.)

Here is a brief hint of how Ken's extraordinary contribution fits into the proof of Fermat's Last Theorem. A beautiful idea of Frey was to start with a putative non-trivial solution of Fermat's equation with exponent ℓ to produce an elliptic curve $\mathcal{E}$ over $\mathbf{Q}$ with very unusual properties. Assuming the modularity theorem, $\mathcal{E}$ would be parametrized by a cuspidal modular form ϕ of weight two with *correspondingly* unusual properties. Ken's ingenious idea [5] is to make use of those properties to construct a different modular form ϕ', which is also of weight two and whose Fourier expansion is congruent modulo ℓ to that of ϕ. The modular form ϕ' which Ken constructs has level 2. But there are no cusp forms of weight 2 and level 2, so ϕ' is constrained to be an Eisenstein series and therefore ϕ itself would have a Fourier expansion congruent modulo ℓ to an Eisenstein series. This would violate known results about rational torsion of elliptic curves; specifically about rational torsion in $\mathcal{E}$. So: the nontrivial solution of Fermat's equation cannot exist! Ken's argument is startling in its originality and makes use, among many other things, of the quaternionic description of the bad fibers of Shimura curves. The general technique Ken used for the construction of such a ϕ', as described above, might be called "level adjustment," Ken having initiated the important systematic study of the various possible levels of modular forms that are associated to the same mod ℓ Galois representation.

Ken as Teacher, Mentor, and Ambassador for Mathematics

Ken's marvelous talent for—and devotion to—teaching, lecturing, and generally guiding young mathematicians is recognized world-wide. At Berkeley he frequently gives large lecture classes in upper-level subjects, and takes special care to make genuine connections with each of his students. In 2014 there were over two hundred students in his linear algebra class, and he extended email invitations to each of them to join him for breakfasts and lunches at the Berkeley Faculty Club.

Ken won the department's distinguished teaching award on two occasions: soon after it was introduced in the 1980s and more recently in 2013. He has an impressively long list of students whose PhD's he supervised[1]. Many of his students have gone on to make notable contributions in teaching and research, both in academia and in industry.

Ken has engaged frequently in outreach in connection with Fermat's Last Theorem beginning with the Fermatfest in San Francisco in 1993. His AMS Invited Address at the 1994 annual meeting drew an overflow crowd, consisting essentially of all people who had registered for the Joint Math Meetings. Ken gave a public lecture on the history of Fermat's Last Theorem this fall at Bowdoin College and has given similar talks in the recent past at Humboldt State University and Southern Oregon University.

[1] *see* genealogy.math.ndsu.nodak.edu/id.php?id=32910.

Conclusion

Ken Ribet has made outstanding contributions to research mathematics, and is a marvelous teacher and lecturer. With vision and immense energy he has already given tremendous service to his department, to the National Academy of Sciences, to the American Mathematical Society, and to the mathematical community in general. We feel he will do great things as President of the AMS.

References

[1] P. Deligne and K. Ribet, Values of abelian L-functions at negative integers over totally real fields, *Invent. Math.* **59** (1980), no. 3, 227–286.

[2] K. Ribet, On ℓ-adic representations attached to modular forms, *Invent. Math.* **28** (1975), 245–275.

[3] ———, A modular construction of unramified p-extensions of $\mathbf{Q}(\mu_p)$, *Inventiones Math.* **34** (1976) 151–162.

[4] ———, Twists of modular forms and endomorphisms of abelian varieties, *Math. Ann.* **253** (1980) 43–62.

[5] ———, On modular representations of $\mathrm{Gal}(\overline{\mathbf{Q}}/\mathbf{Q})$ arising from modular forms, *Invent. Math.* **100** (1990), no. 2, 431–476.

Biographies of Candidates 2015

Biographical information about the candidates has been supplied and verified by the candidates.

Candidates have had the opportunity to make a statement of not more than 200 words (400 words for presidential candidates) on any subject matter without restriction and to list up to five of their research papers.

Candidates have had the opportunity to supply a photograph to accompany their biographical information. Acronyms: AAAS (American Association for the Advancement of Science); AMS (American Mathematical Society); ASA (American Statistical Association); AWM (Association for Women in Mathematics); CBMS (Conference Board of the Mathematical Sciences); IAS (Institute for Advanced Study), ICM (International Congress of Mathematicians); IMA (Institute for Mathematics and Its Applications); IMU (International Mathematical Union); IPAM (Institute for Pure and Applied Mathematics); LMS (London Mathematical Society); MAA (Mathematical Association of America); MSRI (Mathematical Sciences Research Institute); NAS (National Academy of Sciences); NRC (National Research Council); NSF (National Science Foundation; PIMS (Pacific Institute for the Mathematical Sciences); SIAM (Society for Industrial and Applied Mathematics); STEM (Science, Technology, Engineering and Mathematics).

President

Mark L. Green

Distinguished Research Professor, Department of Mathematics, University of California, Los Angeles.
Born: October 1, 1947, Minneapolis, Minnesota.
PhD: Princeton University, 1972.
AMS Offices: Trustee, 2010–2015 (Chair, 2013–2014).
AMS Committees: Committee on the Profession, 2000–2002, 2011–2012 (Chair, 2001); Committee on Meetings and Conferences, 2010–2011; Committee on Education, 2012–2013; Development Committee, 2012–2015; Committee on Publications, 2013–2014; Strategic Planning Committee, 2013–present; Committee on Science Policy, 2014–2015; Investment Committee, 2014–2015.
Selected Addresses: International Congress of Mathematicians, Berlin, 1998; AMS Invited Address, JMM, New Orleans, 2001; Plenary Lecture, Abel Bicentennial, Oslo, Norway, 2002; AMS Congressional Lecture, Washington, D.C., 2013; Chern Medal Plenary Lecture, International Congress of Mathematicians, Seoul, Korea, 2014.
Additional Information: Procter Fellowship, 1971–1972; Sloan Memorial Fellowship, 1976–1980; Director, Institute for Pure and Applied Mathematics, 2001–2008; NSERC Major Resources Support Committee, 2006–2009; Canadian Institutes Site Visit Panel, 2007; Banff International Research Station, Scientific Advisory Board, 2009–2012; Scientific Advisory Board, Centre de Recherches Mathématiques, Montréal, 2009–2013; National Academies study, "The Mathematical Sciences in 2025" (Vice–Chair), 2009–2013; Fellow, American Academy of Arts and Sciences, 2010; US Delegation, General Assembly of the IMU, Bangalore, India, 2010; International Advisory Panel, Canadian Long Range Planning Study for Mathematics, 2011; Fellow, American Association for the Advancement of Science, 2012; Fellow, AMS, 2012; Fellow, Centre de Recherches Mathématiques, Montréal, 2013; NSF–DMS Committee of Visitors (Chair), 2013; Member, AAAS, MAA and SIAM; Board on Mathematical Sciences and Applications, 2013–present; Transforming Post–Secondary Education in Mathematics, 2013–present.
Selected Publications: 1. with P. Griffiths, Two applications of algebraic geometry to entire holomorphic mappings, *The Chern Symposium 1979 (Proc. Internat. Sympos., Berkeley, Calif., 1979)*, 41–74, Springer (1980). **MR0609557 (82h:32026)**; 2. Koszul cohomology and the geometry of projective varieties, *J. Differential Geom.*, **19** (1984), no. 1, 125–171. **MR0739785 (85e:14022)**; 3. with R. Lazarsfeld, Higher obstructions to deforming cohomology groups of line bundles, *J. Amer. Math. Soc.*, **4** (1991), no. 1, 87–103. **MR1076513 (92i:32021)**; 4. The Eisenbud–Koh–Stillman conjecture on linear syzygies, *Invent. Math.*, **136** (1999), no. 2, 411–418. **MR1688437 (2000j:13024)**; 5. with P. Griffiths and M. Kerr, *Mumford–Tate Groups and Domains*: *Their Geometry and Arithmetic*, Ann. of Math. Studies, **183**, Princeton University Press (2012). **MR2918237**.

Statement by Candidate: I want to say at the outset how deeply honored I am to be considered for this position, which has been held by so many people I admire. This is an opportunity to serve our community in an important way.

Being a mathematician is a wonderful career. To get to spend time thinking about mathematics, to teach students about its power and beauty—how lucky we are to be able to do this. It falls to those of us who have enjoyed a career in mathematics to make sure that the next generation will continue to have the opportunities we have had.

Scientifically, this is a great time to be doing mathematical research. We are making major advances in fundamental theory and finding innovative ways to use existing and newly created mathematics. At the same time, the academic institutions that harbor many of us are under enormous cost pressures, and research labs and industry are not immune to these pressures. The AMS is a major voice supporting mathematicians and mathematical research in times like these.

I have had a chance to become familiar with the issues facing the AMS internally, through my work as an AMS Trustee, which involves rotating through the five major policy committees, and as a member of the AMS Strategic Planning Group. I have had an opportunity to acquire a good perspective on the issues facing the mathematical community through my work as Vice-Chair of the National Academies study, "The Mathematical Sciences in 2025," as a member of the Board on Mathematical Sciences and Applications, as Chair of the 2013 NSF-DMS Committee of Visitors, as a member of the group "Transforming Post-Secondary Education in Mathematics," and on the science boards of BIRS, IPAM and the CRM.

My experience as Director of a national mathematics institute (IPAM) during its start-up phase taught me a lot—about budgets, about how to set up new programs, about the importance of listening and building consensus, about the importance of building relationships and constantly reaching out to bring in new constituencies, about why being inclusive matters in a community as multilayered as ours. It also taught me how much I don't know, and the wisdom of getting diverse perspectives before making a major decision.

If you elect me, I will work as hard as I can to live up to the high standards of those who have served you as President.

Kenneth A. Ribet

Courtesy of the University of California, Berkeley.

Professor of Mathematics, University of California, Berkeley.
Born: June 28, 1948, New York, NY.
PhD: Harvard University, 1973.
AMS Offices: Member at Large of the Council, 2013–2016; Executive Committee, 2014–2018.
AMS Committees: Committee on Progress in Mathematics, 1994–1997 (Chair, 1996–1997); Committee to Select the Winner of the Cole Prize, 2007–2008 (Chair); Committee to Select the Winner of the E. H. Moore Research Article Prize, 2009–2015 (Chair, 2012–2013); *Bulletin* Chief Editor Search Committee, 2013–2014; Committee on Science Policy, 2013–2016 (Chair, 2015–2016); Collected Works Editorial Committee, 2013–2017; Committee on Education, 2015–2016; Public Policy Award Selection Committee, 2015–2016; Long Range Planning Committee, 2015–2017.
Selected Addresses: International Congress of Mathematicians, "Congruence relations between modular forms," Warsaw, 1983; AMS–MAA Invited Address, "Update on Fermat's Last Theorem," JMM, 1994; AMS Progress in Mathematics Lecture, "Galois representations and modular forms," Minneapolis, MN, August, 1994; AMS Invited Address, Regional Meeting, "Modular curves and their twisted analogues," Portland, OR, June, 2002; Special Session on Arithmetic Geometry, "Nonoptimal levels of reducible two-dimensional mod l representations of the Galois group of $\mathbf{Q}$," JMM, 2010.
Additional Information: Fermat Prize, 1989; Election to American Academy of Arts and Sciences, 1997; PhD honoris causa, Brown University, 1998; Election to National Academy of Sciences, 2000. Editorial Boards: Graduate Texts in Mathematics, Undergraduate Texts in Mathematics, Universitext, Springer Monographs in Mathematics, *Proceedings of the National Academy of Sciences*, *Journal of Number Theory*, *Mathematical Research Letters*, *International Journal of Number Theory*.
Selected Publications: 1. A modular construction of unramified p-extensions of $Q(\mu_p)$, *Invent. Math.*, **34** (1976), no. 3, 151–162. **MR0419403 (54#7424)**; 2. On modular representations of Gal $(\bar{\mathbf{Q}}/\mathbf{Q})$ arising from modular forms, *Invent. Math.*, **100** (1990), no. 2, 431–476. **MR1047143 (91g:11066)**; 3. Report on mod l representations of Gal $(\bar{\mathbf{Q}}/\mathbf{Q})$, *Motives (Seattle, WA, 1991), Proc. Sympos. Pure Math.*, **55**, Part 2, Amer. Math. Soc., Providence, RI (1994), 639–676. **MR1265566 (95d:11056)**; 4. Galois representations and modular forms, *Bull. Amer. Math. Soc. (N. S.)*, **32** (1995), no. 4, 375– 402. **MR1322785 (96b:11073)**; 5. with A. Agashe and W. Stein, The modular degree, congruence primes and multiplicity one, *Number Theory, Analysis and Geometry*, Springer, New York (2012), 19–49. **MR2867910**.
Statement by Candidate: I have been in love with mathematics all my life. Like so many of our colleagues, I was a math team kid in school and spent countless hours reading all the math books that came my way. Soon after my sixteenth birthday, I attended a summer science program at Brown University and strolled over to the AMS (which was on College Hill in Providence at the time) during my free period in the afternoon. I joined the AMS as a graduate student and have been a member ever since. I have very fond memories of my first AMS Summer Institute (Arcata, 1974) and my first annual meeting, which I attended during my second postdoctoral year.

During my career, I have focused my attention on research, professional service and outreach to the public. (After Andrew Wiles announced a proof of Fermat's Last Theorem in 1993, I gave public lectures on the Theorem and related questions.) On the Berkeley campus, I directed

my department's undergraduate program, graduate program and development efforts. I recently chaired the Mathematics Section of the National Academy of Sciences. Many of you know me through my membership on the editorial boards of the textbook series Graduate Texts in Mathematics and Undergraduate Texts in Mathematics. I am an editor of a half-dozen journals, including (most recently) the *Notices of the AMS*.

I have served on AMS committees throughout my career. My current close connection with our Society began with my election to the Council in 2012. Soon after, the Council elected me to its Executive Committee. I currently serve on the Long Range Planning Committee, the Committee on Science Policy (as chair) and the Collected Works Committee. I have learned about the challenges facing our Society and have deepened my connection with the fundamental issues concerning the future of our profession.

My nomination for the AMS Presidency was an electrifying moment. The next President will have the privilege of shaping the future of our Society as technology brings rapid change and unprecedented opportunity. The next President will need to demonstrate the crucial importance of long-term fundamental research in a context where funding is tilted toward quick payoffs. I feel well prepared for this office because of a half-century of mathematical research, long service to the mathematical community, an extensive background in mathematical publishing and a continuing commitment to public outreach. It will be an honor for me to serve as your President.

Vice President

Raman Parimala

Professor, Emory University, Atlanta, Georgia.

Born: Mayuram, Tamilnadu, India.

PhD: University of Bombay, India, 1976.

AMS Committees: Member, Human Rights Committee, 2008–2010; Member, Cole Prize Committee, 2012; Member, Satter Prize Committee, 2012, 2014; Member, Southeastern Section Program Committee, 2013, 2014.

Selected Addresses: Invited Speaker, International Congress of Mathematicians, Zürich, 1994; Invited Plenary Speaker, International Congress of Mathematicians, Hyderabad, India, 2010; Bernoulli Lecture, EPFL Lausanne, 2012; AWM Noether Lecture, JMM, San Diego, 2013; Coxeter Lectures, Fields Institute, Toronto, 2013.

Additional Information: Bhatnagar Prize for Mathematical Sciences, 1987; President, Ramanujan Mathematical Society, 2004–2006; Third World Academy of Sciences Prize in Mathematical Sciences, 2005; Srinivasa Ramanujan Medal of the Indian National Science Academy, 2006; Fellow, AMS, Indian National Science Academy, Indian Academy of Sciences, The National Academy of Sciences, India.

Selected Publications: 1. with J.-L. Colliot-Thélène, Real components of algebraic varieties and etale cohomology, *Invent. Math.*, **101** (1990), no. 1, 81–99. **MR1055712 (91j:14015)**; 2. with E. Bayer-Fluckiger, Galois cohomology of the classical groups over fields of cohomological dimension ≤ 2, *Invent. Math.*, **122** (1995), no. 2, 195–229. **MR1358975 (96i:11042)**; 3. with J.-L. Colliot-Thélène and P. Gille, Arithmetic of linear algebraic groups over 2-dimensional geometric fields, *Duke Math. J.*, **121** (2004), no. 2, 285–341. **MR2034644 (2005f:11063)**; 4. with V. Suresh, The u-invariant of the function fields of p-adic curves, *Ann. of Math.* (2), **172** (2010), no. 2, 1391–1405. **MR2680494 (2011g:11074)**; 5. with V. Suresh, Period-index and u-invariant questions for function fields over complete discretely valued fields, *Invent. Math.*, **197** (2014), no. 1, 215–235. **MR3219517**.

Statement by Candidate: The American Mathematical Society is at the forefront of promoting research and outreach in mathematics, and it is an honor to be nominated to run for Vice-President. I hope my international experience as someone who spent the majority of her career in India and Europe can contribute a valuable perspective and new opportunities for the AMS. I applaud the Society's efforts to ensure the inclusion of women, for example by publishing annual Statistics on Women Mathematicians in the *Notices*. Real progress has been made since these statistics were first published, in that the percentage of women speakers in AMS Special Sessions has increased even though the percentage of PhDs granted to US women has remained flat. The AMS has other laudable efforts in this direction, such as co-sponsoring the Emmy Noether Lectures with the AWM, and I would like to see yet more done. I would be delighted to serve the AMS as Vice President.

Catherine A. Roberts

Courtesy of College of the Holy Cross.

Professor of Mathematics, College of the Holy Cross.

Editor, *Natural Resource Modeling*.

Born: February 5, 1965, Boston, MA.

PhD: Northwestern University, 1992.

AMS Committees: Committee on Professional Ethics, 2006–2009 (Chair, 2007–2009); Committee on Meetings and Conferences, 2006–2009; Committee on Education, 2010–2013; Advisory Committee on Math Awareness Month: Math and Sustainability, 2012–2013.

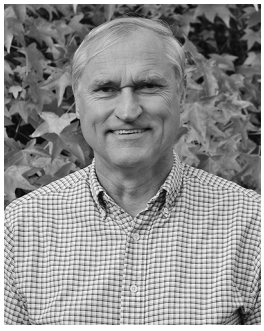
Selected Addresses: Keynote Presentation, Reflections on Launching a Career, Career Mentoring Workshop for women graduate students in mathematics, Wheaton College, 2009; Colloquium Presentation, A River Runs Through It, Wellesley College, 2010; Keynote Presentation, Incorporating the environment into undergraduate math courses, MAA Northeastern Section Meeting, 2013; Keynote Presentation, Mathematics and Planet Earth, Sonya Kovalesvsky Math Day for Girls at Simmons, 2013; Keynote Presentation, Mathematics and Planet Earth, New England Mathematics Association of Two Year Colleges, 2014.

Additional Information: *Positions:* University of Rhode Island, 1992–1995; Northern Arizona University, 1995–2001; Leadership Team, Intel Math Program, 2008–present; Department of Mathematics and Computer Science (Chair), College of the Holy Cross, 2009–present. *Boards:* Rocky Mountain Math Consortium, 1998–2001; Association for Women in Mathematics, 2002–2006; Resource Modeling Association, 2002–present; Regional Environmental Council of Central Massachusetts, 2004–2007; SIAM Activity Group on Mathematics of Planet Earth, 2014–present. *Selected Editorships:* Editor-in-Chief, *Natural Resource Modeling*, 2004–present; *UMAP Journal of Undergraduate Mathematics and Its Applications*, 2005–present; *SIAM Review*, 2009–2011; *American Mathematical Monthly*, 2012–present. *AWM*: Workshop Co-organizer, 1997–1999, 2002–2004; Mentor Network, 2001–2008; Judge, Essay Contest, 2002; Fundraising Committee (Chair), 2004–2006; Selection Committee for Executive Director (Chair), 2005; AWM Committee on Committees, 2011–2014. *Other:* SIAM Education Committee, 1993–1995; Math Contest in Modeling, 1994–1995, 1997–1999, 2001; SIAM Morgan Prize, 1997–1999; Intel Math Program Senior Leadership Team, Edits and Advisory Team, Content Instructor, Senior Content Trainer, Evaluator, and Brain Trust, 2008–present; Moody's Mega Math Challenge, 2011; MAA Committee, Undergraduate Programs in Mathematics, program area study group, Mathematics in Climate and the Environment, 2012–2014. *Co-organizer:* Word Conference on Natural Resource Modeling, 2007, 2016; Special Sessions, Mathematics in Natural Resource Modeling, JMM, 2012–2015; Workshop on Management of Natural Resources (Math of Planet Earth), June 2015.

Selected Publications: 1. with D. Stallman and J. A. Bieri, Modeling complex human–environment interactions: The Grand Canyon river trip simulator, *J. Ecological Modeling,* **153** (2002), Issue 2, 181–196; 2. Perspectives on Modeling Applications in a Service-Learning Framework, *Mathematics in Service to the Community: Concepts and Models for Service-Learning in the Mathematical Sciences*, edited by C. R. Hadlock, MAA Notes, no. 66, Mathematical Association of America, Washington, D.C. (2005); 3. with W. E. Olmstead, Dimensional influence on blow-up in a super-diffusive medium, *SIAM J. Appl. Math.*, **70** (2010), no. 5, 1678–1690. **MR2587775 (2011e:35162)**; 4. Awareness of ethical pitfalls: A requirement for professional protection, *Notices Amer. Math. Soc.*, **57** (2010), no. 4, 485–489; 5. with C. M. Kirk and W. E. Olmstead, A system of nonlinear Volterra equations with blow-up solutions, *J. Integral Equations Appl.*, **25** (2013), no. 3, 377–393. **MR3161618**.

Statement by Candidate: Thank you for this nomination for Vice President. The numerous efforts of our professional society—from conferences and publications, to advocacy, plus more—play a critical role in supporting mathematicians and promoting mathematics. As a beneficiary of many AMS efforts, I would be pleased to have the opportunity to serve the AMS in this new capacity. Although I am an ardent supporter of all AMS undertakings and will contribute wherever I can be most helpful, I am personally quite interested in how the AMS can partner with existing efforts to support K–12 education, as well as how we can attract and support a wider diversity of graduate students and early-career mathematicians.

Richard Schoen



Professor of Mathematics, University of California, Irvine and Professor Emeritus, Stanford University.

Born: Celina, Ohio, October 23, 1950.

PhD: Stanford University, 1977.

AMS Committees: Associate Editor, *Journal of the AMS*, 1992–2001; Committee to Select Winner, Bôcher Prize (Chair), 1993–1994; *Bulletin*, Assoc. Ed./Research Reports, 1995–1999; Progress in Mathematics, 1995–1998; Electronic Research Announcements Editorial Board, 1995–2002; Colloquium Lecture Committee (Chair), 1999–2000; *Journal of the AMS* Editorial Committee, 2001–2003; Committee to Select Winner, Steele Prize, 2008–2011; Committee to Select Winner, E. H. Moore Research Article Prize, 2009–2011; National Awards and Public Representation, 2010–2012.

Selected Addresses: Invited Speaker, ICM, 1982; Plenary Speaker, ICM, 1986; Invited AMS address, Melbourne, Australia, 1999; Invited AMS address, Taichung, Taiwan, 2005; Herman Weyl lectures, IAS, 2008; Plenary Speaker, ICM, 2010.

Additional Information: Sloan Fellowship, 1979; MacArthur Fellowship, 1983; American Academy of Arts and Sciences, 1988; AMS Bôcher Prize, 1989; National Academy of Sciences, 1991; Fellow, AAAS, 1995; Guggenheim Fellowship, 1996; Stanford Department Chair, 2001–2004; Scientific Advisory Committee, Max Planck Institute for Gravitation, 2004–2010; Scientific Advisory Committee, MSRI, 2007–2012 (Co-Chair, 2009–2012); Clay Senior Scholar, Mittag-Leffler Institute, 2008; Committee to choose MSRI director, 2012 (Chair); Fellow, AMS, 2012; Clay Senior Scholar, PCMI, Park City, 2013; Program Committee, Mathematical Congress of the Americas, 2013.

Selected Publications: 1. with S. T. Yau, On the proof of the positive mass conjecture in general relativity, *Comm. Math. Phys.*, **65** (1979), no. 1, 45–76. **MR0526976 (80j:83024)**; 2. with L. Simon, Regularity of stable minimal hypersurfaces, *Comm. Pure Appl. Math.*, **34** (1981), no. 6, 741–797. **MR0634285 (82k:49054)**; 3. Conformal deformation of a Riemannian metric to constant scalar curvature, *J. Differential Geom.*, **20** (1984), no. 2, 479–495. **MR0788292 (86i:58137)**; 4. with J. Corvino, On the asymptotics for the vacuum Einstein constraint equations, *J. Differential Geom.*, **73** (2006), no. 2, 185–217. **MR2225517 (2007e:58044)**; 5. with S. Brendle, Manifolds with 1/4-pinched curvature are space forms, *J. Amer. Math. Soc.*, **22** (2009), no. 1, 287–307. **MR2449060 (2010a:53045)**.

Statement by Candidate: It is an honor for me to be nominated to run for Vice President of the AMS. I have been an AMS member since I was a graduate student, and I recognize and fully endorse the important role the AMS plays in the support of mathematical research, education, and the communication of mathematics to the general public. If I am elected I will work to advance the core mission

of the AMS and to make sure that the society is responsive to the evolving needs of the discipline and its members.

Board of Trustees

Sheldon Katz

Professor, University of Illinois at Urbana–Champaign.
Born: Brooklyn, NY, December 19, 1956.
PhD: Princeton University, 1980.
AMS Offices: Council, 2005–2008.
AMS Committees: Committee on the Profession, 2000–2003; Committee on Education, 2005–2007; Committee on Science Policy, 2007–2008 (Chair, 2008); Nominating Committee, 2008–2011 (Chair, 2009–2010).
Selected Addresses: Nine AMS Special Session talks since 1986; Rational curves on Calabi–Yau manifolds, seven lecture mini–course, Bergen, 1993; Invited Address, De Paul AMS Meeting, 1998; Introduction to Enumerative Geometry and its interaction with theoretical physics, fifteen lectures, Park City, 2001; ADE Geometry and Dualities, three lecture mini–course, Lisbon, 2004.
Additional Information: Math Department Chair, University of Illinois at Urbana–Champaign, 2006–2011; MSRI Committee on Trustees, 2008–2009; Mathematics Section Committee, American Association for the Advancement of Science, 2012–2016; AMS Fellow, 2013; NSF/DMS Committee of Visitors, 2013.
Selected Publications: 1. with D. Morrison, Gorenstein threefold singularities with small resolutions via invariant theory for Weyl groups, *J. Algebraic Geom.*, **1** (1992), no. 3, 449–530. **MR1158626 (93b:14030)**; 2. with C. Vafa, Matter from geometry, *Nuclear Phys. B*, **497** (1997), no. 1–2, 146–154. **MR1467887 (98i:81209)**; 3. with D. Cox, *Mirror Symmetry and Algebraic Geometry*, Mathematical Surveys and Monographs, Amer. Math. Soc., Providence, RI, **68** (1999). **MR1677117 (2000d:14048)**; 4. Genus zero Gopakumar–Vafa invariants of contractible curves, *J. Differential Geom.*, **79** (2008), no. 2, 185–195. **MR2420017 (2009f:14115)**; 5. with J. Choi and A. Klemm, The refined BPS index from stable pair invariants, *Comm. Math. Phys.*, **328** (2014), no. 3, 903–954. **MR3201216**.
Statement by Candidate: It is an honor to be nominated for the Board of Trustees, a position of great importance. The Board receives and administers the funds of the AMS, is responsible for its investments and properties, and conducts the business affairs of the Society, thereby ensuring the financial health and stability of the AMS so that the Society can fund the programs that benefit the membership of the AMS and our profession more broadly. While the AMS is currently in excellent financial shape thanks to the efforts of its current and former leadership, financial challenges and uncertainties lie ahead in the relatively near term. The AMS will need to respond decisively and creatively to these challenges so that the Society and profession can continue to thrive. I have been successful in raising funds for endowed professorships, graduate and undergraduate research, and more, beginning when I was chair of my department during a period of great financial uncertainty. I would welcome the opportunity to build on my experiences in order to raise new revenues for AMS programs so that the Society will not only remain strong but will be able to create new programs strategically.

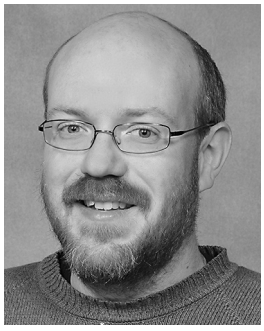
Bryna Kra

Sarah Rebecca Roland Professor of Mathematics, Northwestern University.
Born: October 6, 1966, Boston, MA.
PhD: Stanford University, 1995.
AMS Offices: Council, 2008–2014; Executive Committee, 2010–2014.
AMS Committees: Selection Committee for Current Events Session, 2006; Committee on Ethics in Hiring, 2008–2009; Committee on the Profession, 2008–2010; Central Section Program Committee, 2008–2010 (Chair, 2009–2010); Task Force on Prizes, 2009–2011; Committee on Committees, 2009–2011, 2012–2014; Selection Committee for Programs that Make a Difference, 2010–2011; Task Force on Open Access Publishing, 2013–2014; Fellows Selection Committee, 2013–2016; Colloquium Lecture Committee, 2014–2017.
Selected Addresses: Invited Sectional Talk, International Congress of Mathematicians, Madrid, Spain, 2006; Invited Address, AMS Fall Sectional Meeting, Cincinnati, OH, 2006; AMS–MAA Invited Address, Joint Meeting of AMS–MAA, New Orleans, LA, 2007; Arnold Ross Lecture of the AMS, Museum of Science and Industry, Chicago, IL, 2013; MoMath Museum of Mathematics, New York, NY, 2014.
Additional Information: AMS Centennial Fellowship, 2006; Eisenbud Professor, Mathematical Sciences Research Institute, 2008; Clay Research Scholar, 2009; Levi L. Conant Prize, 2010; Fellow, AMS, 2012.
Selected Publications: 1. with B. Host, Nonconventional ergodic averages and nil manifolds, *Ann. of Math.* (2), 161 (2005), 397–488. **MR2150389 (2007b:37004)**; 2. with V. Bergelson and B. Host, Multiple recurrence and nilsequences, *Invent. Math.*, **160** (2005), no. 2, 261–303. **MR2138068 (2007i:37009)**; 3. The Green–Tao theorem on arithmetic progressions in the primes: an ergodic point of view, *Bull. Amer. Math. Soc.*, **43** (2006), no. 1, 3–23. **MR2188173 (2006h:11113)**; 4. with V. Cyr, Nonexpansive Z^2–subdynamics and Nivat's conjecture, To appear, *Trans. Amer. Math. Soc.* (2015); 5. with V. Cyr, The automorphism group of a shift of linear growth: beyond transitivity, *Forum Math.*, Sigma, **3** (2015), no. 5, 27 pages.
Statement by Candidate: The AMS is the primary US organization supporting research in mathematics, advocating for both mathematicians and mathematics. The challenging funding environment we face today places increasing pressure on individuals, but also on departments and institutions such as the AMS. As a member of the Board of Trustees, my principal responsibility is safeguarding

the long-term financial health of the organization. This requires both innovation and ongoing evaluation of existing AMS programs. To continue playing a major role in the support of mathematics, we need to broaden the constituency of the AMS, increasing membership among under–represented groups, and we need to find creative ways to communicate with the general public, making a compelling case for the support of mathematics. As a mass membership organization, the AMS must serve and advocate for all of its constituencies. As an elite professional organization, it must promote the highest standards and traditions of research mathematics. The Board balances these dual roles, and I look forward to the challenges presented by the shifting landscape.

Member at Large

Henry Cohn



Principal Researcher, Microsoft Research New England and Adjunct Professor of Mathematics, MIT.
Born: Boston, MA, July 22, 1974.
PhD: Harvard University, 2000.
AMS Committees: *Journal of the AMS* Associate Editor, 2012–2016; Selection Committee for ICM 2014 Travel Grants, 2013–2014 (Chair of second round); Fellows Selection Committee, 2015–2018.
Selected Addresses: Journées Arithmétiques, 2005; PIMS Distinguished Chair Lectures, University of Calgary, 2006; Erdős Lectures in Discrete Mathematics and Theoretical Computer Science, Hebrew University, 2008; Combinatorics section, International Congress of Mathematicians, 2010; 38th International Symposium on Symbolic and Algebraic Computation, 2013.
Additional Information: American Institute of Mathematics Five–Year Fellowship, 2000–2005; Lester R. Ford Award, MAA, 2005. Scientific Advisory Boards: ICERM, 2010–present; IPAM, 2011–2014; MSRI, 2014–present. Editorial Boards: *SIAM Journal on Discrete Mathematics*, 2005–present; Contributions to *Discrete Mathematics*, 2005–present; *Journal de Théorie des Nombres de Bordeaux*, 2011–present; *Journal of the AMS*, 2012–present (Associate Editor); *Forum of Mathematics*, 2012–present. Fellow, AMS, 2015.
Selected Publications: 1. with R. Kenyon and J. Propp, A variational principle for domino tilings, *J. Amer. Math. Soc.*, **14** (2001), no. 2, 297–346. **MR1815214 (2002k:82038)**; 2. with N. Elkies, New upper bounds on sphere packings. I, *Ann. of Math.* (2), **157** (2003), no. 2, 689–714. **MR1973059 (2004b:11096)**; 3. with R. Kleinberg, B. Szegedy, and C. Umans, Group–theoretic algorithms for matrix multiplication, *Proceedings of the 46th Annual Symposium on Foundations of Computer Science* (23–25 October 2005, Pittsburgh, PA), IEEE Computer Society, 379–388; 4. with A. Kumar, Optimality and uniqueness of the Leech lattice among lattices, *Ann. of Math.* (2), **170** (2009), no. 3, 1003–1050. **MR2600869 (2011c:11106)**; 5. with J. Woo, Three–point bounds for energy minimization, *J. Amer. Math. Soc.*, **25** (2012), no. 4, 929–958. **MR2947943**.

Statement by Candidate: Of the many issues facing the mathematical community, here are three I am particularly interested in: 1. How should mathematicians respond to the open access movement, serials crisis, etc.? We have a wonderful opportunity to improve the dissemination of mathematics, but we have to be careful not to disrupt the aspects of our publication system that we value. 2. How can the AMS help create a welcoming and supportive environment for all mathematicians, particularly members of underrepresented groups? Mathematics is by no means the most problematic field in this respect, but we ought to be doing better, both as a matter of justice and for the future health of mathematics. 3. As big data becomes increasingly popular, how can the AMS take advantage of this opportunity to emphasize the central role of mathematics without giving in to hype or endorsing questionable models?

Alicia Dickenstein

PhD Mathematics, University of Buenos Aires.
Born: Argentina, 1955.
PhD: University of Buenos Aires, 1982.
Selected Addresses: Evans Lecture, MSRI–UC Berkeley, 1998; Plenary Speaker, FoCM (Foundations of Computational Mathematics), Hong Kong, 2008; Plenary Speaker, FPSAC (Formal Power Series and Algebraic Combinatorics), San Francisco, 2010; Invited Speaker, MCA (First Mathematical Congress of the Americas), Guanajuato, Mexico, 2013; Frontier Lecture Series, Texas A & M University, College Station, 2015.
Additonal Information: Eisenbud Professor, MSRI, Fall 2009; Co–organizer, thematic semester at Institut Mittag–Leffler, Sweden, 2011; Member, Scientific Committee of the Simons Foundation Africa Mathematics Project, 2012; Co–Chair, SIAM Conference, Applied Algebraic Geometry AG13, Fort Collins, 2013; Member, International Advisory Board, ICWM, Korea, 2014; Leader, National Report on Mathematics, National Academies of Sciences and Ministry of Science and Productive Innovation, Argentina, 2014; Senior Simons Research Associate, ICTP, Italy, 2014–2019; Vice President, International Mathematical Union, 2015–2018.
Selected Publications: 1. with C. Sessa, Canonical representatives in moderate cohomology, *Invent. Math.*, **80** (1985), no. 3, 417–434. **MR0791667 (87a:32013)**; 2. with E. Cattani and C. D'Andrea, The $\mathcal{A}$–hypergeometric system associated with a monomial curve, *Duke Math. J.*, **99** (1999), no. 2, 179–207. **MR1708034 (2001f:33018)**; 3. with E. M. Feichtner and B. Sturmfels, Tropical discriminants, *J. Amer. Math. Soc.*, **20** (2007), no. 4, 1111–1133. **MR2328718 (2008j:14095)**; 4. with L. F. Matusevich and E. Miller, Binomial D–modules, *Duke Math. J.*, **151** (2010), no. 3, 385–429. **MR2605866 (2011h:14073)**; 5. with S. Müller, E. Feliu, G. Regensburger, C. Conradi, and A. Shiu, Sign conditions for injectivity of generalized polynomial maps with applications to chemical reaction networks and

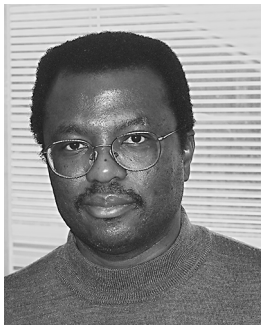
real algebraic geometry, to appear: *Found. Comput. Math.*, 2015 (dx.doi.org/10.1007/s10208-014-9239-3).
Statement by Candidate: Although I live and work in Argentina, I have been a member of the AMS for almost thirty years. During this period I have witnessed the globalization of our profession and have been involved in many synergistic activities at the local, national, and international level. We face many challenges concerning funding, underrepresentation, publications, education and outreach. I am willing to collaborate actively as a Member at Large of the Council of the AMS and hope to be able to contribute a fresh perspective to these issues.

Erica Flapan


Courtesy of Cynthia Peters.

Lingurn H. Burkhead Professor of Mathematics, Pomona College.
Born: August 14, 1956, Kalamazoo, MI.
PhD: University of Wisconsin, Madison, 1983.
AMS Committees: Committee on Professional Ethics, 2014–2016; Editorial Committee: Student Mathematical Library, 2014–2018.
Selected Addresses: Invited Address, AMS sectional meeting, Chapel Hill, NC, 2003; MAA Invited Address, Joint Mathematics Meetings, Phoenix, 2004; Invited lecture at the Workshop on Mathematics of Knotting and Linking in Polymer Physics and Molecular Biology, Banff International Research Station, 2007; Organizer and lecturer, AMS Short Course on Applications of Knot Theory, 2008; Distinguished Lecture, Mathematical Association of America, Carriage House, Washington, DC, 2014.
Additional Information: *National Honors*: MAA Haimo Award for Distinguished College or University Teaching of Mathematics, 2011; Inaugural Fellow of the AMS, 2012; Polya Lecturer of the MAA, 2015–2017. Participation in Non-AMS Organizations: MAA Spectrum Book Series Editorial Board, 2001–2006; Instructor, Summer Mathematics Program for Women Undergraduates (eleven summers), 2000–2014; Budapest Semesters in Mathematics Council Member, 2012–2015. Pomona College Honors: Irvine Foundation Distinguished Faculty Fellowship for mentoring students of color, 2005; First Year Advisor Award, 2013; Wig Award for Distinguished Teaching, 2014.
Selected Publications: 1. *When Topology Meets Chemistry: A Topological Look at Molecular Chirality*, Cambridge University Press and Mathematical Association of America (2000). **MR1781912 (2002e:92029)**; 2. with R. Naimi, J. Pommersheim and H. Tamvakis, Topological symmetry groups of graphs embedded in the 3-sphere, *Comment. Math. Helv.*, **80** (2005), 317–354. **MR2142245 (2006i:57006)**; 3. with D. Buck, Predicting knot or catenane type of site-specific recombination products, *Journal of Molecular Biology*, **374** (2007), 1186–1199; 4. with H. Howards, Every graph has an embedding in S^3 containing no nonhyperbolic knot, *Proc. Amer. Math. Soc.*, **137** (2009), 4275–4285. **MR2538588 (2010f:57006)**; 5. with W. Fletcher and R. Nikkuni, Reduced Wu and generalized Simon invariants for spatial graphs, *Math. Proc. Cambridge Philos. Soc.*, **156** (2014), 521–544. **MR3181638**.
Statement by Candidate: It is an honor to have been asked to be a candidate for the position of Member at Large of the AMS Council. I believe that I can bring a unique perspective to the Council as someone who has experience in many different mathematical arenas. As an active researcher who has spent her career at a liberal arts institution, I am interested in promoting excellent research while supporting teaching and mentoring of the next generation of mathematicians. As a topologist who has collaborated with chemists and molecular biologists, I am committed to both pure mathematics and interdisciplinary applications. As someone who has spent eleven summers as an instructor at a successful NSF sponsored program for undergraduate women in mathematics, I have first-hand knowledge of how to mentor and encourage young women to become mathematicians. As someone who has won awards for mentoring and advising first year college students and students from underrepresented groups, I am sensitive to the challenges confronted by a diverse student population. Finally, as someone who is invited to present five or more talks each year at colleges and universities all over the country, I am aware of the large variety of issues facing mathematics departments at different types of institutions. If elected, I would be honored to bring my experiences in all of these areas to the Council.

Wilfrid D. Gangbo



Professor of Mathematics, Georgia Institute of Technology.
Born: May 11, 1961, Porto-Novo, Benin.
PhD: EPFL, Switzerland, 1992.
AMS Committees: AMS Committee on Human Rights of Mathematicians, 2009–2012; AMS Book Donations Steering Committee, 2012–2016 (Chair, 2015–2016).
Selected Addresses: Plenary Speaker, AMS meeting, New York University, April 12–13, 2003; Plenary Speaker, SIAM Conference on Analysis of PDEs, Houston, TX, December 6–8, 2004; Distinguished Visitor, PDE Pacific Northwest Seminar, Vancouver, BC, Canada, January 2009; Plenary Speaker, 37th Annual SIAM Southeastern Atlantic Sect. Conf., Knoxville, TN, March 22–24, 2013; Plenary Speaker, 4th Ohio River Analysis Meeting, Lexington, KY, March 8–9, 2014.
Additional Information: Member of AMS, 1996–present; Ramanujan Prize Selection Committee, 2008–2012; Members of the SIAG/Activity Group on Analysis of PDEs, 2009–2011; Member, US National Committee on Mathematics, 2011–2016 (the committee works to promote international scientific cooperation, support scientific research and training programs, and disseminate scientific information); Program Director, National Science Foundation, 2012–2013; Fellow of the AMS, Inaugural Class; Eisenbud Chair, MSRI, Berkeley, CA, Fall 2013; ICM selection committee (travel grant), 2013–2014. Editorial boards: Networks and Heterogeneous Media,

January 2008–present; SIMA, 2008–present; ESAIM: COCV, January 2009–present.
Selected Publications: 1. with R. McCann, The geometry of optimal transportation, *Acta Math.*, **177** (1996), no. 2, 113–161. **MR1440931 (98e:49102)**; 2. with E. Carlen, Constrained steepest descent in the 2-Wasserstein metric, *Ann. of Math.*, **157** (2003), 807–846. **MR1983782 (2004c:49027)**; 3. with H. K. Kim and T. Pacini, Differential forms on Wasserstein space and infinite-dimensional Hamiltonian systems, *Memoirs of the AMS*, **211** (2011), no. 993 (3 of 5). **MR2808856 (2012g:37129)**; 4. with R. Awi, A polyconvex integrand; Euler–Lagrange equations and uniqueness of equilibrium, *Arch. Ration. Mech. Anal.*, **214** (2014), no. 1, 143–182. **MR3237884**; 5. with A. Tudorascu, Weak KAM on the Wasserstein torus with multidimensional underlying space, *Comm. Pure Applied Math.*, **67** (2014), no. 3, 408–463. **MR3158572**.
Statement by Candidate: It is an honor to be nominated for the position of Member at Large of the AMS Council. The AMS provides the best platform for promoting research and education. Awareness of the importance of mathematics is becoming more and more critical, particularly in a time of uncertain funding climates and tight job markets. Our discipline deserves to be better supported at the level of fundamental research, applicable research and education. We should support mathematics departments in their effort to attract the best and brightest students. Formulating the right innovative scientific policies will keep us on the right track to achieve these important goals.

Edray Herber Goins

Associate Professor of Mathematics, Purdue University.
Born: Los Angeles, CA, June 29, 1972.
PhD: Stanford University, 1999.
AMS Committees: Central Section Program Committee, 2015–2017.
Selected Addresses: NAM Claytor–Woodard Lecture, JMM, New Orleans, 2011; Principal Lecturer, Modern Math Workshop Mini-Course, SACNAS National Conference, San Antonio, 2013; Plenary Speaker, Palmetto Number Theory Series XXII, 2014; AMS-AWM Special Session on Recent Developments in Algebraic Number Theory, JMM, San Antonio, 2015; Marjorie Lee Browne Colloquium, University of Michigan, 2015.
Additional Information: Positions: Postdoctoral Fellow, MSRI, 1999, 2000; Institute for Advanced Study, Member of the School of Mathematics, 1999–2000; Visiting Scholar, Harvard University, 2000, 2001, 2007; Postdoctoral Fellow, Max Planck Institut für Mathematik, Bonn, 2001; Irvine Foundation Instructor of Mathematics, California Institute of Technology, 2001–2003; Taussky–Todd Instructor of Mathematics, California Institute of Technology, 2003–2004; Assistant Professor of Mathematics, Purdue University, 2004–2010; Associate Professor, Purdue University, 2010–present; Editor of AMS Blog on "e-Mentoring Network in the Mathematical Sciences," 2013–present. Boards: PCMI Diversity Sub-Committee, 2010–present; MSRI Human Resources Advisory Committee (HRAC), 2013–present; President, National Association of Mathematicians (NAM), 2015–present. Editorship: with A. Noël, D. King and G. N'Guérékata, *Council for African American Researchers in the Mathematical Sciences, Vol. V; Contemp. Math.* **467** (2008), 152 pgs. Honors: Black Issues in Higher Education's Emerging Scholar of the Year, 2004; Membership: SACNAS, life member, 2005–present; AWM; MAA; NAM, life member, 2011–present.
Selected Publications: 1. Artin's conjecture and elliptic curves, *Council for African American Researchers in the Mathematical Sciences, Vol. III* (A. G. Noël, E. Barnes and S. A. F. Stephens, eds.), *Contemp. Math.*, **275**, *Amer. Math. Soc.* (2001), 39–51. **MR1827334 (2002d:11054)**; 2. Icosahedral $\mathbb{Q}$-curve extensions, *Math Res. Lett.*, **10** (2003), no. 2–3, 205–217. **MR1981898 (2004c:11080)**; 3. with F. Luca and A. Togbé, On the Diophantine equation $x^2+2^\alpha 5^\beta 13^\Upsilon=y^n$, *Algorithmic Number Theory* (A. J. van der Poorten and A. J. Stein, eds.), *Lecture Notes in Comput. Sci.*, 5011, Springer, Berlin (2008), 430–442. **MR2467863 (2010d:11150)**; 4. with K. Mugo, Points on hyperbolas at rational distance, *Int. J. Number Theory*, **8** (2012), no. 4, 911–922. **MR2926551**; 5. with A. Alvarado, Arithmetic progressions on conic sections, *Int. J. Number Theory*, **9** (2013), no. 6, 1379–1393. **MR3103893**.
Statement by Candidate: It is an honor to be nominated for the position of Member at Large of the AMS Council. I hope to both learn more about and to assist the efforts of the AMS to address the needs of underrepresented minorities in the mathematical sciences. For more than twenty years, I have been an active participant with the Conference for African-Americans in the Mathematical Sciences (CAARMS) as well as the National Conference for the Society for Advancement of Hispanic/Chicano and Native Americans in Science (SACNAS); for the past several years, I have served on committees to diversify the participants at MSRI as well as Park City Mathematics Institute (PCMI); and for the past several summers I've led a successful lecture series through Purdue's ADVANCE grant to feature women of color in the mathematical sciences. As the newly elected president of NAM, I look forward to joining efforts with the AMS to make mathematics more inclusive for everyone!

Tasso J. Kaper

Professor of Mathematics and Chair, Department of Mathematics and Statistics, Boston University.
Born: Groningen, NL, June 25, 1964.
PhD: California Institute of Technology, 1992.
AMS Committees: Editorial Committee, Proceedings of Symposia in Applied Mathematics (Chair), 2014–present.
Selected Addresses: Invited Address, International Workshop on Model Reduction and Multiscale Phenomena, Zurich, 2003; Invited Address, Japan Society for Mathematics, Sendai, 2005; Invited Address, Joint Partial Differential

Equations and Dynamical Systems Meeting, Barcelona, 2010; Invited Address, International Congress of Industrial and Applied Mathematics, Vancouver, 2011; Invited Address, International Conference on Far-From-Equilibrium Dynamics, Kyoto, 2011.

Additional Information: Sloan Research Fellowship, 1995; NSF Career Award in Mathematics, 1996–2000; Associate Editor, *SIAM Journal on Applied Dynamical Systems*, 2000–2005, 2012–present; Editor in Chief, *SIAM Journal on Applied Dynamical Systems*, 2005–2011; Fellow, Society for Industrial and Applied Mathematics, 2009; Fellow, AMS, 2012; Associate Editor, *Nonlinearity*, 2014–present; Member, American Physical Society.

Selected Publications: 1. with G. Kovačič, Multi-bump orbits homoclinic to resonance bands, *Trans. Amer. Math. Soc.*, **348** (1996), no. 10, 3835–3887. **MR1329536 (96m:58224)**; 2. with A. Doelman and R. A. Gardner, A stability index analysis of 1-D patterns of the Gray-Scott model, *Mem. Amer. Math. Soc.*, **155** (2002), no. 737. **MR1878337 (2005c:34090)**; 3. with R. E. L. DeVille, A. Harkin, M. Holzer, and K. Josic, Analysis of a renormalization group method and normal form theory for perturbed ordinary differential equations, *Phys. D*, **237** (2008), no. 8, 1029–1052. **MR2450492 (2009g:34098)**; 4. with M. Holzer and A. Doelman, Existence and stability of traveling pulses in a reaction-diffusion-mechanics system, *J. Nonlinear Sci.*, **23** (2013), no. 1, 129–177. **MR3023088**; 5. with A. Zagaris and H. G. Kaper, Geometry of the computational singular perturbation method for model reduction, *Mathematical Modeling of Natural Phenomena*, in press (2015).

Statement by Candidate: It is an honor to be asked to stand for election to be a Member at Large of the Council of the AMS. The AMS plays a central role in promoting and supporting mathematical research nationally and internationally. The AMS publishes important journals, books, and reports, and it sponsors a plethora of successful activities and programs, which collectively and individually communicate the excitement, results, and significance of mathematics to our community, to the government, and to the broader public. Some of the perspective that I can bring to the Council is that of a chair of a joint mathematics and statistics department. During the past four years, I have been guided by the principle of simultaneously advancing core mathematics, interdisciplinary mathematics, and statistics. This approach has been most important for further developing the core strength of a mathematics program, as well as for enhancing its larger role in the sciences and engineering.

Anna Mazzucato

Photo by Chuck Fong.

Professor, Department of Mathematics, Penn State University.

Born: Milan, Italy, 1970.

PhD: UNC-Chapel Hill, 2000.

AMS Committees: AMS-Simons Travel Grant Program, 2011–2013; Committee on Meetings and Conferences, 2012–2014.

Selected Addresses: Plenary Address, International Conference on Difference Equations and Applications, Trois Rivières, Canada, 2011; Michler Lecture, Cornell University, 2012; Speaker, Distinguished Women Scientist Series, University of Minnesota-Twin Cities, 2013; Invited Speaker, Clifford Lectures, Tulane University, 2013; Invited Speaker, Mathematical Hydrodynamics, École Normale, Paris, France, 2014.

Additional Information: Morgan Prize Selection Committee, 2009–2012 (Chair, 2011–2012); Ruth I. Michler Memorial Prize (awarded by AWM and Cornell University), 2011; Secretary, SIAG/APDE, 2013–2014; Member, AWM and SIAM.

Selected Publications: 1. Besov-Morrey spaces: function space theory and applications to nonlinear PDE, *Trans. Amer. Math. Soc.*, **355** (2003), no. 4, 1297–1364. **MR1946395 (2003j:46053)**; 2. with M. C. Lopes Filho and H. J. Nussenzveig Lopes, Weak solutions, renormalized solutions and enstrophy defects in 2D turbulence, *Arch. Ration. Mech. Anal.*, **179** (2006), no. 3, 353–387. **MR2208320 (2006k:35234)**; 3. with M. Taylor, Vanishing viscosity plane parallel channel flow and related singular perturbation problems, *Anal. PDE*, **1** (2008), no. 1, 35–93. **MR2431354 (2009j:35255)**; 4. with V. Nistor, Well-posedness and regularity for the elasticity equation with mixed boundary conditions on polyhedral domains and domains with cracks, *Arch. Ration. Mech. Anal.*, **195** (2010), no. 1, 25–73. **MR2564468 (2011e:74015)**; 5. with V. Nistor and Q. Qu, A nonconforming generalized finite element method for transmission problems, *SIAM J. Numer. Anal.*, **51** (2013), no. 1, 555–576. **MR3033023**.

Statement by Candidate: I am honored to have been nominated for the AMS Council. I strongly believe that AMS has a leading role in promoting a broad and inclusive view of Mathematics, in publicizing its societal impacts, and in supporting the contribution of Mathematics to education at all levels. If elected, I will work to ensure that the Society realizes these goals.

Alan William Reid

Pennzoil Company Regents Professor of Mathematics and Chair, Department of Mathematics, The University of Texas at Austin.

Born: Aberdeen, UK, 1962.

PhD: University of Aberdeen, 1988.

AMS Committees: Centennial Fellowship Selection Committee, 2001–2003 (Chair, 2002–2003); Editorial Boards Committee, 2008–2011 (Chair, 2010–2011).

Selected Addresses: AMS Invited Address, University of Michigan, 2002; XXth Nevanlinna Colloquium, Lausanne, Switzerland, 2005; Invited address, Georgia Topology Conference, 2009; Rigidity and flexibility in dimensions 2, 3 and 4, CIRM, Luminy, France, 2012; What's Next? The mathematical legacy of Bill Thurston, Cornell University, 2014.

Additional Information: Royal Society University Research Fellow, 1992–1996; Sir Edmund Whittaker Prize, Edinburgh Math. Soc., 1993; Alfred P. Sloan Foundation Research Fellow, 1997–2000; Editorial Board, *Geometriae Dedicata*, 2000–present; Member, AIM Scientific Board, 2010–present; European Math. Soc. Distinguished Speaker, The Hyperbolic and Riemannian Geometry of Surfaces and other Manifolds, 2011; Fellow, AMS, 2012.

Selected Publications: 1. with D. Cooper and D. D. Long, Essential closed surfaces in bounded 3-manifolds, *J. Amer. Math. Soc.*, **10** (1997), no. 3, 553–563. **MR1431827 (97m:57021)**; 2. with I. Agol and D. D. Long, The Bianchi groups are separable on geometrically finite subgroups, *Ann. of Math.* (2), **153** (2001), no. 3, 599–621. **MR1836283 (2002e:20099)**; 3. with C. Maclachlan, *The Arithmetic of Hyperbolic 3-Manifolds*, Graduate Texts in Math., 219, Springer-Verlag, New York (2003). **MR1937957 (2004i:57021)**; 4. with D. D. Long and A. Lubotzky, Heegaard genus and property τ for hyperbolic 3-manifolds, *J. Topol.*, **1** (2008), no. 1, 152–158. **MR2365655 (2008j:57036)**; 5. with G. Masbaum, All finite groups are involved in the mapping class group, *Geom. Topol.*, **16** (2012), no. 3, 1393–1411. **MR2967055**.

Statement by Candidate: The landscape of higher education in the US is evolving rapidly: from the use of technology, to pressures on size of graduate programs, as well as the funding models for research (in mathematics and elsewhere) to name a few. On the other hand, mathematics continues to be a central pillar of research in science and technology: Quoting from the NAS report, *The Mathematical Sciences in 2025*: "The mathematical sciences have an exciting opportunity to solidify their role as a linchpin of twenty-first century research and technology while maintaining the strength of the core, which is a vital element of the mathematical sciences ecosystem and essential to its future." It is vital that the AMS continue to take the lead in promoting and helping to frame the discussion of the role and value of mathematicians and departments (within academia and the broader public arena). As well as continuing its support of cutting edge research, and its efforts to ensure a diverse mathematical community, the AMS needs to be proactive in providing a voice for the new opportunities in mathematics that will arise for students (both undergraduate and graduate), and professional mathematicians. If elected I will work toward these goals.

Bogdan D. Suceavă

Professor of Mathematics, California State University, Fullerton.

Born: September 27, 1969, Curtea de Argeş, Romania.

PhD: Michigan State University, 2002.

Selected Addresses: AMS Special Session, JMM, Baltimore, 2003; AMS Special Session, UC Santa Barbara, 2005; Invited Paper Session, MAA MathFest, 2008; Riemannian Geometry and Its Applications, Bucharest, 2014; AMS Special Session, JMM, San Antonio, 2015.

Additional Information: Member, Pen Club West, 2005; Member, ETS Committee for GRE Subject in Mathematics, 2007–2012; Fiction Award, Bucharest Association of Writers, for the novel, *Miruna, a Tale* (available in English from Twisted Spoon Press, 2014), 2007; Book of the Month, Czech translation of the novel, *Coming from an Off-Key Time* (available in English from Northwestern University Press), Prague, Czech Republic, 2011; MAA Dolciani Enrichment Grants, 2012–2014; Outstanding Contributions to Students Success Award, Cal. State Fullerton, 2014; Author of twelve literary volumes, written in Romanian; Founder/coordinator, Fullerton Mathematical Circle, an outreach program of the Department of Mathematics at Cal. State Fullerton (e.g. `www.ocregister.com/articles/math-643435-circle-students.html`).

Selected Publications: 1. On strongly minimal Kähler surfaces in C^3 and the equality scal(p)=4 inf sec(π'), Results in Mathematics, Springer Online First. DOI: 10.1007/s00025-014-0421-3; 2. with W. G. Boskoff and M. G. Ciucă, Revisiting the foundations of Barbilian's metrization procedure, *Differential Geom. Appl.*, **29** (2011), no. 4, 577–589. **MR2811667 (2012f:53032)**; 3. with B. Chen, Classification theorems for space-like surfaces in 4-dimensional indefinite space forms with index 2, *Taiwanese J. Math.*, **15** (2011), no. 2, 523–541. **MR2810166 (2012d:53171)**; 4. Distances generated by Barbilian's metrization procedure by oscillation of sublogarithmic functions, *Houston J. Math.*, **37** (2011), no. 1, 147–159. **MR2786550 (2012d:51012);** 5. with C. Conley, R. Etnyre, B. Gardener, and L. Odom, New curvature inequalities for hypersurfaces in the Euclidean ambient space, *Taiwanese J. Math.*, **17** (2013), no. 3, 885–895. **MR3072267**.

Statement by Candidate: I joined the AMS as a graduate student in 1996 and over the years developed a profound admiration for the support the Society provides to its members as a conference organizer, publisher, and medium of communication, while also supporting job applicants and employers. I will reinforce AMS objectives that align with my experience in outreach programs (with a particular interest in programs geared towards students

with a strong interest in mathematics, e.g. mathematical circles), as well as in communicating to large audiences about the role of mathematics in society. I believe there are many ways in which the AMS could support young mathematicians, particularly undergraduate and graduate students who already have developed research projects. The role of mathematicians in society depends substantially on the perceptions society has about their work, and the AMS can design useful programs to strategically improve these perceptions. I have extensive experience in encouraging and mentoring undergraduate research, and have worked with students with different cultural heritages. I believe students representing minorities could contribute with their positive energy to the field and the whole mathematical community could benefit from programs designed to support them.

Xiaoming Wang

Professor and Chair, Department of Mathematics, Florida State University.
Born: Shanghai, China.
PhD: Applied Mathematics, Indiana University-Bloomington, 1996.
Selected Addresses: MSRI Workshop, Analytical and Stochastic Fluid Dynamics, Berkeley, CA, October 2005; Fourth International Congress of Chinese Mathematicians, Hangzhou, China, December 2007; IMA Workshop, Transport and mixing in complex and turbulent flows, April 2010; Fourth Workshop, Fluids and PDEs, IMPA, Rio de Janeiro, Brazil, May 2014; IPAM Workshop, Turbulent Transport and Mixing, UCLA, Los Angeles, CA, October 2014.
Selected Publications: 1. A remark on the characterization of the gradient of a distribution, *Appl. Anal.*, **51** (1993), no. 1–4, 35–40. **MR1278991 (95k:46064)**; 2. with R. Temam, Boundary layers associated with incompressible Navier-Stokes equations: the noncharacteristic boundary case, *J. Differential Equations*, **179** (2002), no. 2, 647–686. **MR1885683 (2003b:76052)**; 3. with A. J. Majda, *Non-Linear Dynamics and Statistical Theories for Basic Geophysical Flows*, Cambridge University Press, Cambridge (2006). **MR2241372 (2009e:76214)**; 4. Stationary statistical properties of Rayleigh-Bénard convection at large Prandtl number, *Comm. Pure Appl. Math.*, **61** (2008), no. 6, 789–815. **MR2400606 (2010b:76098)**; 5. Approximation of stationary statistical properties of dissipative dynamical systems: time discretization, *Math. Comp.*, **79** (2010), no. 269, 259–280. **MR2552226 (2011a:35431)**.
Statement by Candidate: It is an honor to be recommended as a candidate for Member at Large. This is a time full of challenges and opportunities, especially at state-funded universities, such as diminishing resources, increasing accountability requirements, higher pressure for productivity, rapid advancement of technology, and the nourishing of interdisciplinary research, among others. The AMS has a crucial role in promoting mathematics, providing guidance on how to meet the challenges, and taking advantage of the opportunities during this time. I have dealt with some of these issues in the capacity of a department chair, and I would be more than happy to serve the mathematics community at large if elected.

Yang Wang

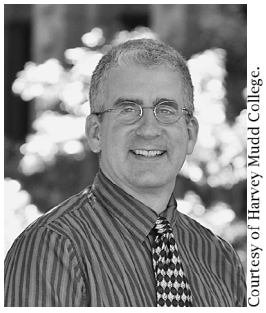
Courtesy of HKUST.

Chair Professor, Hong Kong University of Science and Technology.
Born: April 13, 1963.
PhD: Harvard University, 1990.
Selected Addresses: Invited Speaker, AMS sectional meeting, Washington D.C., 2012; Plenary Speaker, Liberty Bell Summer Symposium in Real Analysis, Reading, PA, 2012; Plenary Speaker, MBI Workshop, Mathematical Challenges in Biomolecular/Biomedical Imaging and Visualization, Ohio State University, 2013; Plenary Speaker, CIMPA, Argentina, 2013; Keynote Speaker, 5th International Conference, Computational Harmonic Analysis, Nashville, 2014.
Additional Information: Program Director, NSF, 2006–2007; Member, External Review Committee, Ohio State University and University of Delaware, 2013; Elected, Board of Governors, IMA, 2014–2018; A main organizer, AMS Central Sectional Meeting, 2015.
Selected Publications: 1. with J. C. Lagarias, Tiling the line with translates of one tile, *Invent. Math.*, **124** (1996), no. 1–3, 341–365. **MR1369421 (96i:05040)**; 2. with J. Lagarias and J. Reeds, Orthonormal bases of exponentials for the n-cube, *Duke Math. J.*, **103** (2000), no. 1, 25–37. **MR1758237 (2001h:11104)**; 3. Wavelets, tiling, and spectral sets, *Duke Math. J.*, **114** (2002), no. 1, 43–57. **MR1915035 (2003e:42057)**; 4. with D. Feng, On the structures of generating iterated function systems of Cantor sets, *Adv. Math.*, **222** (2009), no. 6, 1964–1981. **MR2562770 (2010k:28018)**; 5. with H. Rao and H. Ruan, Lipschitz equivalence of Cantor sets and algebraic properties of contraction ratios, *Trans. Amer. Math. Soc.*, **364** (2012), no. 3, 1109–1126. **MR2869169**.
Statement by Candidate: I have a very strong record of serving the community, and enjoy doing so. I coached the Putnam team at Georgia Tech and worked very closely with a couple of undergraduates to establish the Annual Georgia Tech High School Mathematics Competition, with the goal to attract good students into mathematics. This commitment to serve the community has never left me even when I became the department head at Michigan State University in 2007. During my entire career I had never turned down a request to serve on committees within and without my university, or to give a talk to undergraduates or school kids, or to appear in an outreach and recruitment event. I also know how to get things done, having been a department head for 8 years and a program director at NSF. If elected to the Council I hope to make a bigger impact in serving our community. One area I have a lot of expertise in is international exchange and collaboration, especially between US and Asia. Being currently in Hong Kong and active in both the US and Hong Kong/Greater

China has put me in an ideal situation to promote scholarly exchange and collaborations between the two regions.

Nominating Committee

Andrew J. Bernoff


Courtesy of Harvey Mudd College.

Diana & Kenneth Jonsson Professor of Mathematics, Harvey Mudd College.

Born: Philadelphia, Pennsylvania, July 5, 1960.

PhD: University of Cambridge, 1988.

Selected Addresses: Invited Lecturer, Undergraduate Faculty Program Organizer, IAS/Park City Math Institute on *Harmonic Analysis*, 2003; Cross-Program Invited Speaker, IAS/Park City Math Institute, 2005–2011; Invited Speaker, JMM, AMS–MAA Special Session on Mathematics and Education Reform, 2013; Invited Panelist, JMM, *Out in Mathematics: LGBTQ Mathematicians in the Workplace*, 2015.

Additional Information: Marshall Scholar, 1982–1985; National Science Foundation Postdoctoral Fellowship, 1989–1991; NSF Grants, seven awards, 1989–present; President, Southern California Section of SIAM, 2004–2011; Editor, SIAM Review Education Section, 2005–2010; NSF Committee of Visitors, 2007, 2010, 2013; Steering Committee, IAS/Park City Math Institute, 2008–2011; SIAM Outstanding Paper Prize, 2013; SIAM SIGEST Paper Award, 2013; Committee of Academic Sponsors, MSRI, 2013–present; Simons Foundation Collaboration Grant, 2014–2019.

Selected Publications: 1. with A. Bertozzi and T. Witelski, Axisymmetric surface diffusion: dynamics and stability of self–similar pinchoff, *J. Statist. Phys.*, **93** (1998), no. 3–4, 725–776. **MR1666581 (99k:80013)**; 2. with P. Sternberg, Onset of superconductivity in decreasing fields for general domains, *J. Math. Phys.*, **39** (1998), no. 3, 1272–1284. **MR1608449 (99a:82099)**; 3. with T. P. Witelski and A. Bertozzi, Blowup and dissipation in a critical–case unstable thin film equation, *European J. Appl. Math.*, **15** (2004), no. 2, 223–256. **MR2069680 (2005e:76011)**; 4. with C. Topaz, M. D'Orsogna and L. Edelstein–Keshet, Locust dynamics: behavioral phase change and swarming, *PLoS Comput. Biol.*, **8** (2012), no. 8, e1002642. **MR2988355**; 5. with C. Topaz, Nonlocal aggregation models: a primer of swarm equilibria, *SIAM Rev.*, **55** (2013), no. 4, 709–747. **MR3124884**.

Statement by Candidate: The strength of the AMS lies in its diversity along many dimensions. Our mission is to support excellence in mathematics research, breadth in mathematics education, and to advocate for mathematicians and mathematics education at all levels. That mission is evolving as we embrace new fields, such as data science, that make mathematics and its applications more relevant to industry while still supporting the flourishing growth in more traditional areas of mathematics. The obstacles that mathematics education faces at all levels from diminishing government resources has made addressing issues such as under–representation in STEM fields even more challenging. The role of technology in education brings both opportunities to reach communities we never have before and a changing paradigm for communication as we go from paper and mail to electronic publishing and social media. The continued vitality of the AMS depends on identifying individuals passionate to address these opportunities and challenges, and, as a member of the nominating committee I would strive to find candidates of all genders, races and orientations, who span and represent the breadth of our community, from pure to applied to industrial and from colleges focused on undergraduate education to research universities pushing the forefront of knowledge.

Carolyn Gordon


Courtesy of Joseph Mehling/Dartmouth College.

Benjamin Cheney Professor of Mathematics, Dartmouth College.

Born: Charleston, WV, December 26, 1950.

PhD: Washington University, 1979.

AMS Offices: Editorial Boards Committee, 1994–1997; Member at Large of the Council, 2005–2008.

AMS Committees: Central Section Programming Committee, 1990–1992; *Notices* Editorial Committee, 1991–1994 (Forum Editor, 1991–1993); National Programming Committee, 1996–1998 (Chair, 1997); Joint AMS-MAA Programming Committee (Chair), 1997; Committee on the Profession, 2004–2008; Moore Prize Selection Committee (Chair), 2006–2010; Committee on Committees, 2007–2009; Simons Travel Grant Selection Committee, 2012–2014; Levi Conant Prize Selection Committee, 2015.

Selected Addresses: AMS Invited Hour Address, JMM, San Antonio, TX, 1993; AMS-MAA Invited Hour Address, Mathfest, Providence, RI, 1999; AWM Noether Lecture, JMM, San Francisco, CA, 2010; MAA Invited Hour Address, JMM, Boston, MA, 2012.

Additional Information: AMS Centennial Research Fellowship, 1990; Chauvenet Prize, 2001; AWM President, 2003–2005; CBMS Executive Council, 2005–2006; Inaugural Fellow, AMS, 2012; Fellow, AAAS, 2013.

Selected Publications: 1. with D. L. Webb and S. Wolpert, One cannot hear the shape of a drum, *Bull. Amer. Math. Soc.* (N. S.), **27** (1992), no. 1, 134–138. **MR1136137 (92j:58111)**; 2. with E. N. Wilson, Continuous families of isospectral Riemannian metrics which are not locally isometric, *J. Differential Geom.*, **47** (1997), no. 3, 504–529. **MR1617640 (99a:58159)**; 3. Isospectral deformations of metrics on spheres, *Invent. Math.*, **145** (2001), no. 2, 317–331. **MR1872549 (2003d:58052)**; 4. with E. Makover and D. Webb, Transplantation and Jacobians of Sunada isospectral Riemann surfaces, *Adv. Math.*, **197** (2005), no. 1, 86–119. **MR2166178 (2006i:58047)**; 5. with D. Schueth and C. J. Sutton, Spectral isolation of bi-invariant metrics on compact Lie groups, *Ann. Inst. Fourier (Grenoble)*, **60** (2010), no. 5, 1617–1628. **MR2766225 (2012a:58058)**.

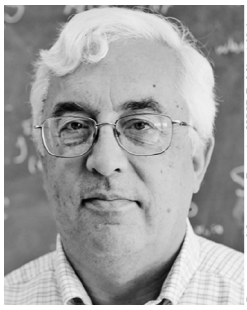
Statement by Candidate: If elected to the Nominating Committee, I will work to identify a diverse and

representative pool of candidates for AMS offices that can provide strong and visionary leadership both within the profession and in enhancing public exposure to the mathematical sciences.

Kevin P. Knudson

Professor of Mathematics, University of Florida.
Born: Wausau, Wisconsin, October 7, 1969.
PhD: Duke University, 1996.
Selected Addresses: Oberwolfach Conference, Computational Algebraic Topology, July 2008; Colloquium, University College, Dublin, May 2009; Colloquium, Louisiana State University, February 2012; Applied and Computational Topology, Universität Bremen, July 2013; AIM Workshop, Generalizations of Persistence, Palo Alto, California, September 2014.
Additional Information: NSF Postdoctoral Fellow, 1996–1999; Organizer, IMA Summer School for Graduate Students, Topology and its Applications, Mississippi State University, July 2006; Member, MSRI, Fall 2006; Director, University of Florida Honors Program, July 2009–August 2014. Co-Organizer, AMS Special Sessions: Chicago, 1998; Chapel Hill, NC, 2003.
Selected Publications: 1. On the *K*-theory of elliptic curves, *J. Reine Angew. Math.*, **507** (1999), 81–91. **MR1670270 (2000b:20056)**; 2. *Homology of Linear Groups*, Progress in Mathematics, 193, Birkhäuser Verlag, Basel (2001). **MR1807154 (2001j:20070)**; 3. with H. King and N. Mramor, Generating discrete Morse functions from point data, *Experiment. Math.*, **14** (2005), no. 4, 435–444. **MR2193806 (2006j:57049)**; 4. A refinement of multi-dimensional persistence, *Homology, Homotopy Appl.*, **10** (2008), no. 1, 259–281. **MR2399474 (2009d:55008)**; 5. *Morse Theory: Smooth and Discrete*, World Scientific, Singapore, 2015 (to appear).
Statement by Candidate: I am honored to stand for election to the Nominating Committee. The AMS requires a diverse collection of mathematical scientists to properly perform its missions—support for research, public outreach, and advocacy for the profession. As a member of the Nominating Committee I will work to ensure that the Society's governing and working groups are populated by a broad array of individuals from all types of institutions, including research universities, liberal arts colleges, industry, and government.

David R. Morrison



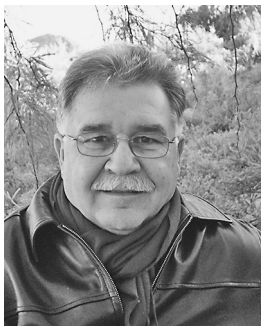
Courtesy of Spencer Bruttig, UCSB Public Affairs.

Professor of Mathematics and Physics, University of California, Santa Barbara.
Born: July 29, 1955, Oakland, California.
PhD: Harvard University, 1980.
AMS Offices: Council of the AMS, 2002–2005; Executive Committee, Council of the AMS, 2002–2005.
AMS Committees: Committee on Publications, 2002–2005; Committee on Committees, 2005–2006; Leonard Eisenbud Prize Committee, 2006–2008; Joint Data Committee, 2011–2014; Fellows Program Selection Committee, 2013–2015.
Selected Addresses: Invited Address, Mathematical Society of Japan, 1985; Invited Address, AMS Meeting, Lexington, Kentucky, 1994; Invited Speaker, ICM, 1994.
Additional Information: AMS Centennial Fellow, 1992–1994; Clay Mathematics Institute Senior Scholar, 2005; Guggenheim Fellow, 2005–2006; Fellow, AMS, 2013; Fellow, American Physical Society, 2014.
Selected Publications: 1. On *K*3 surfaces with large Picard number, *Invent. Math.*, **75** (1984), no. 1, 105–121. **MR0728142 (85j:14071)**; 2. Mirror symmetry and rational curves on quintic threefolds: a guide for mathematicians, *J. Amer. Math. Soc.*, **6** (1993), no. 1, 223–247. **MR1179538 (93j:14047)**; 3. with P. S. Aspinwall and B. R. Greene, Calabi-Yau moduli space, mirror manifolds and spacetime topology change in string theory, *Nuclear Phys. B*, **416** (1994), no. 2, 414–480. **MR1274435 (95i:32027)**; 4. with B. R. Greene and A. Strominger, Black hole condensation and the unification of string vacua, *Nuclear Phys. B*, **451** (1995), no. 1–2, 109–120. **MR1352415 (96m:83085)**; 5. with M. R. Plesser, Non-spherical horizons. I, *Adv. Theor. Math. Phys.*, **3** (1999), no. 1, 1–81. **MR1704143 (2000d:83122)**.
Statement by Candidate: I remember my own first encounter with the Nominating Committee, when I was approached to run for the Council. This was not something I had ever considered, but after some thought (and some prodding by members of the Committee), I agreed to do it. I have been serving the Society in various capacities ever since. I would be pleased to have the opportunity, as a member of the Nominating Committee, to help identify the next generation of leaders for the Society, seeking candidates who will bring a diverse set of experiences to the task.

Karen Hunger Parshall

Professor of History and Mathematics, University of Virginia.
Born: Virginia Beach, Virginia, July 7, 1955.
PhD: University of Chicago, 1982.
AMS Offices: AMS Council, 1998–2001.
AMS Committees: AMS/MAA Joint Archives Committee, 1992–2005 (Chair), 2006–2008, 2015–2018; AMS Representative to Section L of the AAAS, 1995–1998; AMS HMATH Committee (Chair), 1996–2013; Committee on Meetings and Conferences, 1998–2001; Member, Selection Committee for AMS/MAA, hour speaker, JMM, Baltimore, January 1998 and San Antonio, January 1999 (Chair); Member, Selection Committee for the Albert Leon Whiteman Memorial Prize, 2000.
Selected Addresses: Plenary Lecturer, International Congress of Mathematicians, Zürich, Switzerland, 1994; Plenary Lecturer, Sectional AMS Meetings, Eugene, OR, June 1994 and Miami, FL, April 2006; MAA Plenary Lecturer, Joint Meetings, San Francisco, CA, 1995, Washington, D.C., 2000, and San Diego, CA, 2008; MAA Centennial Speaker, Washington, D.C., 2015.
Additional Information: Fellowships: John Simon Guggenheim Fellow, 1996–1997; NSF Visiting Professorship for Women Recipient, 1996–1997. Editorial Responsibilities: Associate Editor, *The Mathematical Intelligencer*, 1989–1992; *Historia Mathematica*, Book Review Editor, 1990–1993, Managing Editor, 1994–1995, Editor, 1996–1999; Member of the Editorial Board, *American Mathematical Monthly*, 1997–2006; *Historia Mathematica*, 2000–present; *Revue d'histoire des mathématiques*, 2001–present. Chair: International Commission for History of Mathematics, 2002–2009. Awards: Inaugural Fellow of the AMS, 2012.
Selected Publications: 1. with D. E. Rowe, *The Emergence of the American Mathematical Research Community, 1876–1900: J. J. Sylvester, Felix Klein, and E. H. Moore*, AMS/LMS Series in the History of Mathematics, **8** (1994), paperback edition, 1997. **MR1290994 (95j:01032)**; 2. *James Joseph Sylvester: Life and Work in Letters*, Oxford: Clarendon Press (1998), paperback edition, 2013. **MR1674190 (99k:01072)**; 3. *James Joseph Sylvester: Jewish Mathematician in a Victorian World*, Johns Hopkins University Press, Baltimore (2006). **MR2216541 (2007a:01013)**; 4. *Episodes in the History of Modern Algebra (1800–1950)*, co-edited with J. G. Gray, AMS/LMS Series in the History of Mathematics, **32** (2007). **MR2307989 (2008g:00019)**; 5. with V. J. Katz, *Taming the Unknown: A History of Algebra from Antiquity to the Early Twentieth Century*, Princeton University Press, Princeton (2014). **MR3237138**.
Statement by Candidate: From its beginnings, the AMS has sought to promote first-rate research across a broad constituency of mathematical practitioners—in colleges and universities as well as in industry and the government. The Nominating Committee serves the key purposes of identifying capable and committed candidates for leadership roles within the AMS and of seeing to it that the diversity of the mathematical community defined by the AMS is reflected in the composition of its committees and in the holders of its offices. If elected, I will do my best to assure that the Nominating Committee achieves these goals.

William Yslas Vélez



University Distinguished Professor, University of Arizona.
Born: January 15, 1947.
PhD: University of Arizona, 1975.
AMS Committees: Committee on Committees, 1990–1992, 1993–1995; Committee on Meetings and Conferences, 1993–1995; Member, organizing committee for the first Joint Meeting, Sociedad Matemática Mexicana, Mérida, Yucatan, December 1994; Committee to Select the Winner of the Award for Public Service, 2001–2006; Young Scholars Award Committee, 2013–2016; AMS-ASA-MAA-SIAM Data Committee (Chair), 2014–2016.
Selected Addresses: James Leitzel Lecturer, MAA Summer Math Fest, August 2005.
Additional Information: President, Society for Advancement of Hispanic/Chicano and Native Americans in Science, 1994–1996; President's Award for Excellence in Science, Mathematics and Engineering Mentoring Program, Washington, D.C., September 1997; Fellow, American Association for the Advancement of Science, January 2009; Fellow, AMS, January 2013; Association for Women in Mathematics, Gweneth Humphreys Award for Mentorship of Undergraduate Women in Mathematics, January 2014.
Selected Publications: 1. with E. Jacobson, Fields arithmetically equivalent to a radical extension of the rationals, *J. Number Theory*, **35** (1990), no. 3, 227–246. **MR1062333 (92b:11081)**; 2. with J. Watkins, The research mathematician as storyteller, *Contemporary Issues in Mathematics Education*, Mathematical Sciences Research Institute Publications, **36**, E. A. Gavosto, S. G. Krantz, and W. McCallum, eds., Cambridge University Press (1999), 45–56; 3. The Role of Academic Departments in Diversity Issues, American Association for the Advancement of Science, *Minority Scientist Network* (2004); 4. Increasing the number of mathematics majors, *Focus* (2006); 5. Mathematics Instruction, An Enthusiastic Activity, On Teaching and Learning Mathematics, AMS Blogs (2014).
Statement by Candidate: I consider myself to be extremely fortunate to have had a career as a mathematician. To have a life surrounded by smart and dedicated people, stimulating ideas, and a safe environment in which to work is indeed a luxury. I have decided to share my good fortunes with others by spending the last years of my academic life recruiting students into the study of mathematics. As the demographics of our country is changing it is even more important for the mathematical establishment to be more inclusive, to educate students to the importance and utility of mathematics. I would be pleased to serve on the Nominating Committee of the AMS and continue my long service for the mathematical organizations of this country.

Editorial Boards Committee

Mladen Bestvina

Distinguished Professor of Mathematics, University of Utah.
Born: Osijek, Croatia, December 1, 1959.
PhD: University of Tennessee, 1984.
Selected Addresses: AMS Invited Address, Greensboro, NC, November 1995; ICM Invited Address, Topology Session, 2002; Namboodiri Lectures, University of Chicago, 2009; AMS Invited Address, Cornell, September 2011; Current Events Invited Lecture, JMM, San Diego, 2013.
Additional Information: Alfred P. Sloan Fellowship, 1988; Presidential Young Investigator Award, 1988; Croatian Academy of Arts and Sciences, Corresponding Member, 2012; Fellow, AMS, 2013. Selected Editorial Boards: *Transactions* and *Memoirs*, 2003–2008; *Ann. of Math.* Associate Editor, 2006–2013; *Groups, Geometry and Dynamics*, 2006–present; *Geom. Funct. Anal.*, 2007–present; *Duke Math. J.*, 2015–present.
Selected Publications: 1. with M. Handel, Train tracks and automorphisms of free groups, *Ann. of Math.* (2), **135** (1992), no. 1, 1–51. **MR1147956 (92m:20017)**; 2. with K.-U. Bux and D. Margalit, The dimension of the Torelli group, *J. Amer. Math. Soc.*, **23** (2010), no. 1, 61–105. **MR2552249 (2011b:20109)**; 3. with A. Eskin and K. Wortman, Filling boundaries of coarse manifolds in semisimple and solvable arithmetic groups, *J. Eur. Math. Soc.*, **15** (2013), no. 6, 2165–2195. **MR3120741**; 4. with M. Feighn, Subfactor projections, *J. Topol.*, **7** (2014), no. 3, 771–804. **MR3252963**; 5. with K. Bromberg and K. Fujiwara, Constructing group actions on quasi-trees and applications to mapping class groups, *Publ. IHES* (2014), 1–64.
Statement by Candidate: It is a great privilege to be asked to run for the Editorial Boards Committee. The AMS journals play a crucial role in publishing high quality research papers at a reasonable price, which are further electronically accessible and have a flexible copyright policy. If elected, I will work to identify mathematicians with best credentials to serve on editorial boards of the Society's publications.

Jeffrey Brock

Professor and Chair, Brown University Department of Mathematics.
Born: Bronxville, NY, June 14, 1970.
PhD: UC Berkeley, 1997.
Selected Addresses: AMS-MAA Invited Address, New Orleans, LA, 2007; Evans-Hall Memorial Lecture, Atlanta, GA, 2009; M. E. Hamstrom Lecture, Urbana-Champaign, 2010; Current Events Bulletin, Boston, 2012; Nevanlinna Colloquium, Helsinki, Finland, 2013.
Additional Information: Harrington Fellow, 2004; Guggenheim Fellow, 2008.
Selected Publications: 1. with K. W. Bromberg, On the density of geometrically finite Kleinian groups, *Acta Math.*, **192** (2004), no. 1, 33–93. **MR2079598 (2005e:57046)**; 2. with J. Souto, Algebraic limits of geometrically finite manifolds are tame, *Geom. Funct. Anal.*, **16** (2006), no. 1, 1–39. **MR2221251 (2008c:57028)**; 3. with H. Masur and Y. Minsky, Asymptotics of Weil-Petersson geodesic. I. Ending laminations, recurrence, and flows, *Geom. Funct. Anal.*, **19** (2010), no. 5, 1229–1257. **MR2585573 (2010k:32020)**; 4. with K. Bromberg, Geometric inflexibility and 3-manifolds that fiber over the circle, *J. Topol.*, **4** (2011), no. 1, 1–38. **MR2783376 (2012g:30099)**; 5. with R. D. Canary and Y. N. Minsky, The classification of Kleinian surface groups, II: The ending lamination conjecture, *Ann. of Math.* (2), **176** (2012), no. 1, 1–149. **MR2925381**.
Statement by Candidate: It is a great honor to have been nominated to serve on the AMS Editorial Boards Committee. The AMS serves as the standard-bearer for quality and accessibility in an increasingly complicated, fraught, and expensive publication marketplace. The commitment of the AMS to principles of openness and the free unencumbered exchange of information plays a vital role in setting the course for mathematical publication moving forward. Quality, high-impact editorship at the AMS is crucial to its continued success. I hope to serve its mission by bringing voices forward that share a commitment to the core values that have made the AMS journals the models of excellence in the community that they are.

Laura DeMarco

Courtesy of Niki Koumoutsos.

Professor, Northwestern University.
Born: November 15, 1974, Japan.
PhD: Harvard University, 2002.
AMS Committees: Employment Services Advisory Board, 2009–2011; Editorial board, AMS Electronic Journal of *Conformal Geometry and Dynamics*, 2013–present; Central Section Program Committee, 2014–2016 (Chair, 2015–2016); AWM-AMS Noether Lecture Committee, 2014–2017.
Selected Addresses: AMS-MAA Invited Address, MathFest, 2011; Colloquium, Harvard University, 2012; AMS Invited Address, JMM, 2013; Plenary Lecture, International Congress of Women Mathematicians, Korea, 2014; Colloquium, Argonne National Laboratory, Physics Division, 2015.
Additional Information: NSF Career Award, 2008; Sloan Fellowship, 2008; Fellow, AMS, 2012; Kreeger Wolf Distinguished Visiting Professorship, Northwestern University, 2013–2014; Simons Fellowship, 2015.
Selected Publications: 1. The moduli space of quadratic rational maps, *J. Amer. Math. Soc.*, **20** (2007), no. 2, 321–355. **MR2276773 (2008c:14021)**; 2. with C. T. McMullen, Trees and the dynamics of polynomials, *Ann. Sci. Éc. Norm. Supér.*, **41** (2008), no. 3, 337–382. **MR2482442 (2010d:37087)**; 3. with M. Baker, Preperiodic points and unlikely intersections, *Duke Math. J.*, **159** (2011), no. 1,

1–29. **MR2817647 (2012h:37170)**; 4. with K. Pilgrim, Polynomial basins of infinity, *Geom. Funct. Anal.*, **21** (2011), no. 4, 920–950. **MR2827015 (2012m:37081)**; 5. with M. Baker, Special curves and postcritically finite polynomials, *Forum Math. Pi*, **1** (2013), e3, 35 pp. **MR3141413**.
Statement by Candidate: The AMS publishes top-quality journals and books, and I will work to maintain the high standards and smooth operation of these publications. It is important that careful thought go into selecting the editorial boards, to find individuals with strong research credentials and an understanding of this competitive and evolving industry.

Tatiana Toro

Professor of Mathematics, University of Washington.
Born: Bogota, Colombia.
PhD: Stanford University, 1992.
AMS Offices: Member, Council at Large, 1999–2001.
AMS Committees: Western Section Program Committee (Chair), February 2001–January 2002; Member, Centennial Fellowship Committee, July 2004–June 2006; Joint Program Committee (Chair), AMS-MAA JMM, February 2012–January 2013; Member, Program Committee for National Meeting, February 2015–January 2018.
Selected Addresses: Invited Address, Central Sectional Meeting, University of Texas, Austin, October 1999; Lars Ahlfors Centennial Celebration, Helsinki, Finland, August 2007; Invited Speaker, Analysis Session, ICM 2010, Hyderabad, India, August 2010; Invited Address, JMM, New Orleans, Louisiana, January 2011; Mini-course, 9th International Conference, *Harmonic Analysis and Partial Differential Equations*, El Escorial, Madrid, Spain, June 2012.
Additional Information: Mathematical Sciences Postdoctoral Research Fellowship, National Science Foundation, 1994–1998; Alfred P. Sloan Research Fellowship, 1996–2000; Member, Committee of Visitors for the Division of the Mathematical Sciences at NSF, February 2007; PIMS Scientific Review Panel (Chair), 2009–2013; Member, IPAM Board of Trustees, 2009–present; Simons Foundation Fellowship, 2012–2013; Chair, Organizing Committee of LATMATH 2015, sponsored by IPAM and PIMS, IPAM, UCLA, April 2015; Guggenheim Foundation Fellowship, 2015–2016.
Selected Publications: 1. Surfaces with generalized second fundamental form in L^2 are Lipschitz manifolds, *J. Differential Geom.*, **39** (1994), no. 1, 65–101. **MR1258915 (95b:49066)**; 2. with C. E. Kenig, Free boundary regularity for harmonic measures and Poisson kernels, *Ann. of Math.* (2), **150** (1999), no. 2, 369–454. **MR1726699 (2001d:31004)**; 3. with D. Preiss and X. Tolsa, On the smoothness of Hölder doubling measures, *Calc. Var. Partial Differential Equations*, **35** (2009), no. 3, 339–363. **MR2481829 (2010g:28006)**; 4. with C. Kenig and D. Preiss, Boundary structure and size in terms of interior and exterior harmonic measures in higher dimensions, *J. Amer. Math. Soc.*, **22** (2009), no. 3, 771–796. **MR2505300 (2010h:28005)**; 5. with G. David, Regularity of almost minimizers with free boundary, *Calculus of Variations and PDEs* (2014), (DOI) 10.1007/s00526-014-0792-z.
Statement by Candidate: I am honored to have been nominated to the AMS Editorial Boards Committee. The AMS journals play a crucial role in disseminating the most recent results in a broad spectrum of areas in Mathematics. I have been an editor for Proceedings, Transactions, Memoirs and the University Lecture series. I would like to have the opportunity to contribute to the journals from a different angle.

2016 AMS Election

Nominations by Petition

Vice President or Member at Large

One position of vice president and member of the Council *ex officio* for a term of three years is to be filled in the election of 2016. The Council intends to nominate at least two candidates, among whom may be candidates nominated by petition as described in the rules and procedures.

Five positions of member at large of the Council for a term of three years are to be filled in the same election. The Council intends to nominate at least ten candidates, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

Petitions are presented to the Council, which, according to Section 2 of Article VII of the bylaws, makes the nominations. The Council of 23 January 1979 stated the intent of the Council of nominating all persons on whose behalf there were valid petitions.

Prior to presentation to the Council, petitions in support of a candidate for the position of vice president or of member at large of the Council must have at least fifty valid signatures and must conform to several rules and procedures, which are described below.

Editorial Boards Committee

Two places on the Editorial Boards Committee will be filled by election. There will be four continuing members of the Editorial Boards Committee.

The President will name at least four candidates for these two places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and procedures, described below, should be followed.

Nominating Committee

Three places on the Nominating Committee will be filled by election. There will be six continuing members of the Nominating Committee.

The President will name at least six candidates for these three places, among whom may be candidates nominated by petition in the manner described in the rules and procedures.

The candidate's assent and petitions bearing at least 100 valid signatures are required for a name to be placed on the ballot. In addition, several other rules and procedures, described below, should be followed.

Rules and Procedures

Use separate copies of the form for each candidate for vice president, member at large, member of the Nominating or Editorial Boards Committees.

1. To be considered, petitions must be addressed to Carla D. Savage, Secretary, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294 USA, and must arrive by 24 February 2016.
2. The name of the candidate must be given as it appears in the *Combined Membership List* (`www.ams.org/cml`). If the name does not appear in the list, as in the case of a new member or by error, it must be as it appears in the mailing lists, for example on the mailing label of the *Notices.* If the name does not identify the candidate uniquely, append the member code, which may be obtained from the candidate's mailing label or by the candidate contacting the AMS headquarters in Providence (amsmem@ams.org).
3. The petition for a single candidate may consist of several sheets each bearing the statement of the petition, including the name of the position, and signatures. The name of the candidate must be exactly the same on all sheets.
4. On the next page is a sample form for petitions. Petitioners may make and use photocopies or reasonable facsimiles.
5. A signature is valid when it is clearly that of the member whose name and address is given in the left-hand column.
6. The signature may be in the style chosen by the signer. However, the printed name and address will be checked against the *Combined Membership List* and the mailing lists. No attempt will be made to match variants of names with the form of name in the *CML*. A name neither in the *CML* nor on the mailing lists is not that of a member. (Example: The name Carla D. Savage is that of a member. The name C. Savage appears not to be.)
7. When a petition meeting these various requirements appears, the secretary will ask the candidate to indicate willingness to be included on the ballot. Petitioners can facilitate the procedure by accompanying the petitions with a signed statement from the candidate giving consent.

CALL FOR Suggestions

Your suggestions are wanted by:

the Nominating Committee, for the following contested seats in the 2016 AMS elections:
vice president, trustee,
and five members at large of the Council.

Deadline for suggestions: November 1, 2015

the President, for the following contested seats in the 2016 AMS elections:
three members of the Nominating Committee and
two members of the Editorial Boards Committee.

Deadline for suggestions: January 31, 2016

the Editorial Boards Committee, for appointments to various editorial boards of AMS publications.

Deadline for suggestions: Can be submitted any time

Send your suggestions for any of the above to:

Carla D. Savage, Secretary
American Mathematical Society
Department of Computer Science
North Carolina State University
Raleigh, NC 27695-8206 USA
secretary@ams.org
or submit them online at www. ams.org/committee-nominate

AMS
American Mathematical Society
www.ams.org

Nomination Petition

for 2016 Election

The undersigned members of the American Mathematical Society propose the name of

_____

as a candidate for the position of (check one):

- ☐ **Vice President** (term beginning 02/01/2017)
- ☐ **Member at Large of the Council** (term beginning 02/01/2017)
- ☐ **Member of the Nominating Committee** (term beginning 01/01/2017)
- ☐ **Member of the Editorial Boards Committee** (term beginning 02/01/2017)

of the American Mathematical Society.

Return petitions by 24 February 2016 to:
Secretary, AMS, 201 Charles Street, Providence, RI 02904-2294 USA

Name and address (printed or typed)	
	Signature
	Signature
	Signature
	Signature
	Signature
	Signature

Search for an Executive Director for the American Mathematical Society

Position

The Trustees of the American Mathematical Society seek candidates for the position of Executive Director of the Society to replace Dr. Donald McClure, who plans to retire in the summer of 2016. This position offers the appropriate candidate the opportunity to have a strong positive influence on all activities of the Society, as well as the responsibility of overseeing a large, complex, and diverse spectrum of people, publications, and budgets. The desired starting date is July 1, 2016.

Duties and terms of appointment

The American Mathematical Society, with headquarters in Providence, RI, is the oldest scientific organization of mathematicians in the U.S. The Society's activities are mainly directed toward the promotion and dissemination of mathematical research and scholarship, broadly defined; the improvement of mathematical education at all levels; increasing the appreciation and awareness by the general public of the role of mathematics in our society; and advancing the professional status of mathematicians. These aims are pursued mainly through an active program of publications, meetings, and conferences. The Society is a major publisher of mathematical books and journals, including MathSciNet, an organizer of numerous meetings and conferences each year, and a leading provider of electronic information in the mathematical sciences. The Society maintains a Washington office for purposes of advocacy and to improve interaction with federal agencies.

The Executive Director is the principal executive officer of the Society and is responsible for the execution and administration of the policies of the Society as approved by the Board of Trustees and by the Council. The Executive Director is a full-time employee of the Society appointed by the Trustees and is responsible for the operation of the Society's offices in Providence and Pawtucket, RI; Ann Arbor, MI; and Washington, DC. The Executive Director is an ex-officio member of the policy committees of the Society and is often called upon to represent the Society in its dealings with other scientific and scholarly bodies.

The Society employs a staff of about 200 in the four offices. The directors of the various divisions report directly to the Executive Director. A major part of the Society's budget is related to publications. Almost all operations (including the printing) of the publications program are done in-house. Information about the operations and finances of the Society can be found in its Annual Reports, available at www.ams.org/annual-reports.

The Executive Director serves at the pleasure of the Trustees. The terms of appointment, salary, and benefits will be consistent with the nature and responsibilities of the position and will be determined by mutual agreement between the Trustees and the prospective appointee.

Qualifications

Candidates for the office of Executive Director should have a Ph.D. (or equivalent) in mathematics, published research beyond the Ph.D., and significant administrative experience. The position calls for interaction with the staff, membership, and patrons of the Society as well as leaders of other scientific societies and publishing houses; thus leadership, communication skills, and diplomacy are prime requisites.

Applications

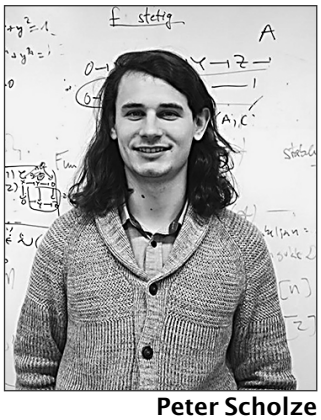
A search committee chaired by Robert Bryant (bryant@math.duke.edu) and Ruth Charney (charney@brandeis.edu) has been formed to seek and review applications. All communication with the committee will be held in confidence. Suggestions of suitable candidates are most welcome. Applicants can submit a CV and letter of interest to:

Executive Director Search Committee
c/o Carla D. Savage
Secretary, American Mathematical Society
Department of Computer Science
North Carolina State University
Raleigh, NC 27695-8206
ed-search@ams.org

The American Mathematical Society is an Affirmative Action/Equal Opportunity Employer.

Mathematics People

Scholze Awarded Ostrowski Prize


©Astrid Slizewski/Uni Bonn.

Peter Scholze

PETER SCHOLZE of the University of Bonn has been awarded the Ostrowski Prize for 2015 "for his breakthrough work in arithmetic algebraic geometry." The prize carries a cash award of 100,000 Swiss francs (approximately US$109,000).

According to the prize citation, Scholze was honored "for developing the theory of perfectoid spaces and successfully applying the theory to address a number of difficult open questions. This theory allows one to reduce problems about algebraic varieties over rings of mixed characteristic to problems about algebraic varieties over rings in a fixed positive characteristic. Scholze proved Deligne's weight monodromy conjecture for varieties that are nonsingular complete intersections in projective space using the theory of perfectoid spaces. This represents the first major progress in the last thirty years towards Deligne's conjecture. He has also used perfectoid spaces to establish p-adic Hodge theory for rigid analytic spaces. Further with Weinstein, he showed that Rapoport-Zink spaces at infinite level are perfectoid spaces. By studying these spaces they [were] able to [reprove] and generalize the Gross-Hopkins conjecture. Scholze has also used the theory of perfectoid spaces to establish the existence of Galois representations associated with the mod p cohomology of the locally symmetric spaces for GL_n over a totally real or CM field. In so doing he resolved conjectures of Ash, Grunewald, and others which had resisted attack for forty years."

Peter Scholze received his PhD in 2012 from the University of Bonn. He currently holds the Hausdorff Chair at the university. He is a fellow of the Clay Mathematics Institute. His honors include the SASTRA Ramanujan Prize (2013), the Clay Research Award (2014), and the Cole Prize in Algebra (2015).

The ceremony for the Ostrowski Prize will be held in Copenhagen on October 30, 2015.

About the Prize

The Ostrowski Foundation was created by Alexander Ostrowski, for many years a professor at the University of Basel. He left his entire estate to the foundation and stipulated that the income should provide a prize for outstanding recent achievements in pure mathematics and the foundations of numerical mathematics.

—From an Ostrowski Foundation announcement

2015 Henri Poincaré Prizes Awarded

The International Association of Mathematical Physics (IAMP) has awarded the 2015 Henri Poincaré Prizes for mathematical physics to THOMAS SPENCER of the Institute for Advanced Study, Princeton; HERBERT SPOHN of Technische Universität München; and ALEXEI BORODIN of the Massachusetts Institute of Technology. Spencer was honored "for his seminal contributions to the theory of phase transitions, the theory of disordered systems, and constructive quantum field theory, including his proofs of the existences of broken symmetry phases and Anderson localization, and his use of novel supersymmetry methods." Spohn was honored "for his seminal contributions to the theory of transitions from microscopic to macroscopic physics, including his derivation of kinetic and diffusive behavior from classical and quantum systems, and his work on the fluctuation behavior of surface growth models." Borodin was honored "for his seminal contributions to the theory of big groups, to determinantal processes and most notably to the elucidation of Macdonald processes, which have important applications to the statistical physics of directed polymers, tiling models and random surfaces."

The Henri Poincaré Prize, which is sponsored by the Daniel Iagolnitzer Foundation, recognizes outstanding contributions that lay the groundwork for novel developments in mathematical physics. It also recognizes and supports young people of exceptional promise who have already made outstanding contributions to the field. The prize is awarded every three years at the International Congress on Mathematical Physics. This year's prizes were awarded on July 27, 2015, in Santiago de Chile. For prior winners, selection committee members and laudations, see `www.iamp.org/page.php?page=page_prize_poincare`.

—Announcement of the IAMP

Babai Awarded Knuth Prize

LÁSZLÓ BABAI of the University of Chicago has been awarded the Donald E. Knuth Prize of the Association for Computing Machinery (ACM) Special Interest Group on

Algorithms and Computation Theory (SIGACT) and IEEE Computer Society's Technical Committee on the Mathematical Foundations of Computing (TCMF) "for his fundamental contributions to algorithm design and computational complexity, including pioneering a new understanding of the notion of mathematical proof." According to the prize citation, Babai was recognized "for his many visionary contributions, which have transformed the landscape of computing theory. He led the way in combining interaction and randomness to broaden the millennia-old concept of mathematical proof. His work on the power of interactive proofs with multiple provers led to the discovery of the fundamental implications of the hardness of approximately solving optimization problems. The methods for interactive proofs introduced by him and his co-authors also became a foundation for the development of locally testable codes and the study of property testing."

The Knuth Prize carries a cash award of US$5,000. It is named in honor of Donald Knuth of Stanford University, who has been called the "father" of the analysis of algorithms. The award recognizes outstanding contributions to the foundations of computer science by individuals for their overall impact in the field over an extended period.

—From an ACM announcement

Spielman and Teng Awarded Gödel Prize

Daniel A. Spielman of Yale University and Shang-Hua Teng of the University of Southern California have been awarded the 2015 Gödel Prize of the Association for Computing Machinery (ACM) Special Interest Group on Algorithms and Computation Theory (SIGACT), together with the European Association for Theoretical Computer Science (EATCS), for "improvements in the running time for core problems in algorithmic graph theory." According to the prize citation, Spielman and Teng were honored for their work addressing "the challenge of improving the efficiency of graph algorithms. Their result delivered a new, extremely powerful algorithmic primitive or basic building block—nearly linear time electrical flow computations—which resolved an outstanding problem in numerical linear algebra. Their approach has been used to obtain substantial improvements in the running time for several core problems in algorithmic graph theory, which are used to model real-world problems."

The Gödel Prize carries a cash award of US$5,000. It is named in honor of Kurt Gödel, whose work has had immense impact upon scientific and philosophical thinking in the twentieth century. The prize recognizes major contributions to mathematical logic and the foundations of computer science.

—From an ACM announcement

Ghys Receives Clay Award for Dissemination

Etienne Ghys of École Normale Supérieure de Lyon, has been selected as the recipient of the first Clay Award for Dissemination of Mathematical Knowledge for his "important contributions to mathematical research and for his distinguished work in the promotion of mathematics." He has spoken before audiences "ranging from schoolchildren to delegates at the International Congress in 2006," according to the prize citation. As editor of *Images des mathématiques*, he transformed it into an online publication that has received more than five million visits. He is a cofounder of an international summer school in mathematics for young people and has coproduced a series of films for DVD and online in many languages. He is a member of the French Academy of Sciences and was a member of the program committee for the International Congress of Mathematicians in Hyderabad and of the Fields Medal Committee in 2014.

—From a Clay Mathematics Institute announcement

Awards of the AWM

The Association for Women in Mathematics (AWM) has made several awards for 2015.

Erica N. Walker of Columbia University has been named the Etta Z. Falconer Lecturer of the AWM and the Mathematical Association of America (MAA). Walker holds an EdD in administration, planning, and social policy and a PhD in education, both from Harvard University. Her research involves social and cultural factors and educational policies and practices that facilitate engagement, learning, and performance in mathematics, especially for underserved students. She collaborates with teachers, schools, districts, and organizations to promote mathematics excellence and equity among young people. She has authored or coauthored more than twenty-five articles and book chapters, as well as two books. Her prize lecture, titled "A Multiplicity All At Once: Mathematics for Everyone, Everywhere," was delivered at the MAA Mathfest in Washington, DC, in August 2015.

Daniela De Silva of Barnard College has been awarded the 2016 AWM-Sadosky Research Prize in Analysis "in recognition of her fundamental contributions to the regularity theory of nonlinear elliptic partial differential equations (PDE) and nonlocal integro-differential equations." She received her PhD from the Massachusetts Institute of Technology in 2005. The prize recognizes exceptional research in analysis by a woman early in her career.

Lauren Williams of the University of California Berkeley has been selected to receive the AWM-Microsoft Research Prize in Algebra and Number Theory "in recognition of her exceptional research in algebraic combinatorics." She received her PhD in 2005 from the Massachusetts Institute of Technology. The prize recognizes exceptional

research in algebra and number theory by a woman early in her career.

—From AWM announcements

Guth and Katz Receive Clay Research Award

LARRY GUTH of the Massachusetts Institute of Technology and NETS KATZ of the California Institute of Technology have been jointly honored with the 2015 Clay Research Award "for their solution of the Erdős distance problem and for other joint and separate contributions to combinatorial incidence geometry. Their work is an important contribution to the understanding of the interplay between combinatorics and geometry."

The distance problem was posed by Paul Erdős in 1946. It concerns the distribution of distances determined by a set of n points in a metric space. At most how many times can the same distance (say the unit distance) occur? What is the minimum number of distinct distances that can occur? In 2010 Guth and Katz published a spectacular breakthrough in which they gave a near-optimal answer to the second question for points in the plane by proving an almost tight lower bound of the order of $n/\log n$. Their paper built on a novel approach to the problem suggested by Elekes and Sharir and also on the earlier work on the Kakeya problem.

Guth received his PhD in 2005 from the Massachusetts Institute of Technology under Tomasz Mrowka. He has made major contributions to harmonic analysis and combinatorics. Katz received his PhD in 1993 from the University of Pennsylvania under Dennis DeTurck. He has made important contributions in additive number theory.

—From a Clay Mathematics Institute announcement

Ford Foundation Fellowships Awarded

Four young mathematicians have been awarded National Research Council-Ford Foundation Predoctoral Fellowships for 2015. They are ERNESTO D. CALLEROS, Rice University, algebra or number theory; ASHLEE K. KALAULI, University of California Santa Barbara, mathematics; VANESSA RIVERA QUIÑONES, University of Illinois, Urbana-Champaign, applications of mathematics; and CHARLES WILKES II, University of Michigan, Ann Arbor, mathematics and education.

—From a Ford Foundation announcement

AMS Menger Awards at the 2015 ISEF

The 2015 Intel International Science and Engineering Fair (ISEF) was held May 10–15, 2015, at the David L. Lawrence Convention Center in Pittsburgh, Pennsylvania. This year about 1,700 students in grades nine through twelve (selected from hundreds of affiliate fairs in more than seventy-five countries, regions, and territories) participated in the world's largest precollege science research competition. The first ISEF was held in Philadelphia in 1950. In 1958 the fair became international when Japan, Canada, and Germany joined the competition.

Student finalists who competed at this year's Intel ISEF went through a multistep process to qualify and won an all-expenses-paid trip to the fair. They qualified by winning local, regional, and state fairs in the United States or national science fairs abroad. In addition to numerous grand awards presented by ISEF, dozens of federal agencies and professional and educational organizations, including the American Mathematical Society (AMS), participated by giving special awards. Prizes given by the AMS included cash (the amounts have been doubled since last year), certificates, and a booklet about Karl Menger, given to each award winner.

For the AMS, this was the twenty-seventh year of participation, and it was the twenty-fifth year of the presentation of the Karl Menger Awards. The members of the 2015 AMS Menger Prize Committee and AMS Special Awards judges were Daniel Dugger, University of Oregon; Irina Mitrea, Temple University; and Mihai Stoiciu, Williams College (chair). The panel of judges initially reviewed all forty-nine projects in mathematics; there were forty individual and nine team projects. From these entries the judges selected a subset of students who were interviewed for further consideration for a Menger Prize. The AMS gave awards to one first-place winner, two second-place winners, and four third-place winners. Five more students received honorable mentions.

The Karl Menger Memorial Prize winners for 2015 are listed below, together with each student's high school and project title.

First Place Award (US$2,000): NITYA MANI, The Harker School, San Jose, California, "Characterizing the constructible n-division points of the rational C-hypocycloids through straightedge and compass constructions." Mani received the first-place award for the second year in a row.

Second Place Awards (US$1,000): STEFAN L. COLTON, Hunter College High School, New York, New York, "Solution to the realization problem for two element delta sets"; PETAR M. GAYDAROV, Model High School of Mathematics, "Akad. Kiril Popov", Plovdiv, Bulgaria, "Vector parking functions and tree inversions."

Third Place Awards (US$500): CHIA HUA CHANG, National Taichung Girls Senior High School, Taichung, Taiwan, "What number cannot be realized as the number of regions divided by n straight lines?" SHASHWAT KISHORE, Unionville High School, Kennet Square, Pennsylvania, "Signatures of multiplicity spaces in tensor products of $\mathfrak{sl}_2$ and $U_q(\mathfrak{sl}_2)$ representations"; ERIC M. NEYMAN,

Montgomery Blair High School, Silver Spring, Maryland, "Cylindric young tableaux and their properties"; VISHAL RAJESH, Plano Senior High School, Plano, Texas, and NISHA RAJESH, Jasper High School, Plano, Texas (team entry), "Mathematical fire fighting: Combating fire with Delaunay triangulation and longitudinal-reversible cellular automata."

Honorable Mention Awards: SANATH KUMAR DEVALAPURKAR, West High School, Torrance, California, "Preserving algebraic structures on exact infinity: Categories with the *K*-theory functor"; GEORGE DRIMBA, Stuyvesant High School, New York, New York, "Categorizing point sets with no empty pentagons"; DANIEL M. HANOVER, John L. Miller Great Neck North High School, Great Neck, New York, "The base dependent behavior of Kaprekar's routine: A theoretical and computational study revealing new regularities"; JUNG YOON KIM, Thomas Jefferson High School for Science and Technology, Alexandria, Virginia, "Connected matchings in graphs with independence number 2"; ABHIMANYU PALLAVI SUDHIR, Dhirubhai Ambani International School, Mumbai, India, "A generalization of the determinant to rectangular matrices: Implications in gauge theory."

As indicated by these project titles, student research covered a wide range of topics. The judges were impressed by the quality, breadth, and originality of the work, as well as by the dedication and enthusiasm shown. The youngest competitor in the mathematics section was fourteen and the youngest winners of the Menger Awards were fifteen: Nisha Rajesh (Third Prize); Sanath Kumar Devalapurkar and Abhimanyu Pallavi Sudhir (Honorable Mentions).

The Society for Science and the Public (www.societyforscience.org), a nonprofit organization based in Washington, DC, owns and has administered ISEF since 1950, first sponsored by Westinghouse and then, since 1998, by Intel. The Intel ISEF finals for next year will be held May 8–13, 2016, in Phoenix, Arizona. See www.societyforscience.org/intelisef2016.

The AMS's participation in ISEF is supported in part by income from the Karl Menger Fund, which was established by the family of the late Karl Menger (www.ams.org/profession/prizes-awards/ams-awards/menger-award). The income from the donation by the Menger family covers less than the amount of the awards. The balance, including the travel expenses of the judges, comes from the AMS's general fund. For more information about this program or to make contributions to this fund, contact the AMS Development Office, 201 Charles Street, Providence, RI 02904-2294; or send email to development@ams.org; or telephone 401-455-4111.

—AMS announcement

Mathematical Sciences Awards at ISEF

The 2015 Intel International Science and Engineering Fair was held in Pittsburgh, Pennsylvania, May 10–15, 2015. The Society for Science and the Public, in partnership with the Intel Foundation, selects a Best of Category contestant, who receives a cash award of US$5,000; in addition, a

Photo courtesy of April Rietze, Society for Science & the Public.

Back row (left to right): Stefan Colton (Second Place), Nitya Mani (First Place), Eric Neyman (Third Place), Vishal Rajesh (Third Place, shared with Nisha Rajesh), (Mihai Stoiciu - AMS); Front row (left to right): Petar Gaydarov (Second Place), Chia Hua Chang (Third Place), Nisha Rajesh (Third Place, shared with Vishal Rajesh), Shashwat Kishore (Third Place).

US$1,000 grant is given to the student's school and the Intel ISEF Affiliated Fair he or she represents. The student chosen this year in the Mathematical Sciences category was SANATH KUMAR DEVALAPURKAR, fifteen, West High School, Torrance, California, for his project, "Preserving algebraic structures on exact infinity: Categories with the *K*-theory functor." Devalapurkar also received a First Award, which carries a cash prize of US$3,000. More award winners and the titles of their projects follow.

First Award (US$3,000): SANATH KUMAR DEVALAPURKAR, West High School, Torrance, California, "Preserving algebraic structures on exact infinity: Categories with the *K*-theory functor."

Second Award (US$1,500): KRITHIKA IYER, sixteen, iSchool High STEM Academy, Lewisville, Texas, "Boolean AlGenebra: A nature-inspired framework for the analysis of cancer genes"; PETAR M. GAYDAROV, eighteen, Model High School of Mathematics, "Akad. Kiril Popov", Plovdiv, Bulgaria, "Vector parking functions and tree inversions"; ROMAN KRUTOVSKIY, seventeen, Gymnasium 1514, Moscow, Russian Federation, "The tie theorems."

Third Award (US$1,000): KIRA KOZLOVA, seventeen, Lyceum "Vtoraya Shkola", Moscow, Russian Federation, "The game with stones and 'generalized Fibonacci sequence'"; NITYA MANI, seventeen, The Harker School, San Jose, California, "Characterizing the constructible *n*-division points of the rational *C*-hypocycloids through straightedge and compass constructions"; ALEXANDER LIN, Millburn High School, Millburn, New Jersey, "Approximating the maximum *k*-colorable subgraph problem on dotted interval graphs"; JARED A. TRAMONTANO, sixteen, Centennial High School, Corona, California, "Fuzzy structures with application to differential topology, manifold learning, and specialized concepts in mathematics."

Fourth Award (US$500): I KADEK SUDIARSANA, eighteen, and I DEWA GEDE ARY PALGUNA, eighteen, both of SMAN Bali Mandara High School, Singaraja, Indonesia, "The motifs development of gringsing sarong"; DANIL

FIALKOVSKIY, seventeen, School 564, Saint Petersburg, Russian Federation, "Fast algorithm of commutator length computing in free group"; SWAPNIL PANDE, seventeen, Mills E. Godwin High School, Henrico, Virginia, "Mathematical modeling and simulation of cardiac tissue electrophysiology: Effect of cardiac deformation on action potential duration"; HEATHER A. NEWMAN, seventeen, Colonia High School, Colonia, New Jersey, "Optimizing sensor configurations for ground-level and aerial intrusion detection by applying the minimum vertex cover problem"; and NITHIN VENKAT KANNAN, sixteen, and YOUNG HAN KIM, sixteen, both of BASIS Scottsdale, Scottsdale, Arizona, "On the constructibility of n-division points of certain polar curves by area."

—From an ISEF announcement

Mathematics Opportunities

American Mathematical Society Centennial Fellowship

Invitation for Applications for Awards for 2016–2017
Deadline December 1, 2015

Description: The AMS Centennial Research Fellowship Program makes awards annually to outstanding mathematicians to help further their careers in research. The number of fellowships to be awarded is small and depends on the amount of money contributed to the program. The Society supplements contributions as needed. At least one fellowship will be awarded for the 2016–2017 academic year. A list of previous fellowship winners can be found at www.ams.org/profession/prizes-awards/ams-awards/centennial-fellow.

Eligibility: The eligibility rules are as follows. The primary selection criterion for the Centennial Fellowship is the excellence of the candidate's research. Preference will be given to candidates who have not had extensive fellowship support in the past. Recipients may not hold the Centennial Fellowship concurrently with another research fellowship such as a Sloan or NSF Postdoctoral fellowship. Under normal circumstances, the fellowship cannot be deferred. A recipient of the fellowship shall have held his or her doctoral degree for at least three years and not more than twelve years at the inception of the award (that is, received between September 1, 2004, and September 1, 2013). Applications will be accepted from those currently holding a tenured, tenure-track, postdoctoral, or comparable (at the discretion of the selection committee) position at an institution in North America. Applications should include a cogent plan indicating how the fellowship will be used. The plan should include travel to at least one other institution and should demonstrate that the fellowship will be used for more than reduction of teaching at the candidate's home institution. The selection committee will consider the plan, in addition to the quality of the candidate's research, and will try to award the fellowship to those for whom the award would make a real difference in the development of their research careers. Work in all areas of mathematics, including interdisciplinary work, is eligible.

Deadline: The deadline for receipt of applications is **December 1, 2015**. The award recipient will be announced in February 2016 or earlier if possible.

Application information: Find Centennial information and the application form via the Internet at www.ams.org/ams-fellowships/. For paper copies of the form, write to the Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence, RI 02904-2294; prof-serv@ams.org; 401-455-4096.

—AMS announcement

Call for Nominations for the Award for Impact on the Teaching and Learning of Mathematics

This award is given annually to a mathematician or group of mathematicians who have made significant contributions of lasting value to mathematics education. Priorities of the award include recognition of (a) accomplished mathematicians who have worked directly with precollege teachers to enhance teachers' impact on mathematics achievement for all students or (b) sustainable and replicable contributions by mathematicians to improving the mathematics education of students in the first two years of college. The US$1,000 annual award is provided through an endowment fund established by a contribution from Kenneth I. and Mary Lou Gross in honor of their daughters, Laura and Karen. The AMS Committee on Education selects the recipient. The deadline for nominations for the 2016 award is **September 15, 2015**. For more information, see the nomination webpage at www.ams.org/profession/prizes-awards/ams-awards/impact .

—AMS Washington Office

AWM Travel Grants for Women

The National Science Foundation (NSF) and the Association for Women in Mathematics (AWM) sponsor travel grant programs for women mathematicians. AWM Travel Grants for Women Researchers enable women to attend research conferences in their fields, thereby providing scholars valuable opportunities to advance their research activities and their visibility in the research community. A Mathematics Travel Grant provides full or partial support for travel and subsistence for a meeting or conference in the grantee's field of specialization, awarding funds of up to US$2,300 for domestic travel and of US$3,500 for foreign travel.

The Mathematics Education Research Travel Grants provide full or partial support for travel and subsistence in math/math education research for mathematicians attending a math education research conference or math education researchers attending a math conference. The grants provide up to US$2,300 for domestic travel and of US$3,500 for foreign travel.

AWM Mathematics Mentoring Travel Grants are designed to help junior women develop long-term working and mentoring relationships with senior mathematicians. A mentoring travel grant funds travel, subsistence, and

other expenses for an untenured woman mathematician to travel to an institute or a department to do research with a specified individual for one month. Up to seven grants will be awarded in amounts up to US$5,000 each.

Mathematics Education Research Mentoring Travel Grants encourage collaboration between mathematicians and researchers in education and related fields in order to improve the education of teachers and students. Women mathematicians who wish to collaborate with an educational researcher or to learn about educational research may use the mentoring grants to travel to collaborate with or be mentored by a mathematics education researcher. Up to seven grants will be awarded in amounts up to US$5,000 each.

The final deadline for the Travel Grants program for 2015 is **October 1, 2015**.

The deadlines for 2016 are **February 1, 2016**; **May 1, 2016**; and **October 1, 2016**.

For the Mathematics Education Research Travel Grant program the deadlines are **October 1, 2015**; **February 1, 2016**; **May 1, 2016**; and **October 1, 2016**.

For the Mathematics Mentoring Travel Grants program the deadline is **February 1, 2016**.

For the Mathematics Education Research Mentoring Travel Grants program the deadline is **February 1, 2016**.

For further information and details on applying, see the website `https://sites.google.com/site/awmmath/programs/travel-grants`; tel: 703-934-0163; email: `awm@awm-math.org`; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

—From an AWM announcement

Call for Nominations for Clay Research Fellowships

The Clay Mathematics Institute (CMI) solicits nominations for its competition for the 2016 Clay Research Fellowships. Fellows are appointed for a period of one to five years. They may conduct their research at whatever institution or combination of institutions best suits their research. In addition to a generous salary, the fellows receive support for travel, collaboration, and other research expenses. The selection criteria are the quality of the candidate's research and promise to become a mathematical leader. All those selected are recent PhDs, and most are selected as they complete their thesis work. Selection decisions are made by CMI's Scientific Advisory Board.

To nominate a candidate, please send the following items by **November 16, 2015**: (1) letter of nomination, (2) names and contact information of two other references, (3) curriculum vitae for the nominee, and (4) publication list for the nominee. For more information and submission instructions, see `www.claymath.org/programs/fellowship-nominations`.

—From a Clay Mathematics Institute announcement

NRC-Ford Foundation Fellowships

Through its Fellowship Programs, the Ford Foundation seeks to increase the diversity of the nation's college and university faculties by increasing their ethnic and racial diversity, to maximize the educational benefits of diversity, and to increase the number of professors who can and will use diversity as a resource for enriching the education of all students. The fellowships are administered by the Fellowships Office of the National Research Council. All citizens or nationals of the United States are eligible, regardless of race, national origin, religion, gender, age, disability, or sexual orientation. The fellowships are awarded to individuals who demonstrate superior academic achievement (such as grade point average, class rank, honors, or other designations) and who are committed to a career in teaching and research at the college or university level.

Approximately sixty Predoctoral Fellowships will be awarded. These fellowships provide three years of support for individuals engaged in graduate study leading to a PhD or ScD degree. The online application deadline is **November 20, 2015**.

Approximately thirty-six Dissertation Fellowships will be awarded. These fellowships provide one year of support for individuals working to complete a dissertation leading to a PhD or ScD degree. The online application deadline is **November 13, 2015**.

Approximately twenty Postdoctoral Fellowships will be awarded. These fellowships provide one year of support for individuals engaged in postdoctoral study after the attainment of the PhD or ScD degree. The online application deadline is **November 13, 2015**.

For further information, visit the website `sites.nationalacademies.org/pga/fordfellowships/` or contact: Fellowships Office, Keck 576, National Research Council, 500 Fifth Street, NW, Washington, DC 20001; tel: 202-334-2872; fax: 202-334-3419; email: `infofell@nas.edu`.

—From the Ford Foundation Fellowships website

News from CIRM

The Centro Internazionale per la Ricerca Matematica (CIRM), located in Trento, Italy, announces the following activities in mathematics research in 2016.

Conferences. A series of conferences and mathematical meetings will be supported in 2016. Proposals must be submitted before **September 30, 2015**, by postal mail to Fondazione Bruno Kessler, Centro Internazionale per la Ricerca Matematica, Via Sommarive n. 14-Povo, 38123 Trento, Italy, or by email to `micheletti@fbk.eu`. For more information see the website `cirm.fbk.eu/call-applications-2016-conferences`.

Visiting Professorships, Visiting Scholars, Research in Pairs. CIRM Visiting Scholars will perform mathematical research in cooperation with scientists and researchers at

Trento University or, more generally, in the Trento area, holding some research seminars; CIRM Visiting Professors will hold short PhD courses, summer courses, or series of seminars. The Research in Pairs program supports two or three partners from universities located in different towns who intend to work together at CIRM on a definite research project for a period of time ranging from one to six weeks. Applications for these programs must be sent by postal mail to Fondazione Bruno Kessler, Centro Internazionale per la Ricerca Matematica, Via Sommarive n. 14–Povo, 38123 Trento, Italy, or preferably by email to micheletti@fbk.eu. Applications can be submitted at any time, though it is recommended that they be submitted at least three months before the planned stay. They must contain a specific indication of the proposed dates for the visit and a list of publications for each applicant. For more information see cirm.fbk.eu/cirm-visiting-professors and cirm.fbk.eu/research-pairs.

—Marco Andreatta, Director
CIRM

News from BIRS

The Banff International Research Station for Mathematical Innovation and Discovery (BIRS) is now accepting proposals for its 2017 program. BIRS will again be hosting a forty-eight-week scientific program at its station in Banff. BIRS is also hoping to run an additional twenty to twenty-five workshops at its developing new station in Oaxaca, Mexico.

The mandate of BIRS is to provide an environment for creative interaction and the exchange of ideas, knowledge, and methods within the mathematical, statistical, and computing sciences and with related disciplines and industrial sectors. Each week, the station hosts either a full workshop (forty-two people for five days) or two half-workshops (each with twenty-one people for five days). As usual, BIRS provides full accommodation, board, and research facilities at no cost to the invited participants in a setting conducive to research and collaboration.

The deadline for five-day workshop and summer school proposals is **September 30, 2015**. Full information, guidelines, and online forms are available at the BIRS website, www.birs.ca.

In addition, BIRS will operate its Research in Teams and Focused Research Groups programs, which allow smaller groups of researchers to get together for several weeks of uninterrupted work at the station. The preferred date to apply for these programs is **September 30, 2015**. However, proposals for projects involving Research in Teams or Focused Research Groups can be submitted at any time, but they must be received at least four months before their requested start date. Proposal submissions should be made using the online submission form. See https://www.birs.ca/proposals.

—Nassif Ghoussoub, Scientific Director
Banff International Research Station

Modern Math Workshop, 2015, Washington, DC

The nine NSF-funded US-based math institutes present the annual Modern Math Workshop (MMW) on October 28–29 (Wednesday–Thursday) in the Washington DC area. The MMW is part of the institutes' Mathematical Sciences Diversity Initiatives and the workshop is a preconference activity of the SACNAS National Conference (Society for Advancement of Chicanos/Hispanics and Native Americans in Science; see sacnas.org/events/national-conf). The MMW includes two minicourses for undergraduates and talks related to the research programs at the math institutes that would be of interest to graduate students and early-career researchers. The workshop is intended to encourage minority undergraduates to pursue careers in the mathematical sciences and to assist undergrads, graduate students and recent PhDs in building their research networks. The MMW culminates on October 29 with a plenary lecture by Dr. Freeman Hrabowski, president of UMBC (The University of Maryland, Baltimore County). Minority undergraduates, graduate students, and postdocs are encouraged to attend the workshop. For more information and to register, please see www.msri.org/e/MMW2015.

—From an MSRI announcement

Mathematical Sciences Research Institute, Berkeley, CA

Call for Program Proposals

The Mathematical Sciences Research Institute invites the submission of preproposals for full- or half-year programs to be held at MSRI. Planning of such programs is generally done about three years ahead. Except in extraordinary cases, a subject is the focus of a program not more than once in ten years.

A scientific program at MSRI generally consists of up to one year (10 months) of concentrated activity in a specific area of current research interest in the mathematical sciences. MSRI usually runs two programs simultaneously, each with about forty mathematicians in residence at any given time. The most common program lengths are five months (typically in the form of a fall or spring semester program). Each program begins with a Connections for Women workshop, followed by an introductory workshop. The purpose of both is to introduce the subject to the broader mathematical community. The programs receive administrative and financial support from the institute, allowing organizers to focus on the scientific aspects of the activities.

The Scientific Advisory Committee (SAC) of the institute meets in January and November each year to consider preproposals for programs. Successful proposals are usually developed from the preproposal in a collaborative process between the proposers, the Directorate and the SAC, and

may be considered at more than one meeting of the SAC before selection.

The scientific planning and organization of each program are the responsibility of a committee of organizers (aided by a liaison of the Directorate and the SAC). The organizers eventually recommend participants chosen from a pool of national and international applicants; they plan workshops and lecture series within the program which many more participants may attend. Each program is allocated a budget for subsistence and travel expenses.

How to submit a program preproposal. Proposals should be submitted to `proposals@msri.org` before **October 15** in time to be reviewed by the Scientific Advisory Committee at its early November meeting. Please see our website for specific preproposal requirements and further information: `https://www.msri.org/web/msri/scientific/request-for-proposals/propose-a-program`.

MSRI programs are funded by the National Science Foundation.

Call for Hot Topics Workshop Proposals

The Mathematical Sciences Research Institute invites the submission of proposals for "Hot Topic Workshops." Each spring MSRI provides a yearly workshop called Hot Topics to showcase what is new, innovative, and interesting to the mathematical sciences community at the present time. The workshop should last five days (or less). A proposal should include a summary of what is going on in the field, especially what makes it suitable for treatment at this moment; a list of possible organizers and/or main speakers (this list need not be complete, and the proposers do not have to contact the people listed in advance); and any known information about other recent or proposed conferences in the area. Please include estimated date(s) of the workshop, noting alternate dates to allow coordination with other MSRI events.

The Scientific Advisory Committee (SAC) of the institute will review all proposals and select one workshop for spring 2017.

How to submit a proposal. Proposals should be submitted to `proposals@msri.org` before **October 15** in time to be reviewed by the Scientific Advisory Committee at its early November meeting.

Please see our website for specific proposal requirements and further information: `www.msri.org/web/msri/scientific/request-for-proposals/propose-a-hot-topics-workshop`.

MSRI workshops are funded by the National Science Foundation.

—From an MSRI announcement

About the Cover

Simple but Effective: Van der Waerden's Tick Diagrams

In this issue is a book review by Reinhart Siegmund-Schulze of Alexander Soifer's biography of the renowned Dutch mathematician Bartel van der Waerden. Soifer's biography has aroused much controversy. Van der Waerden's behavior during World War II caused much criticism in his own country after the war and Soifer has brought this criticism to life again.

Van der Waerden is well known for his textbook on what was then called modern algebra, but also for a striking theorem of his youth—the proof of a conjecture attributed at times to either Issai Schur or P. J. H. Baudet:

> *If the set of positive integers is partitioned into two subsets, then arithmetic progressions of arbitrary length can be found in one or the other.*

Van der Waerden's proof appeared in volume 15 of the *Nieuw Archief voor Wiskunde*. It became famous when a slightly different proof appeared as the first pearl in Khinchin's **Three Pearls of Number Theory**.

N. G. de Bruijn has written a helpful note about the conjecture titled *Commentary*. It was written for a book that never appeared, but can be found on the Internet. De Bruijn remarks that although "Van der Waerden's proof is very clear from his paper, yet the notational difficulties seemed to be a bit awkward to the modern combinatorialists." An extremely brief proof of the conjecture presumably intended to get around that difficulty was presented by Ron Graham and B. L. Rothschild in 'A short proof of Van der Waerden's theorem on arithmetic progressions' (volume 42 of the *Proceedings of the AMS*). Some will be amused by the comment at the end of this paper that "… while previous proofs follow essentially the argument above, the one given above is hopefully clearer."

There are no figures in any of these accounts. But Van der Waerden eventually wrote an informal account of how the proof was discovered, which deserves to be ranked with the greatest short expositions of mathematics of all times. This first appeared in English as a chapter in the book **Studies in Pure Mathematics**, edited by L. Mirsky and published in 1971. It was reprinted, with Van der Waerden's permission, in Chapter 33 of Soifer's **The Mathematical Coloring Book**. The book by Soifer reviewed in this issue discusses the conjecture in an extremely short chapter, but the coloring book treats it and its history at great length as well as reproducing Van der Waerden's account *verbatim*.

In this informal account Van der Waerden narrates the events of two days in Göttingen in 1926. The central event was a discussion, after lunch on the second day, by Van der Waerden, Emil Artin, and Otto Schreier in Artin's office, in the course of which the entire proof was found. Artin and Schreier made important initial observations that reduced the conjecture to something manageable, but it was apparently Van der Waerden who used little diagrams on a blackboard to find the path from the reduction.

The cover of this issue of *The Notices* illustrates the figures for the very first step in his eventual proof. These and similar diagrams turned out to be the key; they make the proof transparent.

The early part of this two-day discussion led to a stronger formulation of the conjecture:

> *Suppose k, ℓ to be integers ≥ 2, and suppose the positive integers are partitioned into k subsets. There exists $n(k,\ell)$ such that any interval of $n(k,\ell)$ positive integers possesses an arithmetic progression of length ℓ in one of the subsets.*

The case $k = 2$, $\ell = 2$ is true by the pigeonhole principle. For $k = 2$, $\ell = 3$ a listing of all possibilities shows that one can take $n(2,3) = 9$, but such a procedure is impossible for all other cases, and this argument gives no hint at all of how to proceed. The diagrams on the cover, on the other hand, do lead to a proof in this simple case that turns out to carry through very generally. Van der Waerden's use of his tick figures is one of the classic examples of schematic diagrams in mathematical proofs.

Unfortunately, how this goes is a little too complicated even to suggest here.

The numbers $n(k,\ell)$ grow astronomically with k and ℓ, very roughly the order of towers of exponentials. Soifer's **Coloring Book** discusses subsequent work on the true order of magnitude, as well as other later generalizations of Van der Waerden's result—for example, the well-known results of Szemeredi and Furstenberg.

—Bill Casselman
Graphics Editor
notices-covers@ams.org

For Your Information

Committee on Women and Mathematics of the IMU

The Executive Committee of the International Mathematical Union (IMU) has established the Committee for Women in Mathematics (CWM) with the following purposes: to promote international contacts between national and regional organizations for women in mathematical sciences; to maintain up-to-date content on the CWM section of the IMU website and, with appropriate assistance from the IMU, to ensure its technical development; to consider how best to facilitate electronic communications among the community of women mathematicians internationally; to work with groups, committees, and commissions of IMU on topics pertaining to women mathematicians and their representation; to publicize and, where needed, to suggest working practices that ensure equal opportunities for women mathematicians in universities and research institutions (for example, appropriate funding arrangements and family-friendly policies and facilities); to report annually to the IMU Executive Committee and to propose actions that would lead to an improvement in the position of women in the mathematical community, and to increase the representation of women in mathematics at all levels.

The CWM features a chair, a vice chair, and six to eight members at large, with one member having specific responsibility for the CWM website and electronic communication. Membership is for a four-year term coinciding with the terms of the IMU Executive Committee and will be widely distributed internationally. The CWM will meet at least once a year, preferably by video conferencing. A member of the IMU Executive Committee will liaise with the CWM and attend meetings while remaining outside the committee.

CWM will have a budget from IMU that can be used to support meetings of the committee (electronic or in person) and contacts between regional organizations for women in mathematics and committee members and for expenses such as those needed to establish and maintain international or regional websites and support regional meetings. The funds granted from the IMU budget will be administered by the IMU office.

Management of funds specifically donated from other bodies or persons to support the purposes of CWM may be done through the Friends of IMU.

Following are the members of CWM for the years 2014–2018: chair, Marie-Françoise Roy (France); vice chair and responsibility for the website: Caroline Series (United Kingdom); members at large: Carolina Araujo (Brazil), Bill Barton (New Zealand), Ari Laptev (Sweden and United Kingdom), Kristin Lauter (United States), Sunsook Noh (South Korea), Marie Françoise Ouedraogo (Burkina Faso), Sujatha Ramdorai (India), and Betul Tanbay (Turkey). John Toland (United Kingdom) will serve as the IMU Executive Committee observer.

This committee should expect to serve until the next IMU General Assembly, which is to be held in Brazil in 2018. The first meeting will be a face-to-face meeting in Cortona, Italy, September 4–5, 2015, immediately after the seventeenth General Meeting of European Women in Mathematics. The website for the CWM is `www.mathunion.org/cwm`; that for the General Meeting is `www.europeanwomeninmaths.org/activities/conference/17th-ewm-general-meeting-cortona-2015`.

—John Toland, IMU Executive Committee

Inside the AMS

AMS Congressional Fellow Chosen

Anthony J. Macula

The AMS is pleased to announce the selection of ANTHONY J. MACULA of the State University of New York, College at Geneseo, as its Congressional Fellow for 2015–16.

The fellowship provides a unique public policy learning experience, demonstrates the value of science-government interaction, and brings a technical background and external perspective to the decision-making process in Congress.

Macula received his PhD in mathematics from Wesleyan University. He has been a rotating program officer in the Directorate for Mathematical and Physical Sciences at the National Science Foundation (NSF), where he served the broad mathematical community in the Division of Mathematical Sciences (DMS). He has done research in pure and applied mathematics, primarily in combinatorics, group testing, information theory, mathematical biology, math education, and topology.

The Congressional Fellowship program is administered by the American Association for the Advancement of Science (AAAS). Fellows spend a year working on the staff of a member of Congress or a congressional committee, working as a special legislative assistant in legislative and policy areas requiring scientific and technical input. The fellowship program includes an orientation on congressional and executive branch operations and a year-long seminar series on issues involving science, technology, and public policy. For more information on the AMS-AAAS Congressional Fellowship go to `bit.ly/AMSCongressionalFellowship`.

—AMS Washington Office

2015 AMS-AAAS Mass Media Fellow Chosen

RACHEL CROWELL, a graduate of the University of Missouri, Kansas City, has been awarded the 2015 AMS-AAAS Mass Media Fellowship. The AMS will sponsor her fellowship at *The Oregonian* for ten weeks this summer.

The Mass Media Science and Engineering Fellows program is organized by the American Association for the Advancement of Science (AAAS). This competitive program is designed to improve public understanding of science and technology by placing graduate and postgraduate science, mathematics, and engineering students in media outlets nationwide. The fellows work as reporters, researchers, and production assistants alongside media professionals to sharpen their communication skills and increase their understanding of the editorial process by which events and ideas become news.

The program is available to enrolled college or university students (graduate, doctoral, or upper-level undergraduates) in the physical, biological, geological, health, engineering, computer, or social sciences, or mathematics with outstanding written and oral communication skills and a strong interest in learning about the media.

Now in its forty-first year, this fellowship program has placed over 635 science, mathematics, and engineering scholars in media organizations nationwide as they research, write, and report today's headlines.

For more information on the AAAS Mass Media Science and Engineering Fellows Program, visit the website `www.aaas.org/mmfellowship`.

—AMS Washington Office

AMS Sponsors Exhibit on Capitol Hill

The AMS sponsored an exhibit at the twenty-first annual Coalition for National Science Funding (CNSF) exhibition and reception on Capitol Hill held on April 29, 2015.

Katharine Gurski of Howard University presented work on "Mathematical Algorithms for Space Weather, Tsunamis, and Plasma Physics." The exhibition was attended by 275 people, including ten members of Congress, to view thirty-five exhibits on research funded by the National Science Foundation.

Photo by Scavone Photography.

Professor Katharine Gurski with Dr. France Córdova, director of the National Science Foundation.

The dynamics of space weather are modeled by the magnetohydrodynamics (MHD) equations that capture the interaction between magnetic fields and moving, conducting fluids. The governing equations of MHD consist simply of Newton's laws of motion and the Maxwell form of the laws of electrodynamics. The goal of Gurski's research group's project is to develop numerical algorithms from applied mathematics to develop solvers for robust, highly accurate, adaptive ideal divergence-free MHD on multidimensional meshes, including geodesic meshes. Partitioning algorithms will enable the numerical simulations to achieve high levels of parallelism.

The algorithms are extended to model multidimensional nonconservative hyperbolic systems (for example: shallow water equations including tsunamis, granular flow, and plasma physics flows) using path conservation methods and Riemann solvers. Better numerical algorithms based on mathematical insights will result in better simulation models for more accurate predictions.

Gurski and the other exhibitors were able to present their work, funded by the National Science Foundation, to congressional representatives and explain the critical importance of increased, sustained federal investments in basic scientific research.

The Coalition for National Science Funding (CNSF) is an alliance of more than 140 professional societies, universities, and corporations advocating support for the National Science Foundation. The coalition is chaired by Samuel M. Rankin III, associate executive director of the AMS and the director of its Washington office.

—AMS Washington Office

From the AMS Public Awareness Office

Daniel Gries: Digital Works, a new album on Mathematical Imagery. Gries, a PhD mathematician, teaches mathematics and computer science at the Hampton School in New Haven, Connecticut. The "Jellyfish 2" pictured here "is based on a morphing fractal curve method, but shaped into an abstract jellyfish through the use of parametric curves and other mathematical tricks." See a selection of his works at `www.ams.org/mathimagery/thumbnails.php?album=43`.

"Jellyfish 2," by Daniel Gries.

Who Wants to Be a Mathematician? A team version of the game was held at the American Regions Mathematics League (ARML) competition at the University of Georgia; a team from Florida won US$4,000. See highlights, including a video of the winning team, at `www.ams.org/programs/students/wwtbam/arml-2015`.

Mathematical Moments Podcasts on Science360 Radio. The AMS now has a podcast "show" on the NSF's Science360 radio site. The first podcasts featured are of Ken Golden ("The Indiana Jones of Math", University of Utah) talking about the mathematics of sea ice and of Emmanuel Candès (Stanford University) discussing the exciting new field of compressed sensing. See `science360.gov/radio/show/2c67a62a-fdae-4899-8bf0-9d719a6fa7c7/ams-mathematical-moments`.

AMS Blogs. AMS blogs, written by mathematicians in all stages of their careers—from graduate students to professors—cover mathematics, teaching mathematics, visual mathematics, mentoring, MathSciNet, and other topics of professional interest. Readers can follow any of the AMS blogs via an RSS subscription. See the list of blogs at `blogs.ams.org/`.

—Annette Emerson and Mike Breen
AMS Public Awareness Officers
`paoffice@ams.org`

Deaths of AMS Members

ROBERT J. BLATTNER, of Malibu, California, died on June 13, 2015. Born on August 6, 1931, he was a member of the Society for 58 years.

FREDERICK W. LEYSIEFFER, of Tallahassee, Florida, died on April 14, 2015. Born on January 30, 1933, he was a member of the Society for 56 years.

LYNN STEEN, of Northfield, Minnesota, died on June 21, 2015. Born on January 1, 1941, he was a member of the Society for 49 years.

Reference and Book List

*The **Reference** section is intended to provide readers with frequently sought information in an easily accessible format. New information is printed as it becomes available and is referenced after its first printing.*

Contacting the *Notices*

The preferred method for contacting the *Notices* is e-mail.

The **editor-in-chief**, **Steven G. Krantz**, should be contacted about articles for consideration. Articles include features, memorials, communications, opinion pieces, and book reviews. The editor is also the person to whom to send news of unusual interest about other people's mathematics research. Contact the **editor-in-chief** at: notices@math.wustl.edu.

The **managing editor**, **Rachel L. Rossi**, should be contacted for additions to "Mathematics People", "Mathematics Opportunities", "For Your Information", and for any corrections. Contact the **managing editor** at: notices@ams.org.

Letters to the editor should be sent to: notices-letters@ams.org.

Permissions requests should be sent to: reprint-permission@ams.org.

Advertising requests should be sent to: notices-ads@ams.org.

Math Calendar additions should be sent to: mathcal@ams.org.

Book List additions should be sent to: notices-booklist@ams.org.

For full contact information, including postal addresses, see: www.ams.org/notices/contact.html.

Information for *Notices* Authors

The *Notices* welcomes unsolicited articles for consideration for publication, as well as proposals for such articles. The following provides general guidelines for writing *Notices* articles and preparing them for submission. Contact information for *Notices* editors and staff may be found on the *Notices* website, www.ams.org/notices.

***Notices* readership**. The *Notices* publishes articles that have broad appeal for a diverse audience with many different types of readers: graduate students, academic mathematicians, industrial mathematicians, researchers in mathematically based fields, and amateur enthusiasts. The paper edition of the *Notices* is sent to the approximately 33,000 members of the AMS, most of whom are professional mathematicians; about 25,000 of them reside in North America. Because the *Notices* is accessible for free over the Internet, the number of readers is much larger than the AMS membership. All readers may be assumed to be interested in mathematics research, but they are not all active researchers.

Where to Find It

A brief index to information that appears in this and previous issues of the *Notices*.

Notices Feature Articles

Topics. The *Notices* seeks exceptional articles that report on major new developments in mathematics or that describe episodes from mathematics history that have connection to current research in the field. We also welcome articles discussing aspects of the mathematics profession, such as grant programs, the job market, professional opportunities for mathematicians, publishing, electronic communications, etc. We are also interested in articles about mathematics education at all levels. We publish reviews of books, films, plays, software, and mathematical tools.

Reaching the audience. Our goal is to educate the readership about new developments in mathematics and in the mathematics profession, as well as other matters of interest to the working mathematician. Each article is expected to have a large target audience of readers, perhaps 5,000 of the 33,000 subscribers. Authors must therefore write their articles for nonexperts rather than for experts or would-be experts. In particular, the mathematics articles in the *Notices* are expository. A *Notices* article should have an introduction that anyone can understand, and almost all readers should be able to understand the key points of the article.

Structure of articles. Most feature articles, including those on mathematics, are expected to be of long-term value and should be written as such. Ideally each article should put its topic in a context, providing some history and other orientation for the reader, and, as necessary, relating the subject matter to things that readers are likely to understand. In most cases, articles should progress to dealing with contemporary matters, not giving only historical material. The articles that are received the best by readers tend to relate different areas of mathematics to each other.

By design the *Notices* is partly magazine and partly journal, and authors' expository styles should take this into account. For example, many readers want to understand the mathematics articles without undue effort and without consulting other sources.

Format and length. Mathematics feature articles in the *Notices* are normally six to nine pages, sometimes a little longer. Shorter articles are more likely to be read fully than are longer articles. The first page is 400 or 500 words, and subsequent pages are about 800 words. From this one should subtract an allowance for figures, photos, and other illustrations and an appropriate allowance for any displayed equations and bibliography. The *Notices* is especially interested in the creative use of graphics and color and encourages illustrations. Articles on professional topics are typically 3 to 5 pages, as are book reviews.

Editorial process. The *Notices* aims to publish exceptionally well-written articles that appeal to a broad audience of mathematicians. Highly technical, specialized articles with a great deal of notation, insider jargon, and a long list of references are not suitable for the *Notices*. Some articles will be rejected by the editors without any external review. Other articles will be carefully refereed, and then a detailed editorial process will be used to bring the article up to the *Notices* standard. There will be considerable give and take between the author(s) and the editor, and it may take several drafts to get the article right.

The "WHAT IS...?" Column

Nearly every issue of the *Notices* carries an installment of the "WHAT IS...?" column. The purpose of the column is to provide brief, nontechnical descriptions of mathematical objects in use in current research. The target audience for the columns is first-year graduate students.

Each "WHAT IS...?" column provides an expository description of a single mathematical object being used in contemporary research. Thus "WHAT IS *M*-Theory?" would be too broad, but "WHAT IS a Brane?" would be appropriate; ideally "WHAT IS a Brane?" would give a flavor of what *M*-theory is.

The writing should be nontechnical and informal. Narrative description conveying main ideas should be favored over notation-heavy precision.

There is a limit of two *Notices* pages (1,400 words with no picture or 1,200 words with one picture). A list of "Further Reading" should contain no more than three references. Inquiries and comments about the "WHAT IS...?" column are welcome and may be sent to notices-whatis@ams.org.

Upcoming Deadlines

August 26, 2015: Full proposals for Research Experiences for Undergraduates (REU) sites. See the website www.nsf.gov/funding/pgm_summ.jsp?pims_id=5517.

September 1, 2015: Nominations for Association for Women in Mathematics (AWM) Falconer Lectureship. See https://sites.google.com/site/awmmath/programs/falconer-lectures.

September 15, 2015: Nominations for the Award for Impact on the Teaching and Learning of Mathematics. See "Mathematics Opportunities" in this issue.

September 15, 2015: Nominations for 2016 Abel Prize. See www.abelprize.no/c53676/artikkel/vis.html?tid=53705.

September 15, 2015: Full proposals for DMS/NIGMS Initiative to Support Research at the Interface of the Biological and Mathematical Sciences. See tinyurl.com/oong9q4.

September 15, 2015: Nominations for Association for Women in Mathematics (AWM) Alice T. Schafer Prize. See https://sites.google.com/site/awmmath/programs/schafer-prize.

September 15, 2015: Nominations for Sloan Research Fellowships. For more information write to: Sloan Research Fellowships, Alfred P. Sloan Foundation, 630 Fifth Avenue, Suite 2550, New York, New York 10111-0242, or consult the foundation's website: www.sloan.org/sloan-research-fellowships/.

September 15, 2015: Applications for spring 2016 semester of Math in Moscow. See www.mccme.ru/mathinmoscow or write to: Math in Moscow, P.O. Box 524, Wynnewood, PA 19096; fax: +7095-291-65-01; email: mim@mccme.ru. Information and application forms for the AMS scholarships are available on the AMS

website at www.ams.org/programs/travel-grants/mimoscow or by writing to: Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence RI 02904-2294; email: student-serv@ams.org.

September 18, 2015: Full proposals for NSF Focused Research Groups (FRG). See www.nsf.gov/funding/pgm_summ.jsp?pims_id=5671.

September 30, 2015: Proposals for conference support from Centro Internazionale per la Ricerca Matematica (CIRM). See "Mathematics Opportunities" in this issue.

September 30, 2015: Proposals for five-day workshops and summer schools at Banff International Research Station for Mathematical Innovation and Discovery (BIRS) and proposals for Research in Teams and Focused Research Groups. See "Mathematics Opportunities" in this issue.

September 30, 2015: Nominations for ASL Gerald Sacks Prize. General information about the prize is available at www.aslonline.org/info-prizes.html. For details about nomination procedures, see www.aslonline.org/Sacks_nominations.html.

October 1, 2015: Applications for AWM Travel Grants and Mathematics Education Research Travel Grants. See https://sites.google.com/site/awmmath/programs/travel-grants ; telephone: 703-934-0163; or email: awm@awm-math.org; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

October 15, 2015: Proposals for NSA Mathematical Sciences Grants Program. See the website www.nsa.gov/research/math_research/index.shtml; or contact the program office at 443-634-4304; email: mspgrants@nsa.gov.

October 21, 2015: Proposals for NSF Postdoctoral Research Fellowships. See www.nsf.gov/pubs/2012/nsf12496/nsf12496.htm.

October 31, 2015: Applications for Adams Prize for 2015–2016. See www.maths.cam.ac.uk/news/4.html.

November 1, 2015: Applications for November review for National Academies Research Associateship programs. See sites.nationalacademies.org/PGA/RAP/PGA_050491 or contact Research Associateship Programs, National Research Council, Keck 568, 500 Fifth Street, NW, Washington, DC 20001; telephone: 202-334-2760; fax: 202-334-2759; email: rap@nas.edu.

November 13, 2015: Applications for NRC-Ford Foundation Dissertation and Postdoctoral Fellowships. See "Mathematics Opportunities" in this issue.

November 16, 2015: Nominations for Clay Research Fellowships. See "Mathematics Opportunities" in this issue.

November 20, 2015: Applications for NRC-Ford Foundation Predoctoral Fellowships. See "Mathematics Opportunities" in this issue.

December 1, 2015: Applications for AMS Centennial Fellowship. See "Mathematics Opportunities" in this issue.

December 1, 2015: Submissions for the John Riordan Prize of the OEIS Foundation. See the website https://oeis.org/wiki/Riordan-Prize.

December 3, 2015: Nominations for 2016 Ferran Sunyer i Balaguer Prize. See ffsb.iec.cat.

February 1, 2016: Applications for AWM Travel Grants, Mathematics Education Research Travel Grants, Mathematics Mentoring Travel Grants, and Mathematics Education Research Mentoring Travel Grants. See https://sites.google.com/site/awmmath/programs/travel-grants ; telephone: 703-934-0163; or email: awm@awm-math.org; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

March 31, 2016: Nominations for 2016 Information-Based Complexity Prize. Nominations may be sent to Joseph F. Traub at traub@cs.columbia.edu.

April 15, 2016: Applications for fall 2016 semester of Math in Moscow. See www.mccme.ru/mathinmoscow, or by writing to: Math in Moscow, P.O. Box 524, Wynnewood, PA 19096; fax: +7095-291-65-01; email: mim@mccme.ru. Information and application forms for the AMS scholarships are available on the AMS website at www.ams.org/programs/travel-grants/mimoscow, or by writing to: Math in Moscow Program, Membership and Programs Department, American Mathematical Society, 201 Charles Street, Providence RI 02904-2294; email: student-serv@ams.org.

May 1, 2016: Applications for AWM Travel Grants and Mathematics Education Research Travel Grants. See https://sites.google.com/site/awmmath/programs/travel-grants; telephone: 703-934-0163; email: awm@awm-math.org ; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

October 1, 2016: Applications for AWM Travel Grants and Mathematics Education Research Travel Grants. See https://sites.google.com/site/awmmath/programs/travel-grants; telephone: 703-934-0163; email: awm@awm-math.org; or contact Association for Women in Mathematics, 11240 Waples Mill Road, Suite 200, Fairfax, VA 22030.

Conference Board of the Mathematical Sciences

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Member Societies:

American Mathematical Association of Two-Year Colleges (AMATYC)
American Mathematical Society (AMS)
Association of Mathematics Teacher Educators (AMTE)
American Statistical Association (ASA)
Association for Symbolic Logic (ASL)
Association for Women in Mathematics (AWM)
Association of State Supervisors of Mathematics (ASSM)
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Institute for Operations Research and the Management Sciences (INFORMS)
Mathematical Association of America (MAA)
National Association of Mathematicians (NAM)
National Council of Supervisors of Mathematics (NCSM)
National Council of Teachers of Mathematics (NCTM)
Society for Industrial and Applied Mathematics (SIAM)
Society of Actuaries (SOA)
TODOS: Mathematics for ALL (TODOS)

Book List

The Book List highlights recent books that have mathematical themes and are aimed at a broad audience, potentially including mathematicians, students, and the general public.

An * indicates a new addition to the book list.

Arnold: Swimming Against the Tide, edited by Boris A. Khesin and Serge L. Tabachnikov. AMS, September 2014. ISBN-13: 978-1-4704-1699-7.

Art in the Life of Mathematicians, by Anna Kepes Szemerédi. American Mathematical Society, June 2015. ISBN-13: 978-1-4704-1956-1.

Automate This: How Algorithms Took Over Our Markets, Our Jobs, and the World, by Christopher Steiner. Portfolio Trade August 2013. ISBN-13: 978-15918-465-29.

Baroque Science, by Ofer Gal and Raz Chen-Morris. University of Chicago Press, March 2013. ISBN-13: 978-0-2262-1298-2.

Beating the Odds: The Life and Times of E. A. Milne, by Meg Weston. Imperial College Press, June 2013. ISBN-13: 978-1-8481-6907-4.

Beautiful Geometry, by Eli Maor and Eugen Jost. Princeton University Press, January 2014. ISBN-13: 978-0-6911-5099-4.

Birth of a Theorem: A Mathematical Adventure, by Cédric Villani (translated from the French by Malcolm DeBevoise). Farrar, Straus and Giroux, April 2015. ISBN-13: 978-0-8654-7767-4.

Combinatorics: Ancient and Modern, by Robin Wilson and John J. Watkins. Oxford University Press, August 2013. ISBN-13: 978-0-1996-5659-2.

The Computing Universe: A Journey through a Revolution, by Tony Hey and Gyuri Pápay. Cambridge University Press, December 2014. ISBN-13: 978-0-5211-5018-7.

Constitutional Calculus: The Math of Justice and the Myth of Common Sense, by Jeff Suzuki. Johns Hopkins University Press, January 2015. ISBN-13: 978-1-4214-1595-6.

A Curious History of Mathematics: The Big Ideas from Early Number Concepts to Chaos Theory, by Joel Levy. Andre Deutsch, February 2014. ISBN-13: 978-0-2330-0385-6.

Doing Data Science: Straight Talk from the Frontline, by Rachel Schutt and Cathy O'Neil. O'Reilly Media, November 2013. ISBN-13: 978-1-4493-5865-5. (Reviewed October 2014.)

Doing Mathematics: Convention, Subject, Calculation, Analogy, by Martin H. Krieger. World Scientific, Second Edition, 2015. ISBN-13: 978-9-8145-7183-8.

Einstein's Dice and Schrödinger's Cat: How Two Great Minds Battled Quantum Randomness to Create a Unified Theory of Physics, by Paul Halpern. Basic Books, April 2015. ISBN-13: 978-0-4650-7571-3.

Electricity and Magnetism for Mathematicians: A Guided Path from Maxwell's Equations to Yang-Mills, by Thomas A. Garrity. Cambridge University Press, January 2015. ISBN-13: 978-1-1074-3516-2.

Enlightening Symbols: A Short History of Mathematical Notation and Its Hidden Powers, by Joseph Mazur. Princeton University Press, March 2014. ISBN-13: 978-0-6911-5463-3. (Reviewed February 2015.)

Experiencing Mathematics: What Do We Do, When We Do Mathematics?, by Reuben Hersh. AMS, February 2014. ISBN-13: 978-0-8218-9420-0.

The Fascinating World of Graph Theory, by Arthur Benjamin, Gary Chartrand, and Ping Zhang. Princeton University Press, January 2015. ISBN-13: 978-0-6911-6381-9.

Fifty Visions of Mathematics, edited by Sam Parc. Oxford University Press, July 2014. ISBN-13: 978-0-1987-0181-1.

Finding Zero: A Mathematician's Odyssey to Uncover the Origins of Numbers, by Amir D. Aczel. Palgrave Macmillan Trade, January 2015. ISBN-13: 978-1-1372-7984-2.

The Formula: How Algorithms Solve All Our Problems—And Create More, by Luke Dormehl. Perigee Trade, November 2014. ISBN-13: 978-0-3991-7053-9.

From Mathematics in Logic to Logic in Mathematics: Boole and Frege, by Aliou Tall. Docent Press, July 2014, ISBN-13: 978-0-9887-4497-4.

Genius At Play: The Curious Mind of John Horton Conway, by Siobhan Roberts. Bloomsbury USA, July 2015. ISBN-13: 978-1-6204-0593-2.

The Goddess of Small Victories, by Yannick Grannec. Other Press, October 2014. ISBN-13: 978-1-5905-1636-2.

Great Mathematics Books of the Twentieth Century: A Personal Journal, by Lizhen Ji. International Press of Boston, April 2014. ISBN-13: 978-1-5714-6283-1.

A History in Sum: 150 Years of Mathematics at Harvard (1825–1975), by Steve Nadis and Shing-Tung Yau. Harvard University Press, October 2013. ISBN-13: 978-0-6747-2500-3. (Reviewed June/July 2014.)

How to Bake Pi: An Edible Exploration of the Mathematics of Mathematics, by Eugenia Cheng. Basic Books, May 2015. ISBN: 978-0-4650-5171-7.

How to Study as a Mathematics Major, by Lara Alcock. Oxford University Press, January 2013. ISBN: 978-0-1996-6131-2.

How to Study for a Mathematics Degree, by Lara Alcock. Oxford University Press, November 2012. ISBN: 978-0-19-966132-9.

**I, Mathematician,* edited by Peter Casazza, Steven G. Krantz, and Randi D. Ruden. Mathematical Association of America, March 2015. ISBN-13: 978-0-8838-5585-0.

The Improbability Principle: Why Coincidences, Miracles, and Rare Events Happen Every Day, by David J. Hand. Scientific American/Farrar, Straus and Giroux, February 2014. ISBN-13: 978-0-3741-7534-4. (Reviewed December 2014.)

James Clerk Maxwell: Perspective on his Life and Works, edited by Raymond Flood, Mark McCartney, and Andrew Whitaker. Oxford University Press, March 2014. ISBN-13: 978-0-1996-6437-5.

Love and Math: The Heart of Hidden Reality, by Edward Frenkel. Basic Books, October 2013. ISBN-13: 978-0-4650-5074-1. (Reviewed October 2014.)

The Magic Garden of George B and Other Logic Puzzles, by Raymond M. Smullyan. World Scientific, April 2015. ISBN: 978-9-8146-7505-5.

The Magic of Math: Solving for x and Figuring Out Why, by Arthur Benjamin. Basic Books. September 2015. ISBN-13: 978-0-4650-5472-5.

The Math Book: From Pythagoras to the 57th Dimension, 250 Milestones in the History of Mathematics, by Clifford A. Pickover. Sterling, February 7, 2012. ISBN-13: 978-1-4027-8829-1. (Reviewed April 2015.)

Math Geek: From Klein Bottles to Chaos Theory, a Guide to the Nerdiest Math Facts, Theorems, and Equations, by Raphael Rosen. Adams Media, June 2015. ISBN: 978-1-4405-8381-0.

Mathematical Understanding of Nature: Essays on Amazing Physical Phenomena and Their Understanding by Mathematicians, by V. I. Arnold. AMS, September 2014. ISBN-13: 978-1-4704-1701-7.

**Mathematicians on Creativity,* edited by Peter Borwein, Peter Liljedahl, and Helen Zhai. Mathematical Association of America, July 2014. ISBN-13: 978-0-8838-5574-4.

The Mathematician's Shiva, by Stuart Rojstaczer. Penguin Books, September 2014. ISBN-13: 978-0-14-31-2631-7.

Mathematics and the Making of Modern Ireland: Trinity College Dublin from Cromwell to the Celtic Tiger, by David Attis. Docent Press, October 2014, ISBN-13: 978-0-9887-4498-1.

Mathematics and the Real World: The Remarkable Role of Evolution in the Making of Mathematics, by Zvi Artstein. Prometheus Books, September 2014. ISBN-13: 978-1-6161-4091-5.

The Mathematics Devotional: Celebrating the Wisdom and Beauty of Mathematics, by Clifford Pickover. Sterling, November 2014. ISBN-13: 978-1-4549-1322-1.

The Mathematics of Love: Patterns, Proofs, and the Search for the Ultimate Equation, by Hannah Fry. Simon & Schuster/TED, February 2015. ISBN: 978-1-4767-8488-5.

Mathematics without Apologies: Portrait of a Problematic Vocation, by Michael Harris. Princeton University Press, January 2015. ISBN-13: 978-0-6911-5423-7.

A Mind For Numbers: How to Excel at Math and Science (Even If You Flunked Algebra), by Barbara Oakley. Tarcher, July 2014. ISBN-13: 978-0-3991-6524-5.

My Life and Functions, by Walter K. Hayman. Logic Press, October 2014. Hardcover ISBN-13: 978-1-3260-3224-1. Paperback ISBN-13: 978-1-3260-3020-9. (Reviewed May 2015.)

On Leibniz: Expanded Edition, by Nicholas Rescher. University of Pittsburgh Press, June 2013. ISBN-13: 978-0-8229-6218-2. (Reviewed August 2015.)

Origins of Mathematical Words: A Comprehensive Dictionary of Latin, Greek, and Arabic Roots, by Anthony Lo Bello. Johns Hopkins University Press, November 2013. ISBN-13: 978-1-4214-1098-2.

Parables, Parabolas and Catastrophes: Conversations on Mathematics, Science and Philosophy, by René Thom. Translated by Roy Lisker and edited by S. Peter Tsatsanis. Thombooks Press, November 2014 (distributed only by `amazon.ca` or `amazon.com`). ISBN-13: 978-0-9939-2690-7.

Pearls from a Lost City: The Lvov School of Mathematics, by Roman Duda (translated by Daniel Davies). AMS, July 2014. ISBN-13: 978-1-4704-1076-6.

Plato at the Googleplex: Why Philosophy Won't Go Away, by Rebecca Newberger Goldstein. Pantheon, March 2015. ISBN: 978-0-3073-7819-4.

Probably Approximately Correct: Nature's Algorithms for Learning and Prospering in a Complex World, by Leslie Valiant. Basic Books, June 2013. ISBN-13: 978-0-4650-3271-6. (Reviewed November 2014.)

Professor Stewart's Casebook of Mathematical Mysteries, by Ian Stewart. Basic Books, October 2014. ISBN-13: 978-0-4650-5497-8.

Quantum Computing since Democritus, by Scott Aaronson. Cambridge University Press, March 2013. ISBN-13: 978-0-5211-9956-8. (Reviewed November 2014.)

Reflections: The Magic, Music and Mathematics of Raymond Smullyan, by Raymond M. Smullyan. World Scientific, April 2015. ISBN: 978-9-8146-4458-7.

The Scholar and the State: In Search of Van der Waerden, by Alexander Soifer. Birkhäuser, January 2014. ISBN-13: 978-3-0348-0711-1. (Reviewed in this issue.)

The Simpsons and Their Mathematical Secrets, by Simon Singh. Bloomsbury, October 2013. ISBN-13: 978-1-4088-3530-2. (Reviewed January 2015.)

Single Digits: In Praise of Small Numbers, by Marc Chamberland. Princeton University Press, June 2015. ISBN-13: 978-0-6911-6114-3.

Taming the Unknown: A History of Algebra from Antiquity to the Early Twentieth Century, by Victor J. Katz and Karen Hunger Parshall. Princeton University Press, July 2014. ISBN-13: 978-0-6911-4905-9.

The War of Guns and Mathematics: Mathematical Practices and Communities in France and Its Western Allies Around World War I, by David Aubin and Catherine Goldstein. AMS, October 2014. ISBN-13: 978-1-4704-1469-6.

What's Math Got to Do with It?: How Teachers and Parents Can Transform Mathematics Learning and Inspire Success, by Jo Boaler. Penguin Books, revised edition, March 2015. ISBN-13: 978-0-1431-2829-8.

Why Is There Philosophy of Mathematics At All?, by Ian Hacking. Cambridge University Press, April 2014. ISBN-13: 978-1-1070-5017-4. (Reviewed December 2014.)

Willful Ignorance: The Mismeasure of Uncertainty, by Herbert I. Weisberg. Wiley, August 2014. ISBN: 978-0-4708-9044-8.

Zombies and Calculus, by Colin Adams. Princeton University Press, September 2014. ISBN-13: 978-0-6911-6190-7.

Mathematics Calendar

The most comprehensive and up-to-date Mathematics Calendar information is available on the AMS website at www.ams.org/mathcal/.

Please submit conference information for the Mathematics Calendar through the Mathematics Calendar submission form at **www.ams.org/cgi-bin/mathcal-submit.pl**.

September 2015

1–4 **IMA Conference on Numerical Methods for Simulation**, Mathematical Institute, University of Oxford, UK. (Aug. 2014, p. 797)
Description: Developments in numerical methods underpin simulations in many ways, for example, in any area where high-dimensional problems are governed by differential equations. Computational fluid dynamics has driven many developments in this area; however there is a wide range of application areas where the problems, and indeed solution techniques may be similar. Numerical methods are important in diverse areas such as geophysical modelling, fluid-structure interaction, high-dimensional dynamical systems, weather prediction, climate modelling, oil reservoir simulation, and so on. The conference will bring together application specialists, applied mathematicians, numerical analysts and computational scientists who develop and use numerical simulations. Applications which focus on data assimilation, inverse problems, uncertainties or control, which contain as a major component a high-dimensional forward model, will also be represented.
Information: www.ima.org.uk/conferences/conferences_calendar.cfm.html

1–4 **Some Trends in Algebra 2015**, Fac. Math. Phys., Charles University, Prague 8, Karlin, Czech Republic.
Description: A conference on module theory and its relations to algebraic geometry, category theory, commutative algebra, homotopy theory, logic, and representation theory.
Information: www.karlin.mff.cuni.cz/~sta/sta15.html

6–19 **School and Conference: Analytic, Algebraic and Geometric Aspects of Differential Equations**, Mathematical Research and Conference Center, Bedlewo, Poland.
Description: The overall goal of the school and conference is to bring together the leading experts in the theory of differential and difference equations in the complex domain from different countries, to tackle and find approaches to open problems in the field, exchange recent research results, learn new methods in the related areas (which is invaluable for young researchers) and identify new topics for future research.
Information: bcc.impan.pl/15AAGA/

7–9 **30th British Topology Meeting**, Pure Mathematics Research Centre, School of Mathematics and Physics, Queen's University Belfast, UK.
Description: The 30th British Topology Meeting, BTM30, will take place in the Pure Mathematics Research Centre of Queen's University Belfast, from Monday, September 7, to Wednesday, September 9, 2015.
List of Speakers: Carles Casacuberta (Barcelona, Spain), Eva Maria Feichtner (Bremen, Germany) and Andrew Tonks (Leicester, UK).
Main Focus: The meeting will be homotopy theory and its links to other areas such as geometry, combinatorics, higher category theory and homology. The meeting is supported by Queen's University Belfast and a conference grant of the London Mathematical Society.
Organisers: David Barnes and Thomas Huettemann
Information: www.qub.ac.uk/puremaths/btm30/home.html

7–11 **Additive Combinatorics in Marseille**, CIRM, Marseille Luminy, France.
Description: At an international level, the scientific subject of the conference, additive combinatorics, has been flourishing for a few years and has now become an independent branch of mathematics. Since the famous Szemeredi's theorem on the density of sets of

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This section contains announcements of meetings and conferences of interest to some segment of the mathematical public, including ad hoc, local, or regional meetings, and meetings and symposia devoted to specialized topics, as well as announcements of regularly scheduled meetings of national or international mathematical organizations. A complete list of meetings of the Society can be found in the Meetings & Conferences Section of each issue.
An announcement will be published in the *Notices* if it contains a call for papers and specifies the place, date, subject (when applicable), and the speakers; a second announcement will be published only if there are changes or necessary additional information. Once an announcement has appeared, the event will be briefly noted in every third issue until it has been held. Asterisks (*) mark those announcements containing new or revised information.
In general, announcements of meetings and conferences carry only the date, title of meeting, place of meeting, names of speakers (or sometimes a general statement on the program), deadlines for abstracts or contributed papers, and source of further information. If there is any application deadline with respect to participation in the meeting, this fact should be noted. All communications on meetings and conferences in the mathematical sciences should be sent to mathcal@ams.org.
In order to allow participants to arrange their travel plans, organizers of meetings are urged to submit information for these listings early enough to allow them to appear in more than one issue of the *Notices* prior to the meeting in question. To achieve this, listings should be received in Providence **eight months** prior to the scheduled date of the meeting.
The complete listing of the Mathematics Calendar will be published only in the September issue of the *Notices*. New information about meetings and conferences that will occur beyond the current twelve-month period will be announced once in full and will not be repeated until the date of the conference or meeting falls within the given twelve-month period.
The Mathematics Calendar, as well as Meetings and Conferences of the AMS, is now available through the AMS website: www.ams.org/.

integers without arithmetic progression, several results have been obtained, of which some attained a high level of notoriety, like the inverse Freiman-Ruzsa's theorem, the Erdös-Ginzburg-Ziv theorem, the Balog-Szemeredi-Gowers theorem, the Green-Tao theorem or the results on the Davenport constant, to quote a few. The conference will offer a good opportunity to summarize the present state of the art on the subject and on its connections to all other branches of mathematics connected to it.
Information: scientific-events.weebly.com/1107.html.

7–11 **The Cauchy Problem in Kinetic Theory: Recent Progress in Collisionless Models**, Imperial College, London, United Kingdom.
Description: In this conference we aim to bring together the top specialists in the field of collisionless kinetic theory, along with promising young mathematicians, to explore recent progress, identify important open problems, and hopefully set a course for the next few years. The field of collisionless kinetic theory has seen a revived interest in recent years, in part due to some noteworthy results, such as the result of C. Mouhot & C. Villani concerning Landau Damping. This conference aims to harness this renewed interest to generate momentum and attract young researchers to this field. Some of the most influential results of the last decades are due to Walter Strauss, Bob Glassey and Jack Schaeffer: three mathematical generations. We will use this opportunity to mark their contributions to this field. In particular, we shall mark Bob's 70th birthday, as well as the 20th anniversary of the publication of his book "The Cauchy Problem in Kinetic Theory".
Information: wwwf.imperial.ac.uk/~jbenartz/Conference-2015/index.html.

7–11 **First Joint International Meeting of the Israel Mathematical Union and the Mexican Mathematical Society**, Instituto Tecnolgico de Oaxaca, Oaxaca, Mexico.
Plenary speakers: Andrés Christen (CIMAT, Mexico), Dania Gutiérrez (CINVESTAV-Monterrey, Mexico), Daniel Juan (CCM-UNAM, Mexico), Nathan Linial (Hebrew University of Jerusalem, Israel), Michael Polyak (Technion, Israel), Sergio Rajsbaum (IMATE-UNAM, Mexico), Jacob Rubinstein (Technion, Israel), Barak Weiss (Tel Aviv University, Israel).
Special sessions: Algebra and Group Theory, Algebraic Geometry, Applied and Industrial Mathematics, Approximation Theory, Bioinformatics and Systems Biology, Combinatorics, Computer Science, Dynamical Systems, Geometry and Topology, Low Dimensional Topology, Numerical Analysis, Partial Differential Equations.
Information: mathmeetingisraelmexico.matem.unam.mx/.

7–11 **Workshop in Nonlinear PDEs**, Université libre de Bruxelles, Brussel, Belgium.
Description: Workshop in nonlinear PDEs. Plenary talks, thematic sessions and contributed talks.
Information: pde2015.ulb.ac.be.

7–12 **Manifolds and Groups**, Ventotene (LT), Italy.
Scope: To strengthen the already existing knowledge of the relationship between 3-manifold theory, topology, probability theory, and analytic group theory, while expanding it in directly related areas of research that recently came to the forefront of the worldwide mathematical scenery. In addition to research talks there will be an instructional component in the form of three minicourses with the focus in Towers of covers and applications. 1. Invariant Random Subgroups in rank one and higher rank Lie groups, Tsachik Gelander (Hebrew University and Weizmann Institute). 2. Coverings and expanders, Emmanuel Kowalski (ETHZ). 3. L2-invariants and growth of homology in towers of finite coverings, Roman Sauer (Karlsruhe Institute of Technology). Doctoral students and young researchers are particularly encouraged to apply by sending email to: ventotene2015@gmail.com; a CV; a short statement describing the relevance of the participation to this conference for their research, and a letter of recommendation.
Deadline: For the application: April 15, 2015.
Information: www.ventotene2015.net.

8–12 **Mathematical Approaches for Traffic Flow Management Tutorials**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
Description: The long program opens with four days of tutorials that will provide an introduction to major themes of the entire program and the four workshops. The goal is to build a foundation for the participants of this program who have diverse scientific backgrounds.
Topics:
- A tutorial on estimation, including particle filtering, Kalman filtering, and model filtering.
- An introduction to traffic flow on networks.
- A primer on ramp metering, traffic signal, and/or variable speed limit control.
- A tutorial on utilizing new (and big) datasets.

Registration for tutorials is free, to encourage broad participation. The application for funding deadline is July 15, 2015.
Information: www.ipam.ucla.edu/tratut

8–13 **International Conference on "Mathematical Analysis, Differential Equations and Their Applications" (MADEA 7)**, Baku, Azerbaijan.
Description: This is Azerbaijan-Turkish-Ukrainian scientific conference in the field of mathematical analysis, differential equations and their applications and organized by Azerbaijan National Aviation Academy, Institute of Mathematics and Mekhanics of NAS of Azerbaijan, Mersin University (Turkey), Institute of Mathematics of NAS of Ukraine, Kyiv Taras Shevchenko National University (Ukraine) and Yu. A. Mitropolskiy International Mathematical Center of NAS of Ukraine.
Scientific Fields: Applied analysis, approximation theory, extremal problems, functional analysis, functional-differential and stochastic equations, functions of real and complex variables, harmonic analysis, integral transformations, interpolation theory, partial differential equations, qualitative and asymptotic methods in the theory of differential equations, summability theory.
Information: madea2015.imm.az.

8–December 11 **New Directions in Mathematical Approaches for Traffic Flow Management**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: The recent emergence of new technologies such as sensor networks, smartphones, and new paradigms such as crowdsourcing social networks has induced profound transformations in the way traffic management will be done in the future. Sensor networks have enabled robust and resilient monitoring of the backbone of the transportation network. Smartphones have provided ubiquitous coverage of the transportation network, but provide unpredictable, sometimes unreliable data, which requires a significant amount of filtering. Finally, the emergence of social networks has enabled direct access to people's mobility patterns and the ability to interact with them, thus presenting an opportunity to incentivize behavior change (either through a social group or the social network). Applications for travel support are due Monday, June 8, 2015. Please consult the webpage for more information.
Information: www.ipam.ucla.edu/tra2015.

9–11 **IMA Conference on Mathematics of Robotics**, St. Anne's College, Oxford, United Kingdom. (Sept. 2014, p. 987)
Description: The IMA Conference on the Mathematics of Robotics aims to bring together researchers working on all areas of robotics which have a significant mathematical content. The idea is to highlight the mathematical depth and sophistication of techniques applicable to robotics and to foster cooperation between researchers working in different areas of robotics.
Information: ima.org.uk/.

9–December 4 **ICERM Semester Program: Computational Aspects of the Langlands Program**, Brown University, Providence, Rhode Island. (Jun/Jul 2014, p. 669)

Description: During the semester we will focus on three specific aspects of the Langlands program. First, we will look at elliptic curves over number fields and genus 2 curves over the rationals and will consider their relationship to modular forms. Second, we will consider computational aspects of modular forms in higher rank. Specifically, we will examine K3 surfaces and their connections to modular forms on orthogonal groups. Our third topic concerns analytic aspects of L-functions, building upon and complementing the algebraic, arithmetic, and geometric data.
Information: icerm.brown.edu/sp-f15/.

10 –12 **International Conference on Special Functions and Applications - ICSFA 2015**, Amity University, Noida, India.
Description: International Conference on Special Functions and Applications - ICSFA 2015 is the XIVth Annual Meeting of the Society for Special Functions and their Applications. The three days conference ICSFA-2015 aims to bring together the researchers working in the area of Special Functions and related areas for interaction and exchange of ideas. In addition, it will inspire young researchers to pursue research in this important branch of Mathematical sciences. The Academic program of the conference will consist of Plenary sessions, Invited Talks and Paper Presentations covering a wide range of topics including Special Functions, Hypergeometric function and its generalizations, Orthogonal polynomials, Lie theoretic approach to Special function, Ramanujan Mathematics, Fractional calculus, Combinatorics, Number theory, q-series and continued fractions, complex function theory, applications of special functions to Statistics, Physical sciences and Engineering.
Information: ssfaindia.webs.com/conf.htm

12–18 **International Conference "Harmonic Analysis and Approximations, VI"**, Tsaghkadzor, Armenia.
Description: The conference continues the series of international conferences on "Harmonic Analysis and Approximations" organized in Armenia. It is co-organized by the Institute of Mathematics of the Armenian National Academy of Sciences and Yerevan State University, and will be held at the Yerevan State University guesthouse, Tsaghkadzor, Armenia. The program of the conference will consist of invited 45 minutes plenary lectures and contributed 20 minutes talks.
The Programme Committee: Norair Arakelian (Armenia), Paul Gauthier (Canada), Boris Kashin (Russia), Michael Lacey (USA), Wolfgang Luh (Germany), Alexander Olevskii (Israel), Alexandr Talalian (Armenia), Vladimir Temlyakov (USA), Przemyslaw Wojtaszczyk (Poland). The Organizing Commitee: Gegham Gevorkyan, Artur Sahakian, Aram Hakobyan, Michael Poghosyan. The Tentative list of Speakers (accepted): Christoph Aistleitner (Austria), Sergei Bochkarev (Russia), Gegham Gevorkyan (Armenia), Ushangi Goginava (Georgia), Viktor Kolyada (Sweden), Sergei Konyagin (Russia), Alexander Olevskii (Israel), Konstantin Oskolkov (USA), Tino Ullrich (Germany), Przemyslaw Wojtaszczyk (Poland).
Information: mathconf.sci.am/haa2015/.

14–15 **The 2015 International Conference on Mathematics, its Applications, and Mathematics Education (ICMAME 2015)**, Sanata Dharma University, Yogyakarta, Indonesia.
Description: The 2015 International Conference on Mathematics, its Applications, and Mathematics Education (ICMAME 2015) is conducted to bring together mathematicians and other scientists working on new trends of mathematics, physics, its applications and also in mathematics education. The aim of this conference is to promote research interests in different fields of mathematics, physics as well as in mathematics education. The scientific program will include invited lectures and contributed talks.
Information: www.usd.ac.id/seminar/icmame/

14–16 **Conference on D-modules and singularities**, Dipartimento di Matematica, Università di Padova, Padova, Italy.
Description: We are pleased to announce the conference "D-modules and singularities."
Invited Speakers: Tomoyuki Abe (University of Tokyo); Konstantin Ardakov (University of Oxford); Alberto Castaño Domínguez (TU Chemnitz); Valentina di Proietto (Freie Universität Berlin); María Cruz, Fernández Fernández (Universidad de Sevilla); Javier Fresan (ETH Zürich); Marco Hien (Universität Augsburg); Naofumi Honda (Hokkaido University); Kiran Kedlaya (University of California); Thomas Krämer (École Polytechnique); Claude Sabbah (École Polytechnique); Christian Schnell (Stony Brook University); Kiyoshi Takeuchi (Tsukuba University); Jean-Baptiste Teyssier (Freie Universität Berlin).
Organizers: Andrea D'Agnolo, Francisco Jesús Castro Jimenez, Teresa Monteiro Fernandes, Luis Narvaez Macarro
Local Scientific Committee: Francesco Bottacin, Corrado Marastoni, Giovanni Morando, Pietro Polesello, Luca Prelli. For any questions, please contact the organizers: d-mod@math.unipd.it.
Information: events.math.unipd.it/d-modules-and-singularities.

14–16 **International Conference on Signal Processing**, Embassy Suites Las Vegas, 4315 Swenson Street, Las Vegas, Nevada.
Description: The conference throws light on thought-provoking topics and recent research in the field of Signal processing like, Wireless Communication Processing, Power Systems, Electromagnetic systems, VLSI Technology and Embedded Systems, Multimedia and Communications, Nano electronics & Nano photonics, Array processing, and many more. The organizing committee is gearing up for an exciting and informative conference program including plenary lectures, symposia, workshops on a variety of topics, poster presentations and various programs for participants from all over the world. We invite you to join us at the Signal Processing-2015 International Conference, where you are sure to have a meaningful experience with scholars from around the world. All the Organizing Committee Members of the Signal Processing-2015 International Conference look forward to meet you in Las Vegas, USA.
Information: signalprocessing.conferenceseries.com/.

14–18 **AdS/CFT and Quantum Gravity**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal, Canada.
Description: Over the last fifteen years, our understanding of quantum gravity in string theory has been transformed by the discovery and exploitation of D-branes and the AdS/CFT correspondence in string theory. Many problems that were thought insuperably difficult have been solved, at least partially: (i) the entropy and thermodynamic properties of many extremal and near-extremal black holes have been precisely explained in terms of microscopic degrees of freedom, (ii) light has been shed on the physics of spacetime singularities, (iii) the holographic principle, positing massive reduction of the degrees of freedom in quantum gravity, has been understood precisely in spacetimes with a negative cosmological constant via a duality between gravity and gauge theory. This program of research has been so successful that it is now being used as a tool to shed light on otherwise intractable problems involving strongly coupled systems in other fields of physics.
Information:
www.crm.umontreal.ca/2015/Gravity15/index_e.|php.

14–18 **Cell Mechanics, Morphogenetics and Pattern Formation: Perspectives from the experimental and theoretical points of view (CGPW02)**, Isaac Newton Institute for Mathematical Sciences, University of Cambridge, Cambridge, UK.
Description: The mechanical characterisation of individual cells is complex and dynamic. Nonetheless, great progress has been made in understanding how the dynamics of subcellular structures lead to cell shape and motility. Static tissues have also been well characterised. It is at the level of morphogenesis where the bridging of scales between individual cell dynamics and tissue dynamics is least understood. This workshop aims to (1) present a framework for understanding what is already known about cell-level and tissue-level

mechanics, (2) identify gaps in our understanding of how cells interact mechanically in tissues in order to actuate morphogenesis, (3) propose new collaborations to increase our understanding of the cell-tissue emergent dynamics. We will bring together experts in development, microscopy, image analysis, biomechanics, and modeling.
Information: www.newton.ac.uk/event/cgpw02

14–18 **GAGTA-9: Geometric, Asymptotic and Combinatorial Group Theory and Applications**, CIRM, Marseille Luminy, France.
Description: The series of conferences named GAGTA is devoted to the confrontation of several viewpoints on the theory of infinite groups: geometric, combinatorial, asymptotic and probabilistic, algorithmic and computational.
Topics: Topics discussed at these conferences include group actions; growth and isoperimetric functions and other asymptotic invariants; random walks; algebraic geometry on groups; algorithmic properties and their complexity; generic properties and more generally generic complexity; and applications of group theory, notably to non-commutative cryptography. The 2015 edition of the conference, the first to be held in France will additionally bring a special emphasis to the contributions of asymptotic theory; the algorithmic aspects of group theory and its connections with computer science.
Information: scientific-events.weebly.com/1212.html.

14–18 **GraVisMa: Computer Graphics, Vision and Mathematics**, Primavera Congress Center (www.primaverahotel.cz) Plzen (The European City of Culture 2015) Close to Prague (The Golden European City) Czech Republic.
Description: GraVisMa submissions are expected in all areas related to Computer Graphics, Visualization, Computer Vision and Mathematics related to (but not limited to) Projective Geometry, Geometrical Algebra, Conformal Geometry and its applications to "Computer Science fields." Mathematics: Numerical Computation, Geometry, Interpolation and Approximation, Meshless (meshfree) methods, Projective Geometry, Geometric Algebra, Conformal Algebra, Grassmann & Clifford Algebra, Other Mathematical Aspects, Influence Mathematics to Computer Science: Computer Graphics, Computer Vision, Algorithms and Data Structures, Human Computer Interaction, 3D Vison, 3DTV, Scientific and Medical Visualization, Image Processing, Scientific Computing, Parallel and Distributed Computing, Interesting applications: Computer Science inspiration to Mathematics Educational Aspects, History of Mathematics and Computer Science.
Information: www.GraVisMa.eu

14–18 **GraVisMa 2015: Computer Graphics, Visualization and Mathematics Workshop: Meshless Methods in Computer Science, Engineering and Mathematics**, Primavera Congress Center (www.primaverahotel.cz) Plzen [Pilsen] close to Praha, Prague, Czech Republic.
Main topics (but not limited to): Meshless methods in computer graphics, vizualization and computer vision, Meshless methods in engineering problems, meshless methods-theory and practice, meshless interpolation and approximation of large data sets, radial basis functions (RBF) in computer graphics, visualization, image processing and computer vision, meshless methods and projective space.
Submission: skala@kiv.zcu.cz; subject: GraVisMa 2015-Meshfree.
Information: www.GraVisMa.eu.

14–18 **The European Numerical Mathematics and Advanced Applications (ENUMATH) Conference**, Institute of Applied Mathematics, Middle East Technical University, Ankara, Turkey. (Dec. 2013, p. 1497)
Description: The European Numerical Mathematics and Advanced Applications (ENUMATH) conferences are a forum for discussion of basic aspects and new trends in numerical mathematics and challenging scientific and industrial applications on the highest level of international expertise. They started in Paris in 1995 and were subsequently held at the universities of Heidelberg (1997), Jyvaskyla (1999), Ischia Porto (2001), Prague (2003), Santiago de Compostela (2005), Graz (2007), Uppsala (2009), Leicester (2011), Lausanne (2013).
Information: enumath2015.iam.metu.edu.tr/.

14–18 **The Seventh Symposium on Nonlinear Analysis**, Faculty of Mathematics and Computer Sciences, Nicolaus Copernicus University, Toruń, Poland.
Objectives: This is the seventh conference in the series of Symposia on Nonlinear Analysis organized by the Schauder Center for Nonlinear Studies in Toruń, Poland (see www.cbn.umk.pl/en/). The main aim of the conference is to bring together specialists in different branches of nonlinear analysis and to offer them good opportunities for exchange of ideas, personal contacts, informal meetings and discussions.
Special Events: Two special events will be held during the conference. On September 14, 2015, the Awarding Ceremony of the Juliusz Schauder Medal for Professor Paul H. Rabinowitz from the University of Madison-Wisconsin, USA, which has been awarded for his outstanding achievements in the field of topological methods in nonlinear analysis. On September 17, the special session will be devoted to celebrate the 70th anniversary of the birth of Professor Andrzej Szulkin from the Stockholm University.
Information: www.sna2015.mat.umk.pl

14–18 **Summer School on Thermodynamic Formalism and Transfer Operator Method**, University of Göttingen, Institute of Mathematics, Bunsenstr. 3-5, D-37073 Göttingen, Germany.
Description: This is the first event of a new series of summer schools on dynamical approaches in spectral geometry. It will discuss Thermodynamic Formalism and Transfer Operator Method, a field which produced a lot of new results in recent years of interest in mathematical physics (quantum chaos), spectral geometry, harmonic analysis and number theory. The main speakers are: Oscar Bandtlow (Queen Mary London), Frédéric Naud (Avignon), Anke Pohl (Göttingen), and Julia Slipantschuk (Queen Mary London).
Information: www.uni-math.gwdg.de/Spirit2015

16–21 **13th International Conference of The Mathematics Education for the Future Project: Mathematics Education in a Connected World**, Grand Hotel Baia Verde, Catania, Sicily, Italy.
Description: Our 12th International Conference of the Mathematics Education for the Future Project in 2014 in Montenegro was attended by 174 people from 29 countries. Our conferences bring together many innovative movers and shakers from around the world, and are renowned for their friendly and productive atmosphere. The conference title, Mathematics Education in a Connected World, continues our search for innovative ways in which mathematics, science, computing and statistics education can succeed in our increasingly connected world. We now call for papers and workshops (which can be peer reviewed) with the possibility of future publication in a book or journal. Please email Alan at alan@cdnalma.poznan.pl for further details.
Information:
directorymathsed.net/montenegro/AAAFACatania3.pdf.

17–20 **The 8th edition of ICTAMI - International Conference on Theory and Applications in Mathematics and Informatics**, "1 Decembrie 1918" University of Alba Iulia, Alba Iulia, Romania.
Description: The aim of the conference is to bring together mathematicians and informaticians from all over the world and to attract original papers on the following topics: Topics in Operator Algebras, Algebraic Geometry and Algebraic Number Theory, Complex Analysis and Operator Theory, Differential Equations and Optimal Control, Probability and Statistics in Mathematical Modeling, Advances in the Theory and Applications of Computer Science, Artificial Intelligence, Product and Process Modeling-Embedded Systems, Knowledge Engineering.
Information: www.uab.ro/ictami

17–20 **The 23rd Conference on Applied and Industrial Mathematics CAIM 2015**, 'Stefan cel Mare University', Suceava, Romania.
Description: The 23-rd Annual Conference of ROMAI, the Romanian Society of Applied and Industrial Mathematics, has the following sections: 1. Real, Complex, Functional and Numerical Analysis, 2. Partial Differential Equations with applications in Mechanics, Biology, etc., 3. Ordinary Differential Equations; Dynamical Systems, 4. Probability Theory, Mathematical Statistics, Operation Research, 5. Algebra, Logic, Geometry (with applications), 6. Mathematical Modeling, 7. Computer Science, 8. Education.
Information: www.romai.ro/conferintele_romai/caim2015en.html and www.ams.org/meetings/calendar/2015sep17-19_strasbourg.html#sthash.aIsQCFL3.dpuf.

17–19 **The 96th Encounter Between Mathematicians and Theoretical Physicists: Geometry and Biophysics**, University of Strasbourg, Strasbourg, France.
Description: The conference is part of the series "Encounters between Mathematicians and Theoretical Physicists".
Invited speakers: Ebbe Sloth Andersen (Aarhus), Joergen Andersen (Aarhus), Hiroyuki Fuji (Tsinghua U.), Misha Gromov (IHES), Sigeo Ihara (Tokyo), Herv Isambert (Paris), Masahide Manabe (Warsaw), Nadya Morozova (IHES), Jose Onuchic (Rice U.), Renzo Ricca (Milan), Piotr Sulkowski (Warsaw and Caltech), Michael Waterman (USC).
Talks: The talks will be in English. Some of the talks will be survey talks intended for a general audience. Graduate students and young mathematicians are welcome.
Registration: Is required (and free of charge) at this link. Hotel booking can be asked for through the registration link. For practical matters and other questions please contact the organizers: Athanase Papadopoulos: athanase.papadopoulos@math.unistra.fr; Bob Penner: rpenner@caltech.edu and Joanna Sulkowska: jsulkowska@chem.uw.edu.pl.
Information: www-irma.u-strasbg.fr/article1453.html.

18–20 **LMS-EMS Mathematical Weekend**, Birmingham University, Edgbaston Campus, Birmingham, United Kingdom.
Description: To celebrate the 150th year of the London Mathematical Society (LMS) and the 25th year of the European Mathematical Society (EMS) we are organizing a mathematical weekend, to be held in Birmingham from Friday September 18th to Sunday 20th, 2015. All mathematicians, from Europe and elsewhere, are warmly invited to participate. The weekend features three themes: Algebra, Analysis and Combinatorics. There will be plenary talks by Noga Alon, Keith Ball, Béla Bollobás, Timothy Gowers, Stefanie Petermichl, and Aner Shalev. There will be over twenty other invited talks presented in parallel sessions. Participation by early-stage researchers is particularly welcome and some funding is available to support them. Additional sessions are planned for post-doctoral researchers to present their work, and there will be a poster session for doctoral students.
Information: web.mat.bham.ac.uk/emslmsweekend/.

18–20 **Workshop on Geometrical Analysis Dedicated to the 60th Birthday of Jan Maly**, Charles University, Prague, Czech Republic.**Description:** The workshop will take place from Friday, September 18, to Sunday, September 20, 2015, at the lecture room K1, second floor, Sokolovska 83, Prague 8, Czech Republic. The program will consist of lectures delivered by invited speakers who are coauthors of Jan Maly. Another purpose of the meeting is to bring together mathematicians with common interest in the Geometrical Analysis and related topics.
Speakers: Luigi Ambrosio (SNS Pisa); Jana Bjorn (Linkoping University); Bernard Dacorogna (EPFL, Lausanne); Irene Fonseca (Mellon College of Science University, Pittsburg); Piotr Hajlasz (University of Pittsburgh); Tero Kilpelainen (University of Jyvaskyla); Pekka Koskela (University of Jyvaskyla); Jaroslav Lukes (Charles University in Prague); Olli Martio (University of Helsinki); Jani Onninen (University of Jyvaskyla); Lubos Pick (Charles University in Prague); Ludek Zajicek (Charles University in Prague).
Information: www.karlin.mff.cuni.cz/workshopprague/.

21–25 **AIM Workshop: Geometric flows and Riemannian geometry**, American Institute of Mathematics, San Jose, California.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to geometric flows and Riemannian geometry.
Information: aimath.org/workshops/upcoming/flowriemannian.

21–25 **Elliptic Methods and Moduli Spaces**, CIRM, Marseille Luminy, France.
Description: Nowadays, most of Symplectic topology and Gauge theory are based on a very diverse and profound set of Floer theories, which are themselves derived from a rich and complex corpus of moduli spaces. In this school, which is part of the Jean Morlet Chair semester granted to François Lalonde, some theories that have all followed the Floer theory, but in contexts that are far more general or in contexts that seem a priori radically different will be the main focus. Such theories are : the Floer theory itself, the Fukaya-Oh-Ohta-Ono theory, the Cornea-Lalonde Cluster theory, the Embedded contact homology, the Symplectic field theory, the cobordisms and rigidity of Lagrangian submanifolds theory developed by Biran-Cornea etc.
Information: lalondeteleman.weebly.com/doctoral-school.html.

21–26 **International Conference in Mathematics Education**, Catania, Sicily, Italy. (Aug. 2014, p. 797)
Description: Dear friends in Mathematics Education: The 12th International Conference of the Mathematics Education into the 21st Century Project will be held this year from Sep. 21-26 in Montenegro. Already more than 160 people have registered and it promises to be a very successful and productive meeting. The First Announcement and Call for Papers, with full details of the conference and a registration form, as well as background on our Project and Conferences, can be downloaded at: www.cdnalma.poznan.pl/static/alan/FAMontenegro6.doc. We are starting to plan our next conference, to be held in a beautiful hotel convention centre overlooking the sea close to Catania, Sicily, Italy, in late September, 2015. It will feature papers and workshops on all aspects of innovation in Mathematics, Science, Statistics and Computer Education. Our conferences are renowned for their friendly and productive atmosphere and they attract many of the movers and shakers in education from all over the world.
Information: Would you be kind enough to give us some personal feedback as follows? It is probable/possible/impossible (please choose one) that I can attend the Catania Conference in late September 2015. Thanks and best wishes, Dr. Alan Rogerson, D. Phil (Oxon), M.Sc., B.Sc., B.A. (Lon), Dip.Ed., Cert. Ed. (Cantab). International Coordinator of the Mathematics Education into the 21st Century Project.

21–26 **Master-Class on Finsler Geometry and Applications to Low-Dimensional Geometry and Topology and Moduli Spaces**, University of Cagliari, Sardinia, Italy.
Description: The master-class on Finsler geometry and applications to low-dimensional geometry and topology and moduli spaces will take place at the University of Cagliari (Sardinia, Italy), on

September 21-26, 2015. The focus of this Summer School will be on the following thematic areas: Finsler geometry, hyperbolic geometry, systolic geometry, Teichmüller theory.
Courses: The courses will be given by: Norbert A'Campo (Basel), Ivan Babenko (Montpellier), Ara Basmajian (CUNY), Ken'ichi Ohshika (Osaka), Hugo Parlier (Fribourg), Viktor Schroeder (Zurich), Sumio Yamada (Tokyo). Besides the courses, there will be a series of specialized lectures. The master-class is primarily intended for PhD students and young researchers.
Organizing Committee: R. Caddeo (Cagliari) and A. Papadopoulos (Strasbourg).
Registration: Is free of charge. PhD students and young mathematicians are particularly welcome. The arrival day is September 20, 2015 and the departure day is September 27, 2015.
Information: people.unica.it/renzoilariocaddeo/master-class/.

* 25–26 **The Thirteenth Annual Prairie Analysis Seminar**, Kansas State University, Manhattan, Kansas.
Description: The conference features David Kinderlehrer, Carnegie Mellon University, who will give two one-hour talks, and also features Rob McCann, University of Toronto and Yekaterina Epshteyn, The University of Utah, who will each give one-hour talks. There is time scheduled for contributed talks; all participants, especially mathematicians early in their careers, are encouraged to contribute a twenty-minute talk. The conference is supported by the NSF and funding is available with priority given to students, postdocs and those early in their careers.
Organizers: Marianne Korten, Nathan Albin, Kansas State University, Estela Gavosto, Rodolfo Torres, University of Kansas, and Charles Moore, Washington State University.
Information: www.math.ksu.edu/pas/2015/

27–October 2 **Mathematical Foundations of Traffic**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
Description: The goal of this workshop is precisely to bring together communities which can mutually benefit from each other: Traffic engineering and mathematics. The mathematics community has historically provided the engineering community with the proper ways to scientifically derive results used in practice, and the engineering community has provided the mathematics community with a variety of interesting problems to study. The workshop will be divided into three parts.
Subtopics: The first subtopic, fundamental models, will assemble experts who have made initial models such as the LWR model progressively more complex because of the need to incorporate new data and paradigms. The second subtopic will assemble experts who have worked on integral forms of the LWR model, in particular the Hamilton-Jacobi model. In the third topic, extensions of traffic flow models to better fit reality will be discussed. Applications received by Monday, August 3, 2015 will receive fullest consideration.
Information:
www.ipam.ucla.edu/programs/workshops/workshop-i-mathematical-foundations-of-traffic/?tab=overview.

* 28–October 1 **6th International Workshop on Set-Oriented Numerics**, Imperial College London, London, United Kingdom.
Description: The goal of this workshop is to bring high-profile international scientists from mathematics, physics, and fluid mechanics together to discuss the latest developments in the field of set-oriented numerics, as well as to promote possible applications. The workshop considers theoretical foundations of set-oriented numerical methods and practical aspects. This meeting will allow constructive discussions about the advantages and disadvantages of different approaches, and will facilitate the development of innovative ways to combine and improve the current state-of-the-art, as well as opening up new application fields.
Information: wwwf.imperial.ac.uk/~mrasmuss/son2015/

28–October 2 **Frontiers of Operator Dynamics**, CIRM, Marseille Luminy, France.
Description: Dynamics of linear operators, often seen as dynamics of the corresponding discrete or continuous operator semigroup, is a mature but at the same time steadily evolving field serving as a common denominator for many other areas of mathematics, such as for instance ergodic theory, complex analysis, harmonic analysis and the theory of partial differential equations. It consists in the study of the long-time behaviour of orbits of certains classes of operators or semigroups acting on Banach or Fréchet spaces, both from the topological and from the ergodic point of view. The aim of the meeting is to bring together researchers whose main interests interact with issues pertaining to the study of qualitative and quantitative properties of operator orbits (or operator semigroups) as well as experts in ergodic theory, and to initiate a fruitful interchange of ideas from complementary areas of expertise.
Information: scientific-events.weebly.com/1125.html.

28–October 3 **Semester Workshop: Modular Forms and Curves of Low Genus: Computational Aspects**, Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University, Providence, Rhode Island.
Description: One of the crowning achievements of number theory in the 20th century is the construction of the modularity correspondence between elliptic curves with rational coefficients and modular forms of weight 2. The consequences of this result resound throughout number theory; for instance, it enables the resolution of certain problems of diophantine equations (e.g., Fermat's last theorem) as well as the systematic tabulation of elliptic curves, which in turn provides the basis for many new conjectures and results. The aim of this workshop is to lay the groundwork for extending this correspondence to curves of small genus over number fields. The general framework for this correspondence is predicted by the Langlands program, but much remains to be made explicit. We will explore theoretical, algorithmic, computational, and experimental questions on both sides of the correspondence, with an eye towards tabulation of numerical data and formulation of precise conjectures.
Information: icerm.brown.edu/sp-f15-w1/.

29–October 1 **Workshop on Analysis and PDE**, Leibniz University Hanover, Hannover, Germany.
Description: This three-day workshop aims to bring together experts working on elliptic and parabolic equations, singular analysis, and geometric aspects of pdes. Limited support for young researchers is available. For further information see the workshop's website.
Main Speakers: Ugo Boscain, Eduard Feireisl, Kenro Furutani, Patrick Guidotti, Colin Guillarmou, Matthias Hieber, Matthieu Hillairet, Chisato Iwasaki, Rafe Mazzeo (tbc), Felix Otto, Gieri Simonett, Alexander Strohmaier, Tobias Weth, Jared Wunsch.
Information: www.math-conf.uni-hannover.de/anapde15

* 29–October 3 **International Symposium "Mathematics of XXI Century and Natural Science"**, Peter the Great St. Petersburg Polytechnic University, St. Petersburg, Russia.
Description: Symposium includes III International Seminar "Nonlinear Phenomenology Advances." II International Seminar "Systemic-Operational Modifications of Mathematical Theories" and II International Wokshop "Scientific and Educational Problems of Belarusian Nuclear Power Plant Project." Recent advances and achievements in nonlinear science and data processing techniques will be discussed. Special attention will be paid to nonlinear tools and techniques, as well as modern approaches and tools for data processing, and studying nonlinear problems in different fields of science (mathematics, physics, chemistry, biology, economics and others).
Information: fans.j-npcs.org/serow2015.pdf

October 2015

3–4 **Central Fall Sectional Meeting**, Loyola University Chicago, Chicago, Illinois.
Information:
www.ams.org/meetings/sectional/sectional.html.

5–9 **Digital Humanities: Critical Edition of Diderot and D'Alembert's Encyclopedia**, CIRM, Marseille Luminy, France.
Description: The ongoing work on a digital critical edition of Diderot and D'Alembert's Encyclopedia has given rise to an ambitious international Digital Humanities project, supported by the Académie des Sciences, called ENCCRE (which stands for `Edition Numérique Collaborative Critique de l'Encyclopédie'). Involving a team of 50 specialists, it is based on cooperation between researchers from different countries working in a variety of disciplines; this diversity of disciplines and critical approaches corresponds to the range of fields of knowledge found in the Encyclopédie. ENCCRE will provide a digital tool adapted to the complexity of the Encyclopédie from the editorial point of view, while at the same time being able to keep up with changes in methods of reading and research.
Information: scientific-events.weebly.com/1191.html.

6–8 **Conference on Agricultural Statistics 2015**, Sarawak, Malaysia.
Description: The health and wealth of a nation and its potential to develop and grow, depends on its ability to feed its people. Accurate and timely statistics about the source and availability of basic agricultural supplies are essential. As nations develop and their economies grow, the need for immediate information will place increased emphasis on agricultural statistics. The rapidly growing world population will require increased productivity which will be enhanced by the use of statistical analysis resulting from the studies of agricultural sciences. Therefore, each nation should highly consider to provide a forum to foster a spirit of cooperation in the sharing of ideas and statistical methodology among the global nations to maintain continual improvement in the accuracy, timeliness and relevance of agricultural statistics.
Information: einspem.upm.edu.my/cas2015.

9–11 **Symposium on Biomathematics and Ecology: Education and Research (BEER-2015)**, Illinois State University, Normal, Illinois.
Description: We welcome researchers, educators, graduate and undergraduate students, and scientists to join in-depth discussions on a wide variety of interdisciplinary problems regarding computational biology, ecology, biomathematics, biostatistics and related fields. We also enthusiastically welcome educators of these fields to share their expertise in curriculum development and related challenges.
Information: www.biomath.ilstu.edu/beer.

* 10–11 **The Sixth Annual Dr. George Bachman Memorial Conference**, St. John's University 8000, Utopia Parkway, Jamaica, NY.
Description: The conference welcomes papers in all areas of mathematics, and encourages graduate students to participate. The Saturday session consists of a welcome, a short introduction, and a dinner. The Sunday session consists of presentation of papers. Abstracts should be submitted by August 20, 2015 to Dr. Edward Beckenstein Drbeckense@aol.com; Dr. Charles Traina trainac@stjohns.edu. Papers may be submitted even if they are not presented at the conference. The deadline for submission is December 3, 2015.
Information: www.math@stjohns.edu

10–11 **35th Annual Southeastern-Atlantic Regional Conference on Differential Equations (SEARCDE 2015)**, The University of North Carolina at Greensboro, Greensboro, North Carolina.
Description: The primary objective of this conference is to promote research and education in the field of differential equations by bringing together established mathematicians, recent PhD recipients, and graduate students. A wide range of topics, including ordinary and partial differential equations, dynamical systems, integral and functional equations, numerical methods, inverse problems, differential geometry, control theory, and applications to biology, finance, engineering and the sciences in general are often represented. Eminent mathematicians H. T. Banks (North Carolina State University), Pavel Drabek (University of West Bohemia), Lisa Fauci (Tulane University) and Peter Polacik (University of Minnesota) are the plenary speakers. In addition to the plenary talks, participants will have the opportunity to present contributed talks.
Information: www.uncg.edu/mat/searcdeconf/2015/.

12–14 **SIAM Conference on Geometric and Physical Modeling (GDSPM15)**, Sheraton Salt Lake City Hotel, Salt Lake City, Utah.
Description: This biennial joint conference (started in 2009) represents a historic union of these communities, their rich academic and industrial histories, as well as the common intellectual themes that continue to move them forward. Over the past twenty years the meetings of the SIAM Special Interest Activity Group on Geometric Design have been one of the main general international conferences on geometric modeling and related areas, and have been well attended by mathematicians and engineers from academia, industry, and government. Since its inception in 1991, the ACM Symposium on Solid and Physical Modeling has been the primary international forum for disseminating research results and exchanging new ideas in relevant mathematical theory, solid modeling, physical modeling, geometric design, analysis, simulation and processing, shape computing and visualization, and various applications.
Information: www.siam.org/meetings/gdspm15/.

12–16 **Ordered Algebraic Structures and Related Topics**, CIRM, Marseille Luminy, France.
Description: The meeting will mark the 30th anniversary of the Paris seminar "Structures algébriques ordonnées" and will be organized around the areas of research that have been central to the seminar activities, namely: Ordered groups, rings and fields; real algebra; valuation theory; Model-theoretic methods and algorithmic aspects; positive polynomials and optimisation; real algebraic and analytic geometry; o-minimality and quadratic forms; abstract spaces of orders and real semigroups.
Information: scientific-events.weebly.com/1155.html.

12–16 **Workshop II: Traffic Estimation**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: The last decade has seen a sharp increase in the amount of data available for traffic estimation, and furthermore the types of data available has also drastically diversified itself. This evolution has been particularly quick in the last few years, with the explosion of cellular devices, leading to novel sources of traffic data. The workshop will investigate techniques which are commonly used for traffic estimation for partial differential equations, ranging from straight extensions of Kalman filtering to statistical methods such as particle filters (subtopic 1). It will also focus on methods which are statistically based, in particular for the arterial networks for which there is not necessarily sufficient amounts of data (subtopic 2). Subtopic 3 will cover optimization methods applied to networks of PDEs, with specific emphasis on traffic models.
Deadline: Applications received by Monday, August 17, 2015 will receive fullest consideration.
Information: www.ipam.ucla.edu/traws2.

14–16 **International Conference "Stochastic Processes in Abstract Spaces"**, Taras Shevchenko National University of Kyiv; Institute of Mathematics, National Academy of Sciences of Ukraine; National Technical University of Ukraine "Kyiv Polytechnic Institute", Kyiv, Ukraine. See: matfiz.univ.kiev.ua/cmf2015.
Description: International Conference Stochastic Processes in Abstract Spaces (SPAS) is dedicated to the 80th anniversary of prominent scientist Professor A. Ya. Dorogovtsev (1935–2004). The aim of the conference is to bring together national and international researchers in stochastic processes. It will provide a unique opportunity for exchanging ideas and discussing recent results and new

trends in a wide range of research areas: theory of stochastic processes in multidimensional spaces, statistics of stochastic processes, stochastic difference and differential equations.
Information: matfiz.univ.kiev.ua/conf2015/

17–18 **Fall Southeastern Sectional Meeting**, University of Memphis, Memphis, Tennessee.
Information:
www.ams.org/meetings/sectional/sectional.html.

18–24 **Workshop on Almost Hermitian and Contact Geometry**, International Mathematics Conference Center in Bedlewo near, Poznan, Poland.
Organizers: Thomas Friedrich (Berlin), Ilka Agricola (Marburg), Aleksy Tralle (Olsztyn).
Sponsors: Banach Center, Warsaw Center of Mathematics and Computer Science (WCNM).
Invited Speakers: Indranil Biswas, Gil Cavalcanti, Andrew Dancer, Marisa Fernandez, Hansjorg Geiges, Christina Toennesen-Friedman, Adriano Tomassini, Robert Wolak. The focus of the workshop is on the interactions of almost hermitian geometry and metric aspects of contact geometry, as well as applicatons in mathematical physics.
Information: wmii.uwm.edu.pl/woahacg/index.php.

19–23 **Applications of AdS/CFT to QCD and Condensed Matter Physics**, Centre de recherches mathématiques, Université de Montrál, Pavillon André-Aisenstadt, Montréal, Canada.
Description: One of the most important problems in mathematical physics is the study of strongly coupled field theories of the sort we use to describe the strong interactions (QCD) and condensed matter systems (CMT). Theorists have very few tools at their disposal, each of which accompanied by its attendant limitations. Perturbative (i.e., weak coupling) computations can probe a large part of the parameter space of QCD. However, these results are valid only at temperatures well above the deconfinement temperature, and at large values of the baryon number chemical potential μ in order for the QCD coupling to be small, and thus the perturbation theory valid. These exclusions limit the applicability to regions of parameter space explored in heavy ion collisions at RHIC and LHC.
Information: www.crm.umontreal.ca/2015/Applications15/index_e.php.

19–23 **Whitney Problems Workshop**, CIRM, Marseille Luminy, France.
Description: Motivated by boundary value problems for partial differential equations, classical trace and extension theorems characterize traces of spaces of generalized smoothness such as Sobolev and Besov to smooth submanifolds of Euclidean space. The subject originated from Hassler Whitney's seminal papers of 1934, which deal with the following problem: given a real function on an arbitrary subset of Euclidean space, determine whether it is extendible to a function of a prescribed smoothness on the entire space. The objective of the meeting is to bring together an international group of experts in the areas of function theory and functional and geometric analysis to report on and discuss recent progress and open problems in the area of Whitney type problems.
Information: scientific-events.weebly.com/1128.html.

19–24 **Semester Workshop: Explicit Methods for Modularity of K3 Surfaces and Other Higher Weight Motives**, Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University, Providence, Rhode Island.
Description: Only recently has it become feasible to do large scale verification of the predictions of the Langlands program in higher rank cases and to present the results in a way that is accessible widely to mathematicians. Moving from the understanding of Galois representations attached to elliptic curves to those attached to surfaces and other higher-dimensional varieties poses interesting problems in both arithmetic, algebra, geometry, and analysis. In this workshop, we will consider computational and other explicit aspects of modular forms in higher rank. Topics covered will include: K3 surfaces and their connections to modular forms on orthogonal groups, algebraic modular forms associated to classical groups and their computation, and motives arising from general Calabi-Yau varieties accessible to explicit methods, including hypergeometric motives.
Information: icerm.brown.edu/sp-f15-w2/.

19–30 **New challenges in PDE: Deterministic dynamics and randomness in high and infinite dimensional systems**, Mathematical Sciences Research Institute, Berkeley, California.
Description: This workshop serves to bring into focus the fundamental aim of the jumbo program by both a) showcasing the spectacular progress in recent years in the study of both nonlinear dispersive as well as stochastic partial differential equations and b) bringing to the fore the key challenges for the future in quantitatively analyzing the dynamics of solutions arising from the flows generated by deterministic and nondeterministic evolution differential equations, or dynamical evolution of large physical systems. During the two weeks long workshop, we intertwine talks on a wide array of topics by some of the key researchers in both communities and aim at highlighting the most salient ideas, proofs and questions which are important and fertile for cross-pollination between PDE and SPDE.
Topics: Global dynamics and singularity formation for geometric and physical nonlinear wave and dispersive models (critical and supercritical regimes); dynamics of infinite dimensional systems (critical phenomena, multiscale dynamics and metastability); symplectic structures of infinite dimensional dynamical systems; randomization and long time dynamics, invariant Gibbs and weighted Wiener measures; derivation of effective dynamics in quantum systems; weak turbulence phenomena; optimization and learning algorithms; distributed, stochastic and parallel.
Information:
www.msri.org/workshops/761. www.ams.org/meetings/calendar/2015_oct19-30_berkeley.html#sthash.QjnzSmOn.dpuf

21–23 **International Conference in Modeling Health Advances 2015**, UC Berkeley, San Francisco Bay Area, California.
Description: A host of new diseases, like HIV/AIDS, BSE, Avian Flu, West Nile Virus and others have appeared on the scene during the last twenty five years and undoubtedly, more will come in the coming years. To tackle these illnesses, the cooperation of modelers, mathematicians, statisticians, computer scientists, and others, and of researchers from the medical community is absolutely essential. Modeling is important because it gives important insight into the method of treatment. In the case of HIV/AIDS, for example, mathematical modeling indicated that a combination of both protease inhibitors and reverse transcriptase inhibitors would be far more effective than any one of these two drugs. The purpose of this conference is to bring all the people working in the area of epidemiology under one roof and encourage mutual interaction.
Information: www.iaeng.org/WCECS2015/ICMHA2015.html.

24–25 **Fall Western Sectional Meeting**, California State University, Fullerton, Fullerton, California.
Information:
www.ams.org/meetings/sectional/sectional.html.

26–30 **Moduli Spaces in Geometry**, CIRM, Marseille Luminy, France.
Description: It is a remarkable fact that the moduli stack of Higgs bundles features prominently in many aspects of the Langlands program. Ngô Bào Châu used the topology of the moduli stack of Higgs bundles and the Hitchin map to prove the fundamental lemma in the Langlands program over function fields over finite fields. Drinfeld and Laumon proposed a geometric version of the Langlands program which works over arbitrary fields, in particular, over C. It postulates an equivalence between the derived category of D-modules on the moduli stack of principal G-bundles and the derived category of O-modules on the stack of local systems for the Langlands dual group

on an algebraic curve. Donagi and Pantev showed that the Hitchin integrable system for a simple algebraic group is dual to the Hitchin system for the Langlands dual group. This can be interpreted as a "classical limit" of the Geometric Langlands Conjecture. The meeting will discuss recent results related to these spectacular developments.
Information: scientific-events.weebly.com/1139.html.

26–30 **Traffic Control**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
Description: In the past decades, traffic control has mainly included approaches based on ramp metering, i.e., actuation on the freeway via lights preventing a too high flow from entering the freeway during congestion times. In the last years, with the advent of distributed computing, wireless communication and ubiquitous sensing, metering can be achieved at large scale (not only locally), and can be allied with numerous other approaches such as variable speed limits, special use lanes, etc. The mathematical formulation of the underlying problems is quite challenging (for example variable speed limits changes the underlying flow model used in the problem set up). The formulation of the corresponding control problems is also quite difficult, as many times it results in nonlinear nonconvex optimization problems. Numerous approaches have been investigated to solve these problems, which include Lyapunov techniques, adjoint based optimization, and convex relaxation.
Information: www.ipam.ucla.edu/programs/workshops/workshop-iii-traffic-control/.

30–November 1 **Meeting of the History and Pedagogy of Mathematics, Americas Section**, University of Massachusetts, Amherst, Massachusetts.
Description: HPM-Americas is pleased to announce a meeting Friday afternoon through Sunday morning, October 30 to November 1, 2015, at the University of Massachusetts, Amherst. Amherst is located just off Rte. 91, and north of the Mass Pike. Amherst is accessible from the Hartford airport (50 minutes) and the Boston and Albany airports (each about 2 hours). A shuttle is available from the Hartford and Boston airports through Valley Transporter. Peter Pan bus lines run from Boston, New York, and DC to the UMass campus. The nearest Amtrak station is in Northampton, which is about 10 miles from Amherst and on public transportation. We seek a variety of talks on relations between the history and pedagogy of mathematics. Talks on experience with using history in mathematics classrooms are especially encouraged. Talks seeking comment on untested ideas for using history to teach mathematics are also welcome. Talks will be about 25 minutes long, followed by abundant time for discussion. Abstracts of proposed talks need to be received by September 1, 2015. Abstracts and registrations can be submitted via www.hpm-americas.org.
Information: www.ams.org/meetings/calendar/2015_oct30-nov1_amherst.html#sthash.i1sWXbxe.dpuf.

November 2015

2–5 **International Conference on Coding and Cryptography**, USTHB, University of Algiers, Algiers, Algeria.
Description: The International Conference on Coding Theory and Cryptography will be organized by the Algebra and Number Theory laboratory of USTHB and will be held on 2–5 November 2015 at USTHB. Mainly the topics of the conference are all aspects of theoretical and practical research in coding theory and cryptography. The conference is also open to all aspects of information theory. The purpose of this conference is to bring specialized researchers to present and discuss their research with a wide variety of other specialists.
Information: www.latn.usthb.dz/spip.php?article35.

2–6 **Conference in Noncommutative Geometry**, CIRM, Marseille Luminy, France.
Description: One of the aims of noncommutative geometry is to generalize the main tools of geometry to a class of regular enough C*-algebras which can be considered as noncommutative spaces and thus get applications in geometry, analysis, number theory and quantum mechanics. This query involves many different tools and questions. This conference will make an overview of some of them, i.e. Index theorems and applications, Applications of cohomological theories, Baum-Connes conjecture, Group Geometry and Von Neumann Algebras, Quantum Groups, sub-factors, Groupoids and applications.
Information: scientific-events.weebly.com/1206.html.

3–5 **International Conference on Mathematical Modeling and Operations Research (ICMMOR 2015)**, X-Consultancy Organization - Online Conference, Sacramento, CA.
Description: ICMMOR 2015 is inviting high quality, original papers that contribute (but are not limited) to methodology and application of mathematical modeling, operations research, Statistics, Statistical Modeling, Optimization and to the practice of engineering, Simulation, modeling, Management and decision making. The papers are classified but not limited to one of the following headings:
1. Applied Mathematics, Operations Research, Numerical Methods
2. Applied Statistics, Survey Analysis
3. Production, Manufacturing and Logistics
4. Stochastic Processes, Simulation and Decision Support
5. Mathematics and Statistics for Management & Engineering
6. Interfaces with other disciplines.
Information: www.xconsultancy.org/ICMMOR.php

3–10 **SEAMS school: Algebras and Their Applications (Quantum Physics, Cryptography and Statistics)**, Institute for Mathematical Research, Universiti Putra, Malaysia.
Description: The South East Asian Mathematical Society initiates the SEAMS School of Mathematics as a series of intensive 7-day workshops. The purpose of this school is to provide opportunities for advanced undergraduate and postgraduate students to have an advanced learning experience in mathematics, and to introduce a research-based learning. This school will introduce fundamental notions of Algebras, Quantum Physics, Cryptography and Statistics. It is addressed to advanced undergraduate and graduate students as well as young researchers from South East Asian countries. It will provide them with some of the knowledge necessary to further study and research.
Speakers: Prof. Dr. Andreas Enge, Institute of Mathematics, Bordeaux, France; Prof. Dr. Michel Planat, FEMTO-ST Institute, France; Prof. Dr. Isamiddin S. Rakhimov, Universiti Putra Malaysia, Malaysia; Prof. Eva Riccomagno, University of Genova, Italy; Assoc. Prof. Dr. Hailiza Kamarul Haili, Universiti Sains Malaysia, Malaysia.
Information: einspem.upm.edu.my/seams2015/index.php.

5–6 **Workshop on q-Calculus and its Applications**, Universidad de Cundinamarca, Sede Principal Fusagasuga, Cundinamarca, Colombia.
Description: The aim of this mathematical meeting is to gather a group of people interested in studying and applying techniques from q-calculus to any branch of mathematics and science. Among the topics of interest we include quantum groups, q-probabilities, combinatorial q-analogues, Rota-Baxter q-algebras, categorification of q-calculus, knot theory, q-differential equations, q-deformations of algebras, Weyl q-algebras, Hecke algebras, Gaussian q-distribution.
Information: sites.google.com/site/workshopqcalculus/

5–7 **The 14th International Conference on Mathematics and its Applications-Icma 2015. Workshop on Mathematical Methods in Quantum Information Theory. Workshop on Dynamical Systems and their Application**, Department of Mathematics, Politehnica University of Timisoara, Romania.
Description: ICMA 2015 is organized by the Department of Mathematics, Politehnica University of Timisoara together with Romanian Academy–Timisoara Branch. The Conference is devoted to the following fields: Mathematical Analysis and Applications; Algebra and Geometry, Computer Algebra Systems in Research; Applied

Mathematics in Engineering and Economics; Probability and Statistics, Applications in Health and Clinical Research.
Information: www.mat.upt.ro/Upt-Timisoara_94_ro.html.

6–8 **Ninth Annual Mathematical Field of Dreams Conference**, Sheraton Birmingham Hotel, Birmingham, Alabama.
Description: The National Alliance for Doctoral Studies in the Mathematical Sciences is pleased to announce the Ninth Annual Mathematical Field of Dreams Conference. This year the conference will be held at the Sheraton Birmingham Hotel located in Downtown Birmingham, Alabama. The Conference brings together faculty in the mathematical sciences with students from backgrounds underrepresented in those fields. This will be an exciting weekend that will provide something for everyone.
Information: mathalliance.org/?page_id=6154

9–11 **Equilibrium and Optimization Methodology in Finance and Economics (ICEOMFE 2015)**, King Saud University, Riyadh, Saudi Arabia.
Description: The main aim of this conference is to bring together leading experts and researchers in mathematical modeling to assess new developments in optimization and equilibria methodology and their applications to Mathematical Finance and Economics. The conference will focus on the following areas:
- Iterative Methods in Optimization and Fixed Point Theory
- Equilibrium theory
- Financial Markets - Actuarial Mathematics

Keynote Speakers: B. Cornet (France), R. T. Rockafellar (USA), H. M. Soner (Switzerland), Hong-Kun Xu (China), Michel Thera (France).
Invited Speakers: H. Ben-El Mechaiekh (Canada), J-M. Bonnisseau (France), Alain Chateauneuf (France), P. Gourdel (France), A. Jofre (Chile), C. Le Van (France), A. Khan (Saudi Arabia), V. Radulescu (Romania), J. Sun (Australia).
Local Organizer: Souhail Chebbi (schebbiu@KSU.EDU.SA)
Information: npst.ksu.edu.sa/en/iceomfe/about

9–13 **Controllability of Partial Differential Equations and Applications**, CIRM, Marseille Luminy, France.
Description: In recent years, the theory of control of partial differential equations (PDEs) has tremendously evolved and the field is rapidly growing and includes control of conservation laws, of nonlinear PDEs, of degenerate equations, of equations with delay or memory, of systems of PDEs etc. Interactions between finite and infinite dimensions are to be mentioned as well both at the theoretical level and for the discretization of some continuous control problems. The objectives of the conference are to review the recent advances and the determination of new and promising research directions.
Information: scientific-events.weebly.com/1368.html.

9–13 **Semester Workshop: Computational Aspects of L-functions**, Institute for Computational and Experimental Research in Mathematics (ICERM) at Brown University, Providence, Rhode Island.
Description: This conference will revolve around several themes: the computational complexity of L-functions; statistical problems concerning L-functions, such as the distribution of their values, and zeros, moments of L-functions, statistics and size of ranks in families of elliptic curves; practical implementations of algorithms and their applications to testing various conjectures about L-functions; rigorous and certifiable computations of L-functions. One goal is to stimulate dialogue between theoreticians and computationally minded researchers regarding problems to which computation might provide insight or important confirmation of conjectures. In the other direction, we hope that discussions will lead to new ideas concerning algorithms for L-functions.
Information: icerm.brown.edu/sp-f15-w3/.

10–11 **ICMCS 2015 - International Conference on Mathematics and Computer Science**, Conference Hall Grand Hotel, Vienna, Austria.
Description: The aim of the conference is to promote research in the field of Mathematics and Computer Science. Another goal is to facilitate exchange of new ideas in these fields and to create a dialogue between scientists and practitioners.
Keynote Speaker: Professor of Pace University—Bel G. Raggad.

14–15 **Fall Eastern Sectional Meeting**, Rutgers University, New Brunswick, New Jersey.
Information:
www.ams.org/meetings/sectional/sectional.html.

14–17 **IEEE Call for Papers**, The IEEE International Conference on Data Mining series, Atlantic City, NJ.
Description: (ICDM) has established itself as the world's premier research conference in data mining. Paper submissions for the conference should be limited to a max of ten (10) pages in the IEEE 2-column format (templates available at www.ieee.org/conferences_events/conferences/publishing/templates.html), including the bibliography and any possible appendices. Manuscripts must be submitted electronically (wi-lab.com/cyberchair/2015/icdm15/cbc_index.php). Author names and affiliations must not appear in the submissions, and bibliographic references must be adjusted.
Important Dates:
* Full paper submissions: June 3, 2015
* Demo and tutorial proposals: July 13, 2015
* Conference paper, tutorial, demo notification: August 25, 2015
* Workshop paper submissions: August 28, 2015
* Workshop paper notifications: September 25, 2015

Information: www.ieee.org

16–20 **Decision Support for Traffic**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: The next decade will see numerous decision support tools emerge for traffic management. This is mainly due to the fact that all pieces necessary for the development of these tools are now at our disposal, and have emerged in the recent years. This includes sensing, communication, high performance, and modeling capabilities. All over the world, several Departments of Transportation have started to investigate the steps required to build tools capable of advising humans in charge of optimization of mobility at the scale of a city. Specific breakthroughs are already visible in Australia, France, and in the Netherlands. Such tools require significant amount of modeling (the interplay of various control schemes on a distributed parameter system, which can be modeled as a partial differential equation), which will be presented in the first subtopic of the workshop.
Deadline: September 21, 2015.
Information: www.ipam.ucla.edu/programs/workshops/workshop-iv-decision-support-for-traffic/.

16–December 25 **Stochastic Methods in Game Theory**, Institute for Mathematical Sciences, National University of Singapore, Singapore.
Description: The program aims at showing the role of stochastic methods in strategic situations. Three workshops will focus on some aspects of the interaction between strategy and stochastics and its interest from a mathematical viewpoint. The first workshop will focus on learning. The second workshop will be about stochastic games. The third workshop will deal with congestion games.
Information:
www2.ims.nus.edu.sg/Programs/015game/index.php.

23–27 **Algebraic Geometry and Complex Geometry**, CIRM, Marseille Luminy, France.
Description: The aim of this conference is to get together algebraic geometers and complex geometers, around recent topics of interest. Mornings are devoted to 5 mini-courses, given by experts of important new developments.
Topics: Stability and applications to birational and hyperkaehler geometry, K-stability and Kähler geometry, Classification of compact Kähler varieties, Hodge modules applications and Tate's conjecture

for K3 surfaces. Afternoons are devoted to more specialized one-hour talks and will be chosen by the scientific committee 3 months before the conference.
Information: scientific-events.weebly.com/1393.html.

26 **4th IMA Conference on Mathematics in Defence**, Satellite Applications Catapult, Harwell, Oxford, United Kingdom.
Description: Science and technology play an increasingly important role in equipping and supporting the armed forces. Mathematics is fundamental to these disciplines, providing a framework for understanding and solving the varied and complex problems faced, and is used to model military systems and scenarios. These models can be used to estimate system performance, suggest improvements, or find weaknesses of real systems. This conference brings together a wide variety of mathematical methods with defence and security applications. The programme will include keynote speakers, contributed presentations and poster sessions as well as refreshment breaks for informal discussions. It is intended for mathematicians, scientists and engineers from industry and academia, as well as government and military personnel who have an interest in how mathematics can be applied to defence problems.
Information: www.ima.org.uk/conferences/conferences_calendar/4th_mathematics_in_defence.cfm.html.

30–December 4 **AIM Workshop: Automorphic kernel functions**, American Institute of Mathematics, San Jose, California.
Description: This workshop, sponsored by AIM and the NSF, will focus on the study of automorphic kernel functions as used in various versions of the trace formula.
Information: aimath.org/workshops/upcoming/automorphkernel.

December 2015

1–5 **BioInfoSummer 2014: Summer Symposium in Bioinformatics**, Monash University (Caufield Campus), Melbourne, Australia. (Jun/Jul 2014, p. 669)
Description: Bioinformatics is an exciting, fast-moving area analysing and simulating the structures and processes of biological systems. BioInfoSummer introduces students, researchers and others working in related areas to the discipline. The program features: Introduction to biology and bioinformatics; evolutionary biology; systems biology; next generation sequencing; and coding and algorithms for bioinformatics.
Information: www.amsi.org.au/BIS.

3–4 **Workshop on Integrable Systems**, School of Mathematics and Statistics, University of Sydney NSW, Australia.
Description: This event follows the workshops that we organised previous years, see www.maths.usyd.edu.au/u/integrable/; wp.maths.usyd.edu.au/igs/workshops/december2014/.

6–11 **71st Annual Deming Conference on Applied Statistics**, Tropicana, Atlantic City, New Jersey.
Description: The full program as well as a downloadable printed version will be available at www.demingconference.com by June 1st and online registration will open in August. The purpose of the three-day Deming Conference on Applied Statistics is to provide a learning experience on recent developments in statistical methodologies. The 3-day conference is followed by two parallel 2-day short courses. The conference is composed of twelve three-hour tutorials on current applied statistical topics. The books, on which these sessions are based, are available for sale at an approximately 40% discount. While these books are not available by mail, if someone from your firm registers, you could ask them to purchase some for you. Attendees will receive bound proceedings of the presentations. There will also be poster sessions. The conference will be held in the state-of-the-art Havana Tower of the Tropicana Casino Resort with free high speed Internet. Walter Young has chaired this conference for 45 consecutive years.
Information: www.demingconference.com.

7–11 **39th Australasian Conference on Combinatorial Mathematics and Combinatorial Computing**, The University of Queensland, Brisbane, Australia.
Description: Contributed talks will be sought from all areas of discrete and combinatorial mathematics and related areas of computer science.
Invited speakers: Confirmed so far: Saad El-Zanati (Illinois State University), Catherine Greenhill (University of New South Wales), Penny Haxell (University of Waterloo), Jonathan Jedwab (Simon Fraser University), Charles Semple (University of Canterbury).
Information: The conference website can be found at 39accmcc.smp.uq.edu.au/. At this stage, the website contains only basic information. Further information will be added as it becomes available. Please send any questions to Darryn Bryant at db@maths.uq.edu.au.

7–11 **BioInfoSummer 2015**, The University of Sydney, Sydney, Australia.
Description: Bioinformatics is an exciting, fast-moving area of analysing and simulating the structures and processes of biological systems. BioInfoSummer provides bioinformatics training to students, researchers and others working in related areas. The 2015 event includes both specialist lectures and hands on introductory and advanced computer workshops. Topics discussed will include: Introduction to Biology and Bioinformatics Epigenomics Translational Genomics Proteomics and Metabolomics Systems Biology, Networks and Data Integration.
Information: bis15.amsi.org.au/

7–11 **New Mathematical and Computational Problems involved in Cell Motility, Morphogenesis and Pattern Formation (CGPW04)**, Isaac Newton Institute for Mathematical Sciences, University of Cambridge, Cambridge, UK.
Description: Cell motility, morphogenesis, and pattern formation are essential features of cell dynamics. The involved biochemical processes and biomechanical properties range from the intracellular level over cell surface dynamics, cell-cell and cell-tissue interactions up to the scale of cell population behaviour influencing organ formation and functioning. Mathematical models handling biological events taking place on one or several such scales can provide a powerful framework to understand these phenomena, test experimentally suggested conjectures, and make predictions about the behaviour of the studied system. Current modelling approaches are often continuous, involving systems of partial differential equations of various kinds (e.g., reaction-diffusion-transport, taxis, kinetic transport, population balance), possibly coupled to ordinary, random, or stochastic differential equations. For full description, see the website.
Information: www.newton.ac.uk/event/cgpw04

7–11 **Present Challenges of Mathematics in Oncology and Biology of Cancer**, CIRM, Marseille Luminy, France.
Description: This workshop will bring together specialists and young researchers from different mathematical backgrounds (modeling, numerical simulations and analysis) and those working in the field of oncology. It will focus on five issues, all of them concerning ongoing projects in the Marseille's units. The first one is Microtubules, migration and cancer; the second Metronomic chemotherapy, the third is 3-Cancer Stem cells, evolution of phenotype; the fourth is Biomarkers and finally we have Imaging and cancer. Through these sessions, we will put in light how mathematical modeling can help oncologists in terms of prognostic, prediction and therapy scheduling. We want to gather international experts in these five area of research in order to exchange and intensify the relations between the mathematical pharmacologists and oncologists communities.
Information: scientific-events.weebly.com/1412.html.

* 8–12 **International Conference on Function Spaces and Inequalities**, Department of Mathematics, South Asian University, New Delhi, India.
Description: The Department of Mathematics of South Asian University, New Delhi will be hosting an International Conference on "Function Spaces and Inequalities" during December 8–12, 2015. The aim of the conference is to bring together experts from all over the world working in the topics of Function Spaces and Inequalities. Some of the topics (but not restricted to) are the following: (Variable/Grand/Small) Lebesgue Spaces, Orlicz Spaces, Lorentz Spaces, Sobolev Spaces, Morrey Spaces, Sequence spaces, Weight Theory, Integral Operators of Hardy Type, Sobolev Type Imbeddings, Function Algebras, Banach Algebras, Spaces & Algebras of Analytic Functions, Geometry of Banach Spaces, Isometries of Function Spaces, (Weighted) Integral and Discrete Inequalities, Convexity Theory, Harmonic Analysis.
Information: fsiconf.sau.int

10–13 **Quasiweekend II—Ten Years After**, Helsinki, Finland.
Description: This meeting is a continuation of the Quasiweekend held in 2005 mathstat.helsinki.fi/analysis/quasiweekend|. The aim of the conference is to bring together internationally leading experts on fields related to the mathematical inheritance of Jussi Visl and Seppo Rickman. The topics of the conference include: Quasiconformal, quasiregular and related mapping classes; analysis on metric spaces; geometric analysis and dynamics; geometric group theory.
Information: wiki.helsinki.fi/display/QuasiWeekend2/.

13–15 **The 4th International Conference on Electrical Engineering**, Boumerdés, Algeria.
Description: After three successful editions, the 4th International Conference on Electrical Engineering – ICEE'2015 will take place at the Institute of Electrical and Electronic engineering (IGEE, ex. INELEC). The ICEE'2015 aims to promote research in electrical engineering and electronics. It is an opportunity to exchange experiences and present research results in the fields of theoretical, experimental, and applied Electrical Engineering. The conference will bring together leading researchers, engineers and scientists in the domain of interest from around the world.

14–16 **International Conference "Relativity and Geometry" in Memory of André Lichnerowicz**, Institut Henri Poincaré, Paris, France.
Description: This conference, to celebrate the centenary of Lichnerowicz's birth, will conclude the trimester on "Mathematical General Relativity" organized at the Centre Emile Borel of the Institut Henri Poincaré. The lectures will present recent advances in Relativity, Riemannian and Poisson geometry, and quantization. A poster session for young researchers (doctoral students and post-docs) will be organized. Deadline for submissions: September 1, 2015.
Preliminary List of Speakers: Robert Bryant (Duke University), Pierre Cartier (I.H.E.S.), Thibault Damour (I.H.E.S.), Simon Donaldson (SUNY at Stony Brook & Imperial College), Michel Dubois-Violette (Université Paris-Sud), Jim Eisenberg (University of Oregon), Edward Frenkel (UC Berkeley), Simone Gutt (ULB), Sergiu Klainerman (Princeton University), Maxim Kontsevich (I.H.E.S.), Alan Weinstein (UC Berkeley).
Scientific Committee: Jean-Pierre Bourguignon (Chair); Michel Cahen, Yvonne Choquet-Bruhat, Ludwig Faddeev, Philippe G. LeFloch, Charles-Michel Marle, Giuseppe Marmo, Andrzej Trautman, Joseph Wolf.
Organizing Committee: Giuseppe Dito, Jean-Pierre Françoise, Paul Gauduchon, Richard Kerner, Yvette Kosmann-Schwarzbach, Daniel Sternheimer.
Information: monge.u-bourgogne.fr/gdito/lichnerowicz2015

14–17 **Geometric Aspects on Capillary Problems and Related Topics**, Granada, Spain.
Description: The aim of this 4-day conference is to bring together active researchers on constant mean curvature/minimal surfaces and capillarity, or other condition on the boundary of the surface, and provide a panorama of the field through a variety of talks. The meeting will cover various topics of the theory of CMC/minimal surfaces and capillarity, free boundary problems or other condition on the boundary of the surface. This includes surfaces in different ambient spaces (Euclidean space, space forms, homogeneous spaces,...) or surfaces with other type of prescribed mean curvature (sessile/pendant drops, translating solitons, rotating drops,...)
Information:
www.ugr.es/~rcamino/meetingcmc/index.html.

14–18 **Geometric and Categorical Representation Theory**, Sunshine Coast, Australia.
Description: The conference will feature prominent international experts in geometric and categorical representation theory. The focus will be on areas currently enjoying a large amount of international attention, including interactions between representation theory, algebraic geometry, symplectic geometry, and number theory. The conference aims to bring some of the best mathematicians in these areas to Australia in order to strengthen the ties between the Australian and international geometric representation theory communities. There is financial support available, especially for grad students and postdoctoral fellows.
Information:
sites.google.com/site/masoudkomi/mooloolaba.

14–18 **Semiclassical Analysis and Non-self-adjoint Operators**, CIRM, Marseille Luminy, France.
Description: The aim of the ANR project NOSEVOL, of which this will be the concluding conference, is to study refined spectral, microlocal or semi-classical estimates for mainly non-selfadjoint operators and their applications to dynamical and evolution problems. This involves in particular resolvent type estimates, spectral and pseudospectral estimates, numerical simulations, Weyllaw type estimates and resonances results. By evolution problems we mean scattering, diffusion, dissipation, damping, propagation or return to the equilibrium phenomena, arising in kinetic theory, relativity, superconductivity, oceanography and mathematical physics. The conference will give an idea of the state of the art and the progress in the study of non-selfadjoint operators at the end of the NOSEVOL project. This will also be an occasion to listen to major actors in connected communities (kinetic theory, dynamical systems, global analysis, statistical physics and mechanics).
Information: scientific-events.weebly.com/1230.html.

15–17 **15th IMA International Conference on Cryptography and Coding**, St. Catherine's College, University of Oxford, Oxford, UK.
Description: The mathematical theory and practice of cryptography and coding underpins the provision of effective security and reliability for data communication, processing and storage. Theoretical and practical advances in the fields of cryptography and coding are therefore a key factor in facilitating the growth of data communications and data networks of various types. Thus, this fifteenth International Conference in an established and successful IMA series on the theme of "Cryptography and Coding" is both timely and relevant. Original research papers on all technical aspects of cryptography and coding are solicited for submission. The proceedings will be published in Springer's Lecture Notes in Computer Science series, and will be available at the conference.
Important Dates: Submission Deadline: June 26, 2015; Author Notification: August 28, 2015; Proceedings Version Deadline: September 14, 2015; Conference: 15–December 17, 2015.
Information: www.cs.ucl.ac.uk/staff/j.groth/IMACC.html

16–18 **Stochastic Limit Analysis for Reacting Particle Systems**, Weierstrass Institute for Applied Analysis and Stochastics, Berlin, Germany.
Description: The workshop aims to present and facilitate discussion of approaches to systems of many particles, which at some level of modelling undergo spatial motion and stochastically interact when they collide or at least get very close. Classic applications of such systems include gas dynamics, particle coagulation and chemical reactions, but zoological and other application areas will also be considered. Alongside strong law of large numbers type results the workshop will showcase methods for obtaining further information to complement a characteristic limiting equation.
Information:
www.wias-berlin.de/workshops/ReactingParticles/.

16–20 **The 20th Asian Technology Conference in Mathematics (ATCM 2015)**, Leshan, China.
Description: The ATCM 2015 is an international conference to be held in Leshan China. To reach Leshan, you will land at Chengdu International Airport (CTU). Chengdu is known as a city of pandas. The ATCM 2015 will continue addressing technology-based issues in all Mathematical Sciences. Thanks to advanced technological tools such as computer algebra systems (CAS), interactive and dynamic geometry, and hand-held devices, the effectiveness of our teaching and learning, and the horizon of our research in mathematics and its applications continue to grow rapidly. The aim of this conference is to provide a forum for educators, researchers, teachers and experts in exchanging information regarding enhancing technology to enrich mathematics learning, teaching and research at all levels. English is the official language of the conference. ATCM averagely attracts 350 participants representing over 30 countries around the world. Be sure to submit your abstracts or full papers in time.
Information: atcm.mathandtech.org.

17–19 **International Workshop on Calculus of Variations and its Applications on the Occasion of Luisa Mascarenhas' 65th Birthday**, Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Caparica, Portugal.
Description: The aim of the workshop is both to bring together experts on Calculus of Variations and its applications, promoting the exchange of ideas and attracting young scientists to the field, and also to honor Professor Lu{í}sa Mascarenhas, recently retired, for her contribution to Science. The workshop will take place at Faculdade de Ciências e Tecnologia, Campus de Caparica. There will be several talks by eminent researchers covering a wide range of methods to treat problems in Engineering, Mechanics and Life Sciences. Several of the invited speakers have directly collaborated with Professor Luísa Mascarenhas. Besides the lectures delivered by the invited speakers, we also plan to have a restricted number of contributed talks and a poster session.
Information: eventos.fct.unl.pt/cvamascar/

17–19 **National Conference on Emerging Trends in Mathematics and Mathematical Sciences (NCETMMS-2015)**, Calcutta Mathematical Society, Asutosh Bhavan, AE-374, Sector-I, Salt Lake City, Kolkata-700064, West Bengal, India.
Description: The Calcutta Mathematical Society (CMS) was founded in 1908 under the image of the London Mathematical Society. It is one of the oldest learned societies of its kind in Asia and had a long-standing association with many illustrious mathematicians and scientists. The main objective of NCETMMS-2015 is to bring together young and senior researchers and scientists in the fields of various branches of Mathematics and sciences which are considerably dependent on Mathematics. This will provide a platform where scientists can exchange their views and share their experiences regarding the latest developments in their respective fields of specialization. The thrust areas are given below:
i) Analysis
ii) Algebra
iii) Geometry and Relativity
iv) Dynamical Topology
v) Computational Fluid Dynamics
vi) Astrophysics and Space Science
vii) Ecology and Environment
viii) Information Theory
ix) Plasma and Magneto Hydrodynamics.
Deadline of receiving abstract August 31, 2015.
Information: www.calmathsoc.org

19–20 **4th International Conference on Mathematical and Computational Sciences**, Asian Institute of Technology Conference Center P.O. Box 4, Klong Luang, Pathumthani 12120, Thailand.
Description: The 4th International Conference on Mathematical and Computational Sciences(ICMCS-2015) is a premier forum for the presentation of new advances and research results in all areas of Mathematical and Computational Sciences. ICMCS-2015 will bring together leading researchers, engineers and scientists in the domain of interest from around the world. Leading researchers around the world shall deliver Key Note Addresses and Chair sessions.
Topics of interest: For submission include, but are not limited to: Algebra, algebraic topology, advanced calculus, advanced numerical methods, artificial neural networks, calculus and trigonometry, complex analysis, computational fluid dynamics, control theory, differential topology, differential geometry, dynamical systems, chaos and fractals, fluid dynamics and applications, fractional differential equations, functional analysis, fuzzy logic, general topology, genetic algorithms, linear algebra, linear programming models, mathematical modelling, markov chains and applications, etc.
Information: ijmsa.yolasite.com/icmsa-2015.php.

21–23 **7th WMVC-2015 (A National Conference on Wave Mechanics and Vibrations)**, Indian School of Mines, Dhanbad, India.
Description: 7th WMVC-2015 is one of the conference series on wave mechanics and vibrations. This national conference will be held during December 21, 2015 to December 23, 2015 at Indian Institute of Technology), Dhanbad, India. This conference covers the topics like: Computational and Mathematical methods in Science and Technology, Solid mechanics, Fluid dynamics, Theoretical astrophysics and Celestial mechanics, Numerical methods, Differential equations and Mathematical modeling. Several renowned experts from top organizations/institutes will be keynote speakers in this conference. This conference provides a unified stage to the academicians/researchers of both science and technology.

21–23 **9th International Conference of IMBIC on "Mathematical Sciences for Advancement of Science and Technology (MSAST 2015)"**, IMBIC, Salt Lake City, Kolkata, India.
Description: The main objective of the conference is to bring specialized topics in mathematics, statistics, computer science, information technology, bioinformatics and closely related interdisciplinary areas to the forefront. Original full papers are invited. All papers are to be screened and accepted papers will be published in the *Proceedings of IMBIC*, Volume 4 (2015), having ISBN 978-81-925832-3-5, except for a few full scientific papers of high quality, which may be published in the highly acclaimed series of monographs of IMBIC. Many scientists from India, USA, Japan, Canada, Sweden, France, Germany, Finland, Australia, Russia, Egypt, Mexico, Algeria, Botswana, Korea, South Africa and many other countries participated in the earlier conferences.
Contact: All correspondences in respect to the conference are to be addressed to Dr. Avishek Adhikari, Convenor MSAST 2015 & Secretary, IMBIC; email: msast.paper@gmail.com; website: www.isical.ac.in/~avishek_r/.
Information: www.imbic.org/forthcoming.html

27–29 **Modern Mathematical Methods And High Performance Computing in Science & Technology (M3HPCST-2015)**, Department of Mathematics Raj Kumar Goel Institute of Technology NH-58 Delhi-Meerut Road, Ghaziabad UP 201003, INDIA.
Description: The goal of this conference is to explore multi-disciplinary research. It focuses on algorithms development and implementation of Modern Mathematical Methods and High Performance Computing by Scientists, Researchers and Engineers. Current research in computational science requires multi-disciplinary knowledge, not only in sciences and engineering but also in technologies of computing. This conference offers academic researchers, developers and practitioners an opportunity to discuss various aspects of computational science and engineering related problems solving techniques for science and engineering research. The focus area will include but not limited to: Computational Methods for Linear and Non Linear Optimization, Mathematical Models, Mathematical Modeling and Computational Techniques, Functional Analysis, Operation Theory,Approximation Theory, Algebraic Coding Theory, Number Theory, Image and Signal Processing, Computational Biology, High Performance Computing, Advance Numerical Methods.
Important Dates:
Receipt of Abstract July 15, 2015
Intimation of Acceptance of Abstract July 25, 2015
Submission of full length paper (Max. 8 Pages) - August 30, 2015
Notification of review comments - November 10, 2015
Final submission in camera ready format - November 30, 2015
Date of the Conference - December 27–29, 2015.
Information: www.rkgit.edu.in/m3hpcst-2015.php

28–30 **Riemann Legacy Conference**, Sanya, Hainan, China.
Description: There are only a few mathematicians in history whose works and questions are still intensively studied after 150 years by many people in the original form and are continuing to provide inspiration to generations to come. Bernhard Riemann is one such mathematician. His work has been analyzed, amplified and generalized in many ways in many fields, but a good part of his mathematical output has withstood the test of time and the search for new perspectives remarkably well. This is not to imply that new perspectives have not been found but simply that in many instances, Riemann's own approach has not been superseded definitely. To help the mathematics community understand better the work of Riemann and its impact, Professor S. T. Yau and several of us are launching one book project with the title: *The Legacy of Bernhard Riemann After One Hundred and Fifty Years*. It will consist of systematic contributions by leading experts around the world on subjects or topics influenced by Riemann.
Information: msc.tsinghua.edu.cn/sanya/2015/LBR2015/synopsis organizers.aspx.

28–31 **Ninth International Triennial Calcutta Symposium on Probability and Statistics**, Department of Statistics, University of Calcutta, 35 Ballygunge Circular Road, Kolkata 700019, West Bengal, India.
Description: Organised by the Department of Statistics, University of Calcutta and Calcutta Statistical Association, the ninth edition of the Symposium will feature special sessions; invited and contributory sessions on Theoretical and Applied Statistics and Probability; and poster sessions for students and young researchers. Best posters will be awarded. Sponsored posters from industries will also be entertained. As in previous editions, special lectures on Design of Experiments in memory of late Professor R. C. Bose and on Multivariate Analysis in memory of late Professor S. N. Roy will be held during the symposium.
Keynote Speaker: Professor Sheldon M. Ross, University of California at Berkeley.
S. K. Chakravarti Memorial Speaker: Professor Sabina Alkire, Oxford University.
Deadlines: Abstracts: June 30, 2015; Early registration: October 31, 2015
Information:
calcuttastatisticalassociation.org/triennial/sympBrochure.php

31–January 4 **String Mathematics 2015**, Sanya, Hainan, China.
Description: String theory plays a central role in theoretical physics as a candidate for the quantum theory unifying gravity with other interactions. It has profound connections with broad branches of modern mathematics ever since the birth. In the last decades, the prosperous interaction, built upon the joint efforts from both mathematicians and physicists, has given rise to marvelous deep results in supersymmetric gauge theory, topological string, M-theory, and duality on the physics side as well as in algebraic geometry, differential geometry, algebraic topology, representation theory, and number theory on the mathematics side. The inter play is two-fold. The mathematics has provided powerful tools to fulfill the physical interconnection of ideas and clarify physical structures to understand the nature of string theory. On the other hand, ideas from string theory and quantum field theory have been a source of significant inspirations to reveal surprising mathematical structures and create new spectrums of mathematics. The aim of the String-Math annual conference is to bring together researchers working at the rapidly developing interface of these two academic fields to exchange current significant ideas and explore future directions.
Information:
msc.tsinghua.edu.cn/sanya/StringMath2015/home.aspx.

January 2016

3–16 **New Challenges in Reverse Mathematics**, Institute for Mathematical Sciences, National University of Singapore, Singapore.
Description: The central theme of Reverse Mathematics is calibrating the strength of classical mathematical theorems in terms of the axioms needed to prove them; this calibration also takes into account recursion-theoretic complexity measures and consistency strength.
Topics: Collaborative Research and Workshop: January 3–16, 2016. There will be talks in the mornings and free discussions in the afternoons.
Information:
www2.ims.nus.edu.sg/Programs/016reverse/index.php

* 4 **2016 AMSI Summer School**, RMIT University, Melbourne, VIC, Australia.
Description: The AMSI Summer School is an exciting opportunity for mathematical sciences students to come together over the summer break to develop their skills and networks. Learn from Australias leading mathematicians and statisticians. Gain credit towards your degree. Meet future employers at the Careers Afternoon Build your networks at dinners, BBQs, and special events. Broaden and deepen your knowledge base with advanced coursework. Choose from a wide range of courses to suit your speciality. Discover the latest subject in your discipline.
Information: ss16.amsi.org.au/

5–9 **Conference on General Relativity**, Sanya, Hainan, China.
Description: Einstein's general relativistic field equations govern the universe, in particular phenomena in cosmology, astrophysics, and notably gravitational waves. The study of these equations has led to thriving new mathematical research in the areas of geometric analysis, nonlinear partial differential equations (PDE) of hyperbolic and elliptic character, differential geometry as well as in scattering theory and the analysis of asymptotic behavior of solutions. Purely analytic and numerical methods complement each other on this road. Modern mathematical breakthroughs allows to attack and solve physical problems that have been a challenge for the last century. Among these are the study and detection of gravitational waves. Mathematically gravitational waves are investigated by means of

geometric analysis as well as numerics. Through geometric analysis Christodoulou's findings of a nonlinear memory effect of gravitational waves, displacing test masses permanently has sparked new research leading to insights into this very effect for other fields coupled with Einstein equations. Moreover, Christodoulou's results on black hole formation have likewise launched abundant activities in hyperbolic PDE. This conference discusses recent developments in these areas.
Information: msc.tsinghua.edu.cn/sanya/2016/CGR2016/synopsis andorganizers.aspx.

9–13 **Moduli Spaces, Integrable Systems, and Topological Recursions**, Centre de recherches mathématiques, Université de Montréal, Pavillon André-Aisenstadt, Montréal, Canada.
Description: The computation and enumeration of invariants of moduli spaces took a sudden turn with the conjecture of Witten that they could be combined into a formal series that solved the KdV hierarchy. This conjecture, subsequently proven by Kontsevich, was motivated by considerations of quantum gravity.
Information:
www.crm.umontreal.ca/2016/Moduli16/index_e.php.

10–12 **ACM-SIAM Symposium on Discrete Algorithms (SODA16), being held with Analytic Algorithmics and Combinatorics (ANALCO16) and Algorithm Engineering and Experiments (ALENEX16)**, Crystal Gateway Marriott, Arlington, Virginia.
Description: Information on SODA, ALENEX and ANALCO will be available on the website in June 2015.
Information: www.siam.org/meetings/da16/.

11–15 **AIM Workshop: High and Low Forcing**, American Institute of Mathematics, San Jose, California.
Description: This workshop, sponsored by AIM and the NSF, is devoted to new methods of forcing, in infinitary combinatorics, and in connection with axioms about the real line.
Information:
aimath.org/workshops/upcoming/highlowforcing.

11–May 20 **Differential Geometry (DG)**, Mathematical Sciences Research Institute, Berkeley, CA.
Description: Differential geometry is a subject with both deep roots and recent advances. Many old problems in the field have recently been solved, such as the Poincaré and geometrization conjectures by Perelman, the quarter pinching conjecture by Brendle-Schoen, the Lawson Conjecture by Brendle, and the Willmore Conjecture by Marques-Neves. The solutions of these problems have introduced a wealth of new techniques into the field. This semester-long program will focus on the following main themes: (1) Einstein metrics and generalizations, (2) Complex differential geometry, (3) Spaces with curvature bounded from below, (4) Geometric flows, and particularly on the deep connections between these areas.
Information: www.msri.org/programs/286

14–15 **Connections for Women: Differential Geometry**, Mathematical Sciences Research Institute, Berkeley, California. (Jun/Jul 2014, p. 669)
Description: The purpose of this meeting is to help junior female researchers to become familiar with the focus topics of the main MSRI program, and also for the junior researchers to have an opportunity to get acquainted with more senior women researchers in differential geometry.
Information: www.msri.org/workshops/702.

18–22 **Introductory Workshop: Modern Riemannian Geometry**, Mathematical Sciences Research Institute, Berkeley, California. (Jun/Jul 2014, p. 669)
Description: The week will be devoted to an introduction to modern techniques in Riemannian geometry. This is intended to help graduate students and younger researchers get a headstart, in order to increase their participation during the main semester programs and research lectures. To increase outreach, the week will focus on Riemannian geometry and should be largely accessible. Some minicourses on topics of recent interest will be included. The workshop will also have semi-expository lectures dealing with aspects of spaces with curvature bounded from below, since such spaces will occur throughout the semester. We expect that many Berkeley mathematicians and students will participate in the introductory workshop.
Information: www.msri.org/workshops/703.

18–February 28 **Semidefinite and Matrix Methods for Optimization and Communication**, Institute for Mathematical Sciences, National University of Singapore, Singapore.
Description: The program will cover topics in combinatorial optimization, approximation algorithms, and communication complexity and links connecting these areas. A common approach to hard combinatorial optimizations is to look at relaxations of these problems as linear or semidefinite programs. On the algorithmic side, one hopes to show that these relaxations can provide good approximations to the optimal value. On the hardness side, one hopes to show that (ever more complicated) relaxations are still far from the true value.
Workshops: Workshop 1 on Log Rank Conjecture: January 18–22, 2016; Workshop 2 on Positive Semidefinite Rank: February 1–5, 2016; Workshop 3 on Approximation Algorithms: February 15–19, 2016.
Information:
www2.ims.nus.edu.sg/Programs/016semi/index.php

25–29 **Partial Order: Mathematics, Simulations and Applications**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: Partially ordered materials, between the conventional solid and liquid phases of matter, are ubiquitous in nature. Examples include liquid crystals and complex fluids, glassy matter, the cell cytoskeleton, and vibrated granular media. The theory of partial order not only presents cutting-edge mathematical challenges but can also be transformative for materials science and nano-technology. This workshop has three central themes: the mathematics, modeling, and simulation of (i) liquid crystals and complex fluids, (ii) bio-materials, and (iii) nano-materials and will feature invited talks in equilibrium and non-equilibrium phenomena for these materials, their singularities, numerical methods, and new experiments. As such, the workshop promises to be a unique platform for consolidating new and exciting ideas from different research communities in the field and formulate new plans for long-lasting collaboration.
Deadline: The application deadline for funding is November 30, 2015.
Information:
www.ipam.ucla.edu/programs/workshops/partial-order-mathematics-simulatio ns-and-applications/

26–28 **2nd International Conference on Mathematical Sciences and Statistics (ICMSS2016)**, Kuala Lumpur, Malaysia.
Description: The Department of Mathematics, Faculty of Science, Universiti Putra Malaysia(UPM) is proud to organise the 2nd International Conference on Mathematical Sciences and Statistics (ICMSS2016). This international conference aims to bring together academicians, researchers and scientists for knowledge sharing in Mathematics and Statistics areas. The ICMSS2016 serves as a good platform for the scientific community members to meet with each other and to exchange ideas. All accepted papers will be compiled and published in the American Institute of Physics proceedings (indexed by ISI Thomson). Selected papers will be published in a special issue of Malaysian Journal of Mathematical Sciences (indexed by SCOPUS), Springer Verlag (indexed by ISI Thomson) or Discovering Mathematics (Menemui Matematik) indexed by Zentralblatt MATH.
Information: math.upm.edu.my/icmss2016/.

February 2016

1–6 **ICERM Semester Program on "Dimension and Dynamics"**, Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, Rhode Island.
Description: During the semester we will focus on three specific aspects of the interaction between these two areas: (i) Ergodic, algebraic and combinatorial methods in dimension theory (ii) Computations in fractal geometry in dynamical systems; and (iii) Fractal geometry and hyperbolic dynamics.
Information: icerm.brown.edu/programs/sp-s16/.

2–6 **36th Linz Seminar on Fuzzy Set Theory "Functional Equations and Inequalities"**, St. Magdalena, Linz, Austria.
Description: Since their inception in 1979 the Linz Seminars on Fuzzy Set Theory have emphasized the development of mathematical aspects of fuzzy sets by bringing together researchers in fuzzy sets and established mathematicians whose work outside the fuzzy setting can provide direction for further research. The philosophy of the seminar has always been to keep it deliberately small and intimate so that informal critical discussions remain central. LINZ 2016 will be the 36th seminar carrying on this tradition and is devoted to the theme "Functional Equations and Inequalities." The goal of the seminar is to present and to discuss recent advances on (algebraic) functional equations and inequalities and their applications in pure and applied mathematics, with special emphasis on many-valued logics, multicriteria decision aid and preference modelling. LINZ 2016 is organized by the Department of Knowledge-Based Mathematical Systems of the Johannes Kepler University Linz, Austria.
Information: www.flll.jku.at/linzseminars

15–19 **Ergodic, Algebraic and Combinatorial Methods in Dimension Theory**, Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, Rhode Island.
Description: There are natural interactions between dimension theory, ergodic theory, additive combinatorics, metric number theory and analysis. Each of these fields provides different perspectives on, and complementary approaches to, the hierarchical structures which appear in fractal geometry. The workshop will focus on recent advances at the interfaces of these fields, including: Classical fractals (self-similar and self-affine sets, random fractals). Dimension theory and additive combinatorics. Diophantine approximation and equidistribution. Schmidt games. Rigidity phenomena. Scenery flow methods. Projection and slice theorems.
Information: icerm.brown.edu/programs/sp-s16/w1/.

15–June 17 **Melt in the Mantle**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Apr. 2014, p. 433)
Description: The Earth's mantle is almost entirely solid, but on geological timescales it convects vigorously, the well-known surface expression of this being plate tectonics. Although the basic thermodynamics of melt generation in these settings is well understood, how the melt is transported to the surface is not, despite several decades of work on the problem. Sophisticated mathematical techniques are needed to map an understanding of physics at the smallest scales to plate-tectonic scales. Seismology offers a way to image melt in the mantle, but development of new tools in inverse theory is required to extract that information. Models are cast as a series of coupled non-linear PDEs, which require advanced numerical techniques to solve. This programme will bring together a broad spectrum of mathematicians and solid Earth scientists to tackle these and other challenges in the area. Several workshops will take place during the programme. For full details please see www.newton.ac.uk/events.html.
Information: www.newton.ac.uk/programmes/MIM/.

22–26 **Algebraic Geometry for Coding Theory and Cryptography**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
Description: Coding theory and cryptography are important in everyday life, because they form some of the building blocks of e-commerce. Error-correction via coding theory protects information as it is stored or sent, and efficient error-correction may provide significant benefits and cost-savings for enterprise. Cryptographic systems are necessary to secure information in storage, transmission, and interaction, and provide both confidentiality and authenticity guarantees. While there has always been significant and fruitful interaction between algebraic geometry and both coding theory and cryptography, new directions in coding theory—such as locally decodable codes, codes for distributed storage systems, and network coding—suggest the possibility of new connections with algebraic geometry. Participants will spend one week working together in small groups on one of six projects related to the theme of the workshop.
Information:
Apply at www.mathprograms.org/db/programs/369
URL: www.ipam.ucla.edu/agc2016

* 24–26 **7th International Conference on Post-Quantum Cryptography (PQCrypto 2016)**, Kyushu University Nishijin Plaza, Fukuoka, Japan.
Description: The aim of PQCrypto is to serve as a forum for researchers to present results and exchange ideas on the topic of cryptography in an era with large-scale quantum computers. The conference will be preceded by a winter school on February 22–23, 2016. Original research papers on all technical aspects of cryptographic research related to post-quantum cryptography are solicited.
Submission Deadlines: The initial submission deadline is October 7, 2015. Papers submitted by this deadline may be in draft form but must include a title and an abstract. The final submission deadline is October 14. Authors who submitted a paper by the October 7 deadline will be permitted to revise their papers anytime before the final submission deadline.
Important Dates:
Initial submission deadline: October 7, 2015
Final submission deadline: October 14, 2015
Notification deadline: November 20, 2015
Final version: December 2, 2015
Information: pqcrypto2016.jp

29–March 4 **AIM Workshop: Hereditary Discrepancy and Factorization Norms**, American Institute of Mathematics, San Jose, California.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to the application of methods from functional analysis and asymptotic convex geometry to combinatorial discrepancy theory.
Information:
aimath.org/workshops/upcoming/hereddiscrep.

March 2016

* 1–4 **12th German Probability and Statistics Days 2016 - Bochumer Stochastik-Tage**, Ruhr University Bochum, Bochum, Germany.
Description: Continuing the series of Conferences in Marburg 1993, Freiberg 1996, München 1998, Hamburg 2000, Magdeburg 2002, Karlsruhe 2004, Frankfurt 2006, Aachen 2008, Leipzig 2010, Mainz 2012 and Ulm 2014 the DMV-Fachgruppe Stochastik organizes jointly with the Ruhr-Universität Bochum the 12th German Probability and Statistics Days 2016—Bochumer Stochastik-Tage. In the tradition of the previous conferences, this meeting provides an international forum for presentation and discussion of new results in the area of probability and statistics. Contributed talks will be given in 12 sections devoted to specific topics; the highlight of each section will be one invited main talk. Over the last years, the `Stochastik-Tage' organized biannually have been attracting also an increasing number of participants from abroad. The conference language is English. Participants from academia, business, administration and industry are welcome.
Information: www.gpsd-2016.de/

6–31 **New Developments in Representation Theory**, Institute for Mathematical Sciences, National University of Singapore, Singapore.

Description: Collaborative Research: March 6–31, 2016; Tutorial on Hecke Algebras: March 7–11, 2016, by Dan Ciubotaru, University of Oxford; Tutorial on Automorphic Descent: March 7–11, 2016, by Lei Zhang, National University of Singapore; Workshop on New Developments in Representation Theory: March 14–25, 2016.
Information:
www2.ims.nus.edu.sg/Programs/016theory/index.php

7–June 10 **Culture Analytics**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, California.
Description: The explosion in the widespread use of the Internet and social media and the ubiquity of low-cost computing have increased the possibilities for understanding cultural behaviors and expressions, while at the same time have facilitated opportunities for making cultural artifacts both accessible and comprehensible. The rapidly proliferating digital footprints that people leave as they crisscross cyberspace offer a treasure trove of cultural information, where culture is considered to be expressive of the norms, beliefs, and values of a group. This program encourages the exploration of the unsolved mathematical opportunities that are emerging in this cultural information space. The application deadline is Monday, December 7, 2015.
Information:
www.ipam.ucla.edu/programs/long-programs/culture-analytics/.

12–13 **6th Ohio River Analysis Meeting (ORAM 6)**, University of Kentucky, Lexington, KY.
Description: ORAM is an annual event jointly sponsored by mathematicians at the University of Cincinnati and the University of Kentucky highlighting research in analysis and partial differential equations. ORAM 6 is hosted by the University of Kentucky. The confirmed invited speakers are Scott Armstrong (Université Paris-Dauphine), Hans Lindblad (Johns Hopkins University), Camil Muscalu (Cornell University), Malabika Pramanik (University of British Columbia), and Monica Visan (UCLA). There will be 20–25 contributed talks, with priority given to young mathematicians and those from underrepresented groups. Travel support is available through a grant from the National Science Foundation. Please see the website for registration and details.
Information: math.as.uky.edu/oram6

21–25 **Kähler Geometry, Einstein Metrics, and Generalizations**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2014, p. 797)
Description: The workshop will integrate elements from complex differential geometry with Einstein metrics and their generalizations. The topics will include 1. Existence of Kähler-Einstein metrics and extremal Kähler metrics. Notions of stability in algebraic geometry such as Chow stability, K-stability, b-stability, and polytope stability. Kähler-Einstein metrics with conical singularities along a divisor. 2. Calabi-Yau metrics and collapsed limit spaces. Connections with physics and mirror symmetry. 3. Einstein metrics and their moduli spaces, ϵ-regularity, noncompact examples such as ALE, ALF, and Poincaré-Einstein metrics. Generalizations of the Einstein condition, such as Bach-flat metrics and Ricci solitons. 4. Sasaki-Einstein metrics and metrics with special holonomy. New examples and classification problems.
Information: www.msri.org/workshops/704.

* 22–23 **IMA Conference on Theoretical and Computational Discrete Mathematics**, The Enterprise Centre, University of Derby, Derby,UK.
Description: Discrete mathematics is a branch of the mathematical sciences which poses a wide range of challenging research problems and gives rise to important applications in other fields such as computer science, engineering, industry, business, finance and the physical/biological sciences. It is a dynamic subject in which techniques, theories and algorithms are drawn from many different areas, and it offers a diverse and stimulating environment for those whose work lies within it. The purpose of this conference is to highlight theoretical and computational advances in the general field of discrete mathematics. It is open to researchers working with mathematical structures and abstract constructs, and to those involved in the theory and practice of discrete algorithmic computing.
Information:
www.ima.org.uk/conferences/conferences_calendar/discrete_mathematics_2015.html.

28–April 1 **AIM Workshop: Sheaves and modular representations of reductive groups**, American Institute of Mathematics, San Jose, California.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to recent developments in the representation theory of algebraic groups in positive characteristic.
Information:
aimath.org/workshops/upcoming/sheavemodular.

* 28–April 1 **Hot Topics: Cluster Algebras and Wall-Crossing**, Mathematical Sciences Research Institute, Berkeley, California.
Description: Cluster algebras were introduced in 2001 by Fomin and Zelevinsky to capture the combinatorics of canonical bases and total positivity in semisimple Lie groups. Since then they have revealed a rich combinatorial and group-theoretic structure, and have had significant impact beyond these initial subjects, including string theory, algebraic geometry, and mirror symmetry. Recently Gross, Hacking, Keel and Kontsevich released a preprint introducing mirror symmetry techniques into the subject which resolved several long-standing conjectures, including the construction of canonical bases for cluster algebras and positivity of the Laurent phenomenon. This preprint reformulates the basic construction of cluster algebras in terms of scattering diagrams (or wall-crossing structures). This leads to the proofs of the conjectures and to new constructions of elements of cluster algebras. But fundamentally they provide a new tool for thinking about cluster algebras. The workshop will bring together many of the different users of cluster algebras to achieve a synthesis of these new techniques with many of the different aspects of the subject. There will be lecture series on the new techniques, and other lecture series on connections with Lie theory, quiver representation theory, mirror symmetry, string theory, and stability conditions.
Information: www.msri.org/workshops/783

April 2016

4–8 **Semester Workshop: Computation in Dynamics**, Institute for Computational and Experimental Research in Mathematics (ICERM), Providence, Rhode Island.
Description: This workshop will bring together experts in Dynamical Systems and experts in the theory of Computability to exchange ideas and results, and promote collaborations in view of significant developments in the field over the next few years. The workshop will include four main streams of research: Approximation of Dynamical Quantities Regular and Stochastic Properties Renormalization Computability in Dynamics.
Information: icerm.brown.edu/programs/sp-s16/w3/.

5–8 **SIAM Conference on Uncertainty Quantification (UQ16)**, SwissTech Convention Center, EPFL Campus, Lausanne, Switzerland.
Description: Uncertainty quantification is key for achieving validated predictive computations in a wide range of scientific and engineering applications. The field relies on a broad range of mathematics and statistics groundwork, with associated algorithmic and computational development. This conference will bring together mathematicians, statisticians, scientists, and engineers with an interest in development and implementation of uncertainty quantification methods. While applications of UQ in many fields will be represented at the conference, the focal application for UQ14 is earth science. The

goal of the meeting is to provide a forum for the sharing of ideas, and to enhance communication among this diverse group of technical experts, thereby contributing to future advances in the field.
Information: www.siam.org/meetings/uq16.

11–15 **Workshop II: Culture Analytics and User Experience Design**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
Description: Culture analytics concerns itself with the highly interwoven and complex interactions among individuals, society, and technology that are catalyzed by the enormous growth in data that characterizes the current age. User experience design requires more than a thin interface veneer on top of an algorithmic layer. The shape of the user experience must be rooted in the computational structure from the beginning and co-designed along with the statistical and machine learning algorithms for data exploration and analysis. In order to best design the next generation of technologies to enhance communication, collaboration, and cultural understanding, and to prepare for unintended consequences, we need to incorporate a robust understanding of human and social capabilities with deep technical and mathematical skills. To accomplish this, researchers, developers, and designers must demonstrate a willingness to transcend disciplinary concerns. The funding application deadline is February 15, 2016.
Information: www.ipam.ucla.edu/caws2

May 2016

2–6 **AIM Workshop: Algebraic Vision**, American Institute of Mathematics, San Jose, CA.
Description: This workshop, sponsored by AIM and the NSF, will focus on multi-view geometry, the sub-discipline of computer vision that studies 3D scene reconstructions from images, and has deep foundations in projective geometry and linear algebra.
Information: aimath.org/workshops/upcoming/algvision

2–6 **Geometric Flows in Riemannian and Complex Geometry**, Mathematical Sciences Research Institute, Berkeley, California. (Aug. 2014, p. 797)
Description: The workshop will concentrate on parabolic methods in both Riemannian and complex geometry. The topics will include
1. Ricci flow. Analytic questions about Ricci flow in three dimensions. Possible applications of Ricci flow to 4-manifold topology. Ricci flow in higher dimensions under curvature assumptions.
2. Kähler-Ricci Flow. Applications to the Kähler-Einstein problem. Connections to the minimal model program. Study of Kähler-Ricci solitons and limits of Kähler-Ricci flow.
3. Mean curvature flow. Singularity analysis. Generic mean curvature flow.
4. Other geometric flows such as Calabi flow and pluriclosed flow.
Information: www.msri.org/workshops/705.

9–13 **Cultural Patterns: Multi-scale Data-driven Models**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
Description: The proliferation of cultural data has given data-driven approaches a significant edge in modeling various cultural phenomena. This workshop focuses on such approaches that make use of mathematical tools in machine learning, data mining, network science, and computational social science. We are particularly interested in presenting methods, both normative and descriptive, that offer a gestalt or structure-first approach to culture analysis and that provide a multi-layered summarization of these phenomena suitable for exploration at multiple scales. These models are applied to various datasets such as social and information networks, social media, narrative and story detection in texts, group dynamics or behavior, and collaboration and competition leading to emergent behavior. The application deadline for funding is March 14, 2016.
Information: www.ipam.ucla.edu/programs/workshops/workshop-iii-cultural-patterns-multi-scale-data-driven-models/.

16–20 **AIM Workshop: The Galois Theory of Orbits in Arithmetic Dynamics**, American Institute of Mathematics, San Jose, CA.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to the study of Galois properties of points in orbits of algebraic maps.
Information:
aimath.org/workshops/upcoming/galarithdyn

22–25 **Fifteenth International Conference in Approximation Theory**, Menger Hotel, San Antonio, Texas.
Description: These triennial meetings have traditionally been the main general international conferences in Approximation Theory, and are designed to bring together students and researchers from all subareas of the subject.
Confirmed Invited Speakers: Josef Dick (New South Wales), Simon Foucart (Georgia), Elisabeth Larsson (Upssala), Doron Lubinsky (Georgia Tech), Carla Manni (Rome), Mike Neamtu (Vanderbilt), and Ulrich Reif (Darmstadt). A plenary lecture will also be given by the recipient of the eighth Vasil A. Popov Prize in Approximation Theory, see imi.cas.sc.edu/popov-prize-description. To organize a minisymposium on a topic of your choice, please submit a proposal via the website by April 1, 2016. Titles and abstracts for contributed talks or posters are due by April 30, 2016. Students, postdocs, and members of under-represented groups from the US and overseas are especially welcome, and are encouraged to apply for travel support. The deadline is April 1, 2016.
Information: www.math.vanderbilt.edu/~AT15

23–28 **The Eighth International Conference "Inverse Problems: Modeling and Simulation"**, In the distinguished hotels of the Mediterranean Region, in Liberty Hotels, Lykia, Ölüdeniz, Fethiye, Turkey.
Description: The objective of this meeting is to be multidisciplinary and international, bringing together scientists working on various topics of inverse problems in diverse areas of mathematical, engineering, physical and computer sciences.
Information: www.ipms-conference.org/

June 2016

6–10 **AIM Workshop: Markov Chain Mixing Times**, American Institute of Mathematics, San Jose, California.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to new connections between the topic of Markov chain mixing times and other subareas of modern probability theory.
Information:
aimath.org/workshops/upcoming/markovmixing

13–17 **AIM Workshop: Equivariant Derived Algebraic Geometry**, American Institute of Mathematics, San Jose, CA.
Description: This workshop, sponsored by AIM and the NSF, will explore computations and examples that will help guide the development of the fledgling field of "equivariant derived algebraic geometry".
Information:
aimath.org/workshops/upcoming/equideralggeom

13–24 **Algebraic, Enumerative, and Geometric Combinatorics—ECCO 2016**, Universidad de Antioquia, Medellin, Colombia.
Description: Combinatorics is at the center of many areas in pure and applied mathematics. This summer school will focus on the versatility of combinatorics to shed light on problems in algebra, geometry, optimization, and mathematical physics. We will also discuss how algebraic and geometric perspectives can help us understand purely combinatorial objects. The main goal of the school is to bring young mathematicians from Colombia and other Latin American countries into close contact with each other and with world experts in various fields of combinatorics. This is part of a long term goal to build a strong regional community of mathematicians in combinatorics and related fields.

Information:
www.cimpa-icpam.org/ecoles-de-recherche/ecoles-de-recherche-2016/liste-chronologique-des-ecoles-de/article/algebraic-enumerative-and-757?lang=fr.

* 13–24 **Michigan Summer School on Random Matrices**, Ann Arbor, Michigan, USA.
Description: This summer school on random matrices is motivated by the observation that there are several (often) non-overlapping techniques used in random matrix theory. Our goal is to provide an opportunity for graduate students (and postdocs) to learn these different techniques and acquire the background necessary to understand how/when/where they can/have/should be applied for understanding the properties of random matrices. We expect students to have some basic working knowledge on random matrix theory (e.g., they know what a GOE ensemble is and what the semi-circle law describes.) We hope that the summer school provides a venue where, for example, a student already familiar with the orthogonal polynomial method for RMT can learn about how Stieltjes transform techniques are used, and so on. We have asked the lecturers to make each course self-contained and cover the necessary basic materials at the level of a first and second year graduate school student.
Information: web.eecs.umich.edu/~rajnrao/rmtschool/

* 15–18 **Second International Congress on Actuarial Science and Quantitative Finance**, Universidad de Cartagena, Cartagena, Colombia.
Description: The Second International Congress on Actuarial Science and Quantitative builds on the success of the first ICASQF, and consolidates the Congress as the premier event in Actuarial Science and Quantitative Finance in Colombia, the Andean Region (Peru, Colombia, Venezuela, Ecuador, and Bolivia) and the Caribbean Region. The Congress will cover a variety of topics in Actuarial Science and Quantitative Finance.
Topics: Statistics techniques in Finance and Actuarial Science, Portfolio Management, Derivative Valuation, Risk Theory and Life and Pension Insurance Mathematics, Non-Life Insurance Mathematics, and Economics of Insurance among others.
Invited Speakers: Jan Dhaene (KU Leuven, Belgium), Bruno Dupire (Bloomberg LP. New York, US), Nicole El Karoui (École Polytechnique, Palaiseau, France), Christian Hipp (Karlsruher Institute of Technology, Karlsruhe, Germany), Jean Jacod (Université Paris VI, Paris, France.), Ioannis Karatzas (University of Columbia, NY, US), Glenn Meyers (ISO Innovative Analytics, New York USA), Kees Oosterlee (Dutch national research center for mathematics and computer science, Amsterdam Netherlands), Michael Sherris (UNSW, Sydney Australia), Fernando Zapatero (USC, Los Angeles, CA, US).
Information: icasqf.org

27–July 1 **AIM Workshop: Representation Stability**, American Institute of Mathematics, San Jose, CA.
Description: This workshop, sponsored by AIM and the NSF, will be devoted to recent developments in representation stability. Among these developments are results on algebraic and combinatorial aspects of functor categories and stable representation categories, and the use of "large" algebraic structures on limit objects to obtain finiteness results.
Information: aimath.org/workshops/upcoming/repnstability

* 27–July 1 **ICOSAHOM 2016—International Conference on Spectral and High-Order Methods**, Rio de Janeiro, Brazil.
Description: The purpose of this conference series is to bring together researchers and practitioners with an interest in the theoretical, computational, and applied aspects of high-order and spectral methods for the solution of differential equations.
Information: www.icosahom2016.org

27–July 1 **Optimal and Random Point Configurations: From Statistical Physics to Approximation Theory**, Institut Henri Poincaré, Paris, France.
Description: This conference aims at bringing together the communities of probabilists, statistical physicists, approximation theorists, and analysts, who work with different points of view on issues of optimal and random point configurations such as Fekete sets, Coulomb gases, point processes arising in random matrices, and crystallization questions. Particular attention will be given to the lectures being accessible to young researchers and a poster session will be organized.
Information: djalil.chafai.net/wiki/ihp2016:start

July 2016

1–5 **The 11th AIMS Conference on Dynamical Systems, Differential Equations and Applications**, Hyatt Regency, Orlando, Florida.
Description: Featuring the celebration of Peter Lax's 90th birthday. Dedicated is a special journal (DCDS) issue, edited by Alexandre Chorin and Andrew Majda. Proposals of special sessions are welcome.
Plenary Speakers: Suncica Canic (USA), Alessio Figalli (USA), Irene Fonseca (USA), Martin Hairer(UK), Anatole Katok (USA), Manuel de Leon (Spain), Wei-Ming Ni (USA), Stan Osher (USA), Hal Smith (USA), Gang Tian (China).
Scientific Committee: Shouchuan Hu (Chair: general@aimsciences.org), John Ball, Jerry Bona, William Bray, Alberto Bressan, Gunduz Caginalp, Danielle Hilhorst, Peter Lax, Alain Miranville, Roger Temam, Enrico Valdinoci, Marcelo Viana.
Organizing Committee: Xin Lu (chair: lux@uncw.edu), Yaw Chang, Wei Feng, Michael Freeze, Beth Casper (Administrative Assistant).
Information: aimsciences.org.

3–8 **Conference on Rings and Polynomials**, Graz University of Technology, Graz, Austria.
Description: Continuing the series of ring-theory conferences in Graz 2012 and 2014. Rings, algebras and polynomials, with emphasis on: - Integer-valued polynomials; Polynomial functions; Multiplicative ideal theory Factorization theory in rings and semigroups; Module theory and linear algebra over rings; Homological algebra; Pruefer domains and related topics; Zariski-Riemann spaces of valuation domains.
Invited Speakers: Silvana Bazzoni (Univ. of Padova, Italy), Paul-Jean Cahen, (Univ. Aix-Marseille III, France), Mátyás Domokos (Hungarian Acad. Sci.), Mi Hee Park [unconfirmed] (Chung-Ang Univ., Korea), Hans Schoutens (CUNY, USA), Nicholas Werner (SUNY, USA)
Information: integer-valued.org/conf2016/

* 4–8 **The 28th International Conference on Formal Power Series and Algebraic Combinatorics (FPSAC)**, Vancouver, British Columbia, Canada.
Description: The scientific scope of this meeting includes all aspects of combinatorics and their relations with other parts of mathematics, physics, computer science, and biology. The conference will include invited lectures, contributed presentations, poster sessions, and software demonstrations. There will be no parallel sessions. The official languages of the conference are English and French. Invited Speakers Federico Ardila (San Francisco State University) Jason Bell (University of Waterloo) Ben Brubaker (University of Minnesota) Guillaume Chapuy (CNRS/ Universit{é} Paris-Diderot) Jennifer Morse (Drexel University) Margaret Readdy (University of Kentucky) Masato Okado (Osaka City University) Jozsef Solymosi (University of British Columbia) Mike Steel (University of Canterbury).
Information: sites.google.com/site/fpsac2016/

4–31 **Mathematics of Shapes and Applications**, Institute for Mathematical Sciences, National University of Singapore, Singapore.
Description: Tutorial on Applications: Shapes in Multiples Disciplines: July 4–8, 2016; Summer School on Mathematics of Shapes:

July 11–22, 2016; Workshop on State-of-the-Art Shape Research and its Applications: July 25–29, 2016.
Information:
www2.ims.nus.edu.sg/Programs/016shape/index.php.

11–December 21 **Theoretical Foundations for Statistical Network Analysis**, Isaac Newton Institute for Mathematical Sciences, Cambridge, United Kingdom. (Apr. 2014, p. 433)
Description: The core of this 6-month programme is understanding and quantifying mathematical structure in network models. Networks are ubiquitous in modern science and society. In fact, whenever we observe entities and relationships between them, we have network data. The behaviour of almost all networks, natural or engineered, physical or information-based, involves a strong component of randomness and is typically not fully or directly observed. Considerable open challenges remain in proving properties both of generative mechanisms for such networks, as well as of methods for inference. This motivates the development of theoretical foundations for statistical network analysis. Several workshops will take place during the programme, including an opening, midterm and closing workshop, as well as a Satellite Meeting and an Open for Business industry day. For full details please see www.newton.ac.uk/events.html.
Information: www.newton.ac.uk/programmes/SNA/.

25–29 **XXI Coloquio Latinoamericano de Álgebra**, Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, Ciudad Universitaria, Buenos Aires, Argentina.
Description: The series "Coloquios Latinoamericanos de Algebra" started in 1981. Following tradition, there will be plenary talks in the morning and thematic sessions in the afternoon.
Format: Wednesday afternoon will be free. Sessions: 1. Commutative Algebra and Algebraic Geometry. 2. Hopf Algebras. 3. Operator Algebras. 4. Rings and Algebras. 5. Algebraic Combinatorics. 6. Lie Groups and Representations. 7. Logic and Universal Algebra. 8. Homological Methods. 9. Representations of Algebras. 10. Group Theory.
Information: cms.dm.uba.ar/Members/gcorti/workgroup.2014-12-15.2886996475/index_html.

25–29 **Twelfth Symposium on General Topology and its Relations to Modern Analysis and Algebra - TOPOSYM 2016**, Prague, Czech Republic.
Description: The TOPOSYM is a conference series held in Prague, running in a five-year cycle since 1961, serving as a traditional meeting point for general topological audience. TOPOSYM 2016 will be organized by the Institute of Mathematics of the Czech Academy of Sciences and the Faculty of Mathematics and Physics of the Charles University in Prague. The following mathematicians have agreed to present an invited talk: Alexander Arhangel'skii, Leandro Aurichi, Dikran Dikranjan, Alan Dow, Michael Hrušák, Ondrej Kalenda, Alexander Kechris*, Piotr Koszmider, Mikolaj Krupski, Wieslaw Kubis, Aleksandra Kwiatkowska, Jordi Lopez-Abad, Veronica Martinez de la Vega, Julien Melleray, Jan van Mill, Arnold Miller, Justin Moore, Chris Mouron, Lionel Nguyen Van Thé, Lex Oversteegen, Christian Rosendal, Marcin Sabok, Slawomir Solecki, Lajos Soukup, Mikhail Tkachenko, Stevo Todorcevic**, Toshimichi Usuba, Benjamin Weiss.*
* provisionally confirmed. ** to be confirmed.
Information: www.toposym.cz

August 2016

1–5 **XVI International Conference on Hyperbolic Problems: Theory, Numerics, Applications**, RWTH Aachen University, Aachen, Germany.
Description: The objective of the conference is to bring together scientists with interests in the theoretical, applied, and computational aspects of hyperbolic partial differential equations and of related mathematical models appearing in the area of applied sciences.
Information: www.hyp2016.de.

8–11 **SIAM Conference on Nonlinear Waves and Coherent Structures (NW16)**, Sheraton Philadelphia Society Hill Hotel, Philadelphia, Pennsylvania.
Description: Information on NW16 will be available at www.siam.org/meetings/nw16/ in October of 2015.
Information: www.siam.org/meetings/nw16.

* 10–19 **Workshop and International Conference on Representations of Algebras (ICRA 2016)**, Syracuse University, Syracuse, NY.
Description: The 17th bi-annual Workshop and International Conference on Representations of Algebras (ICRA 2016) will be hosted by Syracuse University. There are two parts to the ICRA. The workshop will run August 10–13, 2016 (Wednesday–Saturday), and will feature expository lecture series by leading researchers: Claire Amiot (Institut Fourier), Michel Brion (Institut Fourier), Markus Linckelmann (City University London), Robert Marsh (Leeds), Julia Pevtsova (Washington), and Ryo Takahashi (Nagoya). The exact workshop schedule will be posted closer to the event. The conference proper will run August 15–19, 2016 (Monday–Friday) and will include both plenary lectures and parallel sessions. The plenary speakers will include Srikanth Iyengar (Utah), Bernard Leclerc (Caen), Steven Sam (Wisconsin), Catharina Stroppel (Bonn), Hugh Thomas (New Brunswick), and Antoine Touzé (Paris 13). Additional plenary and parallel talks will be selected based on the submitted abstracts by the participants.
Information: icra2016.syr.edu/

15–December 16 **Geometric Group Theory (GGT2)**, Mathematical Sciences Research Institute, Berkeley, CA.
Description: The field of geometric of geometric group theory emerged from Gromov's insight that even mathematical objects such as groups, which are defined completely in algebraic terms, can be profitably viewed as geometric objects and studied with geometric techniques Contemporary geometric group theory has broadened its scope considerably, but retains this basic philosophy of reformulating in geometric terms problems from diverse areas of mathematics and then solving them with a variety of tools. The growing list of areas where this general approach has been successful includes low-dimensional topology, the theory of manifolds, algebraic topology, complex dynamics, combinatorial group theory, algebra, logic, the study of various classical families of groups, Riemannian geometry and representation theory. The goals of this MSRI program are to bring together people from the various branches of the field in order to consolidate recent progress, chart new directions, and train the next generation of geometric group theorists.
Information: www.msri.org/programs/278

17–19 **Connections for Women: Geometric Group Theory**, Mathematical Sciences Research Institute, Berkeley, California.
Description: This three-day workshop will feature talks by six prominent female mathematicians on a wide range of topics in geometric group theory. Each speaker will give two lectures, separated by a break-out session during which participants will meet in small groups to discuss ideas presented in the first lecture. The workshop is open to all mathematicians.
Information: www.msri.org/workshops/768.

The following new announcements will not be repeated until the criteria in the next to the last paragraph at the bottom of the first page of this section are met.

September 2016

* 14–16 **15th IMA Conference on Mathematics of Surfaces**, University of Bath, Bath, UK.
Description: Computer-based methods for the capture, construction, representation, fitting, interrogation and manipulation of complicated surfaces have led to a wide interest in, and need for, the mathematics of surfaces and related topics including curves, motions and computational geometry. Many applications require the

use of surface descriptions, especially in such fields as computer aided design and manufacturing, isogeometric analysis, computer graphics, computer vision and computer animation. The description of surfaces is also of interest in geographic information systems, multimedia, and many other areas of science and medicine.
Information: www.ima.org.uk/conferences/conferences_calendar/15th_maths_of_surfaces.html.

19–30 **Workshop on Mathematics of Information–Theoretic Cryptography**, Institute for Mathematical Sciences, National University of Singapore, Singapore.
Description: Our workshop is the third in a series of workshops on Mathematics of Information-Theoretic Cryptography. Activities: Tutorials: September 19–23, 2016 Workshop: September 26–30, 2016.
Information: www2.ims.nus.edu.sg/Programs/016wcrypto/index.php

26–30 **Machine Learning Meets Many-Particle Problems**, Institute for Pure and Applied Mathematics (IPAM), UCLA, Los Angeles, CA.
Description: This workshop will set the stage and define research directions for the rest of the program. The idea is to achieve a healthy mix between mathematicians, computer scientists, physicists, and chemists and establish common grounds that will enable rational applications of machine learning techniques to many-particle problems. One prominent outcome of this workshop will be the establishment of a common repository of datasets corresponding to different many-particle problems (structures and energies of molecules and materials, protein structures and dynamics, spectroscopic signatures of complex systems, etc.). These datasets can be used to assess the performance of different ML techniques during the IPAM program and beyond. The application deadline for funding is August 1, 2016.
Information: www.ipam.ucla.edu/mpsws1

November 2016

7–11 **Homological Mirror Symmetry: Methods and Structures**, Institute for Advanced Study, Princeton, New Jersey.
Description: This workshop is part of the 2016/17 IAS program on Homological Mirror Symmetry.
Information: www.math.ias.edu/sp/mirrorsymmetry.

December 2016

13–22 **Recent Advances in Operator Theory and Operator Algebras 2016 (OTOA 2016)**, Indian Statistical Institute, Bangalore, India.
Description: Recent advances in Operator Theory and Operator Algebras–2016 (OTOA-2016) to be held at Indian Statistical Institute, Bangalore, during December 13–22, 2016. This conference is a continuation of the earlier conferences and workshops on Operator theory and Operator algebras held in Indian Statistical Institute, Bangalore. OTOA-2016 aims bringing experts and researches from around the world, including postdocs and advanced doctoral students,to share their recent findings related to the various fields of Functional Analysis, Operator Theory, Operator Algebras and related fields. The meeting will start with a workshop during December 13–17, 2016 followed by a conference during December 19–22, 2016.
Programme: (i) Workshop part—December 13 till December 17, 2016. (ii) Conference part—December 19 till December 22 noon, 2016. The Conference encourages and promotes excellence of young mathematicians.
Information: www.isibangac.in/~jay/OTOA/OTOA16/otoa16.html.

July 2017

30–August 4 **Current Trends in Dynamical Systems and the Mathematical Legacy of Rufus Bowen**, University of British Columbia, Vancouver, BC, Canada.
Description: The conference will focus on areas of current interest that are broadly related to the work of Rufus Bowen.
Information: www.math.ubc.ca/~marcus/RBowenConference/

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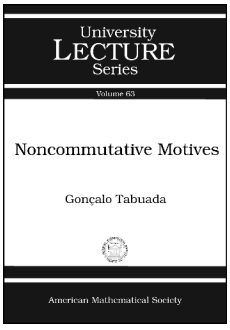
Algebra and Algebraic Geometry



Noncommutative Motives

Gonçalo Tabuada, *Massachusetts Institute of Technology, Cambridge, MA*

The theory of motives began in the early 1960s when Grothendieck envisioned the existence of a "universal cohomology theory of algebraic varieties". The theory of noncommutative motives is more recent. It began in the 1980s when the Moscow school (Beilinson, Bondal, Kapranov, Manin, and others) began the study of algebraic varieties via their derived categories of coherent sheaves, and continued in the 2000s when Kontsevich conjectured the existence of a "universal invariant of noncommutative algebraic varieties".

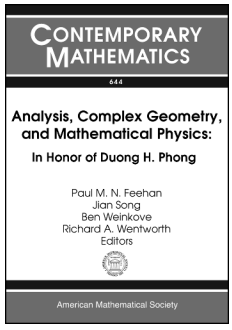
This book, prefaced by Yuri I. Manin, gives a rigorous overview of some of the main advances in the theory of noncommutative motives. It is divided into three main parts. The first part, which is of independent interest, is devoted to the study of DG categories from a homotopical viewpoint. The second part, written with an emphasis on examples and applications, covers the theory of noncommutative pure motives, noncommutative standard conjectures, noncommutative motivic Galois groups, and also the relations between these notions and their commutative counterparts. The last part is devoted to the theory of noncommutative mixed motives. The rigorous formalization of this latter theory requires the language of Grothendieck derivators, which, for the reader's convenience, is revised in a brief appendix.

Contents: Introduction; Differential graded categories; Additive invariants; Background on pure motives; Noncommutative pure motives; Noncommutative (standard) conjugates; Noncommutative motivic Galois groups; Jacobians of noncommutative Chow motives; Localizing invariants; Noncommutative mixed motives; Noncommutative motivic Hopf dg algebras; Appendix; Bibliography; Index.

University Lecture Series, Volume 63

October 2015, 114 pages, Softcover, ISBN: 978-1-4704-2397-1, LC 2015018204, 2010 *Mathematics Subject Classification:* 14A22, 14C15, 18D20; 18E30, 18G55, 19D55, **AMS members US$35.20**, List US$44, Order code ULECT/63

Analysis



Analysis, Complex Geometry, and Mathematical Physics

In Honor of Duong H. Phong

Paul M. N. Feehan and **Jian Song**, *Rutgers University, Piscataway, NJ*, **Ben Weinkove**, *Northwestern University, Evanston, IL*, and **Richard A. Wentworth**, *University of Maryland, College Park, MD*, Editors

This volume contains the proceedings of the Conference on Analysis, Complex Geometry and Mathematical Physics: In Honor of Duong H. Phong, which was held from May 7–11, 2013, at Columbia University, New York. The conference featured thirty speakers who spoke on a range of topics reflecting the breadth and depth of the research interests of Duong H. Phong on the occasion of his sixtieth birthday. A common thread, familiar from Phong's own work, was the focus on the interplay between the deep tools of analysis and the rich structures of geometry and physics.

Papers included in this volume cover topics such as the complex Monge-Ampère equation, pluripotential theory, geometric partial differential equations, theories of integral operators, integrable systems and perturbative superstring theory.

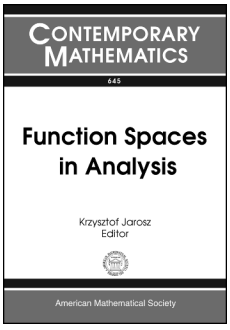
This item will also be of interest to those working in mathematical physics.

Contents: Z. Błocki, Bergman kernel and pluripotential theory; **T. C. Collins** and **A. Jacob**, On the convergence of the Sasaki-Ricci flow; **Q. Dai**, **X.-J. Wang**, and **B. Zhou**, The signed mean curvature measure; **E. D'Hoker**, Topics in two-loop superstring perturbation theory; **P. Guan** and **X. S. Shen**, A rigidity theorem for hypersurfaces in higher dimensional space forms; **P. Eyssidieux**, **V. Guedj**, and **A. Zeriahi**, Continuous approximation of quasiplurisubharmonic functions; **C. Hongler**, **K. Kytölä**, and **A. Zahabi**, Discrete holomorphicity and Ising model operator formalism; **A. Jacob**, Stable Higgs bundles and Hermitian-Einstein metrics on non-Kähler manifolds; **S. Kołodziej** and **N. N. Cuong**, Weak solutions to the complex Monge-Ampère equation on Hermitian manifolds; **C.-J. Liu** and **Z. Lu**, Uniform

asymptotic expansion on Riemann surfaces; **X. Ma**, **G. Marinescu**, and **S. Zelditch**, Scaling asymptotics of heat kernels of line bundles; **L. Ni**, Parabolic frequency monotonicity and a theorem of Hardy-Pólya-Szegö; **M.-C. Shaw**, Topology of Dolbeault cohomology groups; **B. Shiffman**, Uniformly bounded orthonormal sections of positive line bundles on complex manifolds; **M. Taylor**, Poisson equations, uniformization, and geometrical optics; **V.'Tosatti**, Non-Kähler Calabi-Yau manifolds; **Rakesh** and **G. Uhlmann**, The point source inverse back-scattering problem; **Y. Wang**, Local regularity of the complex Monge-Ampère equation; **E. Witten**, Notes on holomorphic string and superstring theory measures of low genus.

Contemporary Mathematics, Volume 644

August 2015, 359 pages, Softcover, ISBN: 978-1-4704-1464-1, LC 2014050310, 2010 *Mathematics Subject Classification:* 31C10, 32J25, 53C07, 35R01, 53C44, 53C55, 53C80, **AMS members US$84**, List US$105, Order code CONM/644



Function Spaces in Analysis

Krzysztof Jarosz, *Southern Illinois University at Edwardsville, IL*, Editor

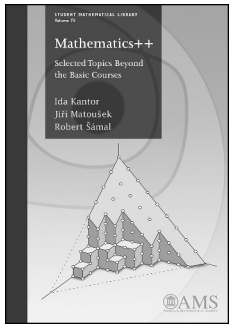
This volume contains the proceedings of the Seventh Conference on Function Spaces, which was held from May 20–24, 2014 at Southern Illinois University at Edwardsville.

The papers cover a broad range of topics, including spaces and algebras of analytic functions of one and of many variables (and operators on such spaces), spaces of integrable functions, spaces of Banach-valued functions, isometries of function spaces, geometry of Banach spaces, and other related subjects.

Contents: **M. Abel**, On algebraic properties of the spectrum and spectral radius of elements in a unital algebra; **M. Abel**, Automatic continuity of surjective homomorphisms between topological algebras; **J. T. Anderson**, Characterization of holomorphic and meromorphic functions via maximum principles; **F. Botelho** and **J. Jamison**, Hermitian operators on $\mathbf{H}^p_{\mathcal{H}}(\triangle^n)$; **J. A. Chávez-Domínguez** and **T. Oikhberg**, Some notions of transitivity for operator spaces; **J. Craig**, **J. F. Feinstein**, and **P. Patrick**, Removability of exceptional sets for differentiable and Lipschitz functions; **D. E. Edmunds** and **J. Lang**, Generalizing trigonometric functions from different points of view; **G. O. S. Ekhaguere**, Partial W^*-dynamical systems and their dilations; **J. F. Feinstein**, **S. Morley**, and **H. Yang**, Swiss cheeses and their applications; **O. Hatori**, Isometries on the special unitary group; **T. Hõim** and **D. A. Robbins**, Amenability as a hereditary property in some algebras of vector-valued functions; **P. Jain**, **M. Singh**, and **A. P. Singh**, Weighted norm inequalities for Hardy type operators on monotone functions; **K. Jarosz**, Norms on normal function algebras; **A. Yu. Karlovich**, Maximally modulated singular integral operators and their applications to pseudodifferential operators on Banach function spaces; **S. G. Krantz**, Smoothness to the boundary of biholomorphic mappings: An overview; **K. Lee**, A multiplicative Banach-Stone theorem; **D. M. Luan** and **L. H. Khoi**, Weighted composition operators on weighted sequence spaces; **M. Mathieu** and **M. Young**, Spectral isometries into commutative Banach algebras; **O. Méndez**, Eigenvalues and eigenfunctions of the $p(\cdot)$-Laplacian. A convergence analysis; **T. Miura**, Surjective isometries between function spaces; **D. C. Moore**, Endomorphisms and the Šilov representation; **R. Rahm** and **B. D. Wick**, The essential norm of operators on the Bergman space of vector-valued functions on the unit ball; **S. K. Srivastava** and **U. Singh**, Trigonometric approximation of periodic functions belonging to weighted Lipschitz class $W(L^p, \Psi(t), \beta)$; **J. Wermer**, Analytic structure of polynomial hulls.

Contemporary Mathematics, Volume 645

August 2015, 301 pages, Softcover, ISBN: 978-1-4704-1694-2, LC 2015000884, 2010 *Mathematics Subject Classification:* 46B04, 46E10, 46E15, 46E25, 46E30, 46H05, 46J10, 46J15, **AMS members US$84**, List US$105, Order code CONM/645



Mathematics++

Selected Topics Beyond the Basic Courses

Ida Kantor, *Charles University, Prague, Czech Republic*, **Jiří Matoušek**, *Charles University, Prague, Czech Republic, and ETH, Zurich, Switzerland*, and **Robert Šámal**, *Charles University, Prague, Czech Republic*

Mathematics++ is a concise introduction to six selected areas of 20th century mathematics providing numerous modern mathematical tools used in contemporary research in computer science, engineering, and other fields. The areas are: measure theory, high-dimensional geometry, Fourier analysis, representations of groups, multivariate polynomials, and topology. For each of the areas, the authors introduce basic notions, examples, and results. The presentation is clear and accessible, stressing intuitive understanding, and it includes carefully selected exercises as an integral part. Theory is complemented by applications—some quite surprising—in theoretical computer science and discrete mathematics. The chapters are independent of one another and can be studied in any order.

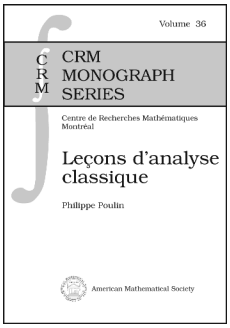
It is assumed that the reader has gone through the basic mathematics courses. Although the book was conceived while the authors were teaching Ph.D. students in theoretical computer science and discrete mathematics, it will be useful for a much wider audience, such as mathematicians specializing in other areas, mathematics students deciding what specialization to pursue, or experts in engineering or other fields.

This item will also be of interest to those working in algebra and algebraic geometry, number theory, and geometry and topology.

Contents: Measaure and integral; High-dimensional geometry and measure concentration; Fourier analysis; Representations of finite groups; Polynomials; Topology; Index.

Student Mathematical Library, Volume 75

September 2015, 353 pages, Softcover, ISBN: 978-1-4704-2261-5, LC 2015016136, 2010 *Mathematics Subject Classification:* 14-01, 20Cxx, 28-01, 43-01, 52Axx, 54-01, 55-01, **AMS members US$39.20**, **All Individuals US$39.20**, List US$49, Order code STML/75



Leçons d'analyse classique

Exposition d'un cours fait par Paul Koosis à l'Université McGill, Montréal

Philippe Poulin, *United Arab Emirates University, Al Ain, Abu Dhabi, United Arab Emirates*

Ce livre est basé sur un cours de deuxième cycle donné en 2005–2006 par M. Paul Koosis, professeur émérite à l'université McGill. Il traite de sujets soigneusement choisis par le professeur à l'intention de ceux qui, plutôt que de rechercher un catalogue exhaustif de résultats techniques et abstraits, veulent être initiés aux découvertes les plus essentielles et prolifiques de l'analyse classique du vingtième siècle. Analyse harmonique, quasi-analyticité, zéros des fonctions entières (dont une preuve inédite du théorème de Levinson–Cartwright), approximation pondérée, principe d'incertitude, mesures harmoniques…, les résultats saillants et géniaux de l'analyse classique sont présentés dans un style soigné, rigoureux et détaillé, préparant les étudiants à des études plus poussées ; et au service du lecteur qui, connaissant les bases de la théorie de la mesure et de l'analyse complexe, désire suivre le merveilleux développement de M. Koosis et accroître sa connaissance du sujet.

Je reconnais les choix et le style de Paul Koosis, et j'aime beaucoup les deux. Le titre est volontairement modeste et hors-mode; ce qui fait l'originalité du livre est que, sous l'apparence du "classique", il échappe complètement aux modes actuelles. Il ne me parait pas avoir d'équivalent, en aucune langue. C'est un beau cadeau au français…

—***Jean-Pierre Kahane, Université Paris-Sud Orsay, France***

This book is based on a graduate course given in 2005–2006 by Paul Koosis, Emeritus Professor at McGill University. It addresses topics carefully selected by Prof. Koosis and is intended for those who, far from seeking an exhaustive catalog of technical and abstract results, prefer to be initiated in the most essential and prolific discoveries of the 20th century in classical analysis. Harmonic analysis, quasi-analyticity, zeroes of classes of entire functions (including a new proof of the Levinson–Cartwright theorem), weighted approximation, gap theorems, harmonic measures, and other gems of classical analysis are presented in a rigorous, detailed, and elegant style. This work prepares students for more advanced studies and serves readers who, aware of the basics in measure theory and complex analysis, wish to follow Prof. Koosis in his marvelous development of the subject.

I recognize the choice and style of Paul Koosis, and I greatly appreciate both. The title is intentionally modest and out of fashion; the originality of the book is that, under the guise of the "classic", it completely avoids the current fashions. It does not appear to me to have its equivalent in any language. It is a beautiful gift to the French language…

—***Jean-Pierre Kahane, Université Paris-Sud Orsay, France***

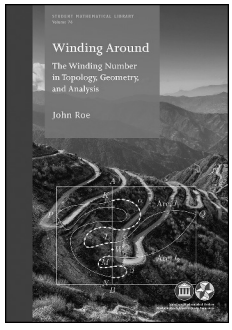
Titles in this series are co-published with the Centre de Recherches Mathématiques.

Contents: *Première partie Automne 2005:* Fonctions harmoniques et sous-harmoniques; Quasi-analyticité: le critère de Carleman–Ostrowski; Fonctions entières de type exponentiel: leurs zéros; *Seconde partie Hiver 2006:* Mesures rapidement décroissantes à l'infini, lacunarité de leurs transformées de Fourier; Mesures harmoniques; Problème de Dirichlet; Introduction aux longueurs extrémales; Annexe A. Compléments; Annexe B. Devoirs; Bibliographie; Index.

CRM Monograph Series, Volume 36

September 2015, approximately 173 pages, Hardcover, ISBN: 978-1-4704-1993-6, 2010 *Mathematics Subject Classification:* 30-02; 30D20, **AMS members US$87.20**, List US$109, Order code CRMM/36

Geometry and Topology



Winding Around

The Winding Number in Topology, Geometry, and Analysis

John Roe, *Pennsylvania State University, State College, PA*

The *winding number* is one of the most basic invariants in topology. It measures the number of times a moving point P goes around a fixed point Q, provided that P travels on a path that never goes through Q and that the final position of P is the same as its starting position. This simple idea has far-reaching applications. The reader of this book will learn how the winding number can

- help us show that every polynomial equation has a root (the fundamental theorem of algebra),
- guarantee a fair division of three objects in space by a single planar cut (the ham sandwich theorem),
- explain why every simple closed curve has an inside and an outside (the Jordan curve theorem),
- relate calculus to curvature and the singularities of vector fields (the Hopf index theorem),
- allow one to subtract infinity from infinity and get a finite answer (Toeplitz operators),
- generalize to give a fundamental and beautiful insight into the topology of matrix groups (the Bott periodicity theorem).

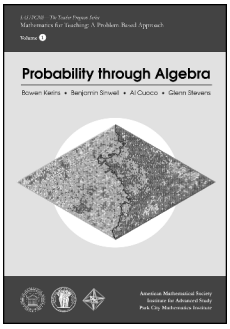
All these subjects and more are developed starting only from mathematics that is common in final-year undergraduate courses.

Contents: Prelude: Love, hate, and exponentials; Paths and homotopies; The winding number; Topology of the plane; Integrals and the winding number; Vector fields and the rotation number; The winding number in functional analysis; Coverings and the fundamental group; Coda: The Bott periodicity theorem; Linear algebra; Metric spaces; Extension and approximation theorems; Measure zero; Calculus on normed spaces; Hilbert space; Groups and graphs; Bibliography; Index.

Student Mathematical Library, Volume 76

September 2015, 269 pages, Softcover, ISBN: 978-1-4704-2198-4, LC 2015019246, 2010 *Mathematics Subject Classification:* 55M25; 57M05, 47A53, 58A10, 55N15, **AMS members US$39.20**, **All Individuals US$39.20**, List US$49, Order code STML/76

Math Education



Probability through Algebra

Bowen Kerins, *Education Development Center Inc., Waltham, MA*, **Benjamin Sinwell**, *Pendleton High School, Anderson, SC*, **Al Cuoco**, *Education Development Center Inc., Waltham, MA*, and **Glenn Stevens**, *Cambridge, MA*

Designed for precollege teachers by a collaborative of teachers, educators, and mathematicians, *Probability through Algebra* is based on a course offered in the Summer School Teacher Program at the Park City Mathematics Institute.

But this book isn't a "course" in the traditional sense. It consists of a carefully sequenced collection of problem sets designed to develop several interconnected mathematical themes, and one of the goals of the problem sets is for readers to uncover these themes for themselves.

The specific themes developed in *Probability through Algebra* introduce readers to the algebraic properties of expected value and variance through analysis of games, to the use of generating functions and formal algebra as combinatorial tools, and to some applications of these ideas to questions in probabilistic number theory.

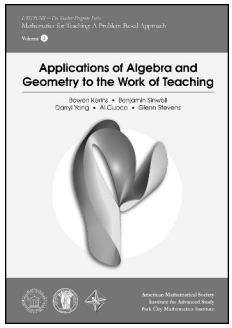
Probability through Algebra is a volume of the book series "IAS/PCMI–The Teacher Program Series" published by the American Mathematical Society. Each volume in that series covers the content of one *Summer School Teacher Program* year and is independent of the rest.

Titles in this series are co-published with the Institute for Advanced Study/Park City Mathematics Institute. Members of the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) receive a 20% discount from list price.

Contents: Problem sets; Facilitator notes; Teaching notes; Mathematical overview; Solutions.

IAS/PCMI–The Teacher Program Series, Volume 1

October 2015, approximately 175 pages, Softcover, ISBN: 978-1-4704-1925-7, 2010 *Mathematics Subject Classification:* 00-01; 00A07, **AMS members US$23.20**, List US$29, Order code SSTP/1



Applications of Algebra and Geometry to the Work of Teaching

Bowen Kerins, *Education Development Center Inc., Waltham, MA*, **Benjamin Sinwell**, *Pendleton High School, Anderson, SC*, **Darryl Yong**, *Harvey Mudd College, Claremont, CA*, **Al Cuoco**, *Education Development Center Inc., Waltham, MA*, and **Glenn Stevens**, *Cambridge, MA*

Designed for precollege teachers by a collaborative of teachers, educators, and mathematicians, *Applications of Algebra and Geometry to the Work of Teaching* is based on a course offered in the Summer School Teacher Program at the Park City Mathematics Institute.

But this book isn't a "course" in the traditional sense. It consists of a carefully sequenced collection of problem sets designed to develop several interconnected mathematical themes, and one of the goals of the problem sets is for readers to uncover these themes for themselves.

The specific theme developed in *Applications of Algebra and Geometry to the Work of Teaching* is the use of complex numbers—especially the arithmetic of Gaussian and Eisenstein integers—to investigate some questions that are at the intersection of algebra and geometry, like the classification of Pythagorean triples and the number of representations of an integer as the sum of two squares.

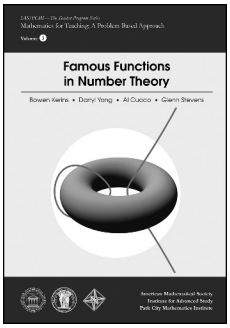
Applications of Algebra and Geometry to the Work of Teaching is a volume of the book series "IAS/PCMI–The Teacher Program Series" published by the American Mathematical Society. Each volume in that series covers the content of one *Summer School Teacher Program* year and is independent of the rest.

Titles in this series are co-published with the Institute for Advanced Study/Park City Mathematics Institute. Members of the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) receive a 20% discount from list price.

Contents: Problem sets; Facilitator notes; Teaching notes; Mathematical overview; Solutions.

IAS/PCMI–The Teacher Program Series, Volume 2

October 2015, approximately 205 pages, Softcover, ISBN: 978-1-4704-1924-0, 2010 *Mathematics Subject Classification:* 00-01; 00A07, **AMS members US$23.20**, List US$29, Order code SSTP/2



Famous Functions in Number Theory

Bowen Kerins, *Education Development Center Inc., Waltham, MA*, **Darryl Yong**, *Harvey Mudd College, Claremont, CA*, **Al Cuoco**, *Education Development Center Inc., Waltham, MA*, and **Glenn Stevens**, *Cambridge, MA*

Designed for precollege teachers by a collaborative of teachers, educators, and mathematicians, *Famous Functions in Number Theory* is based on a course offered in the Summer School Teacher Program at the Park City Mathematics Institute.

But this book isn't a "course" in the traditional sense. It consists of a carefully sequenced collection of problem sets designed to develop several interconnected mathematical themes, and one of the goals of the problem sets is for readers to uncover these themes for themselves.

Famous Functions in Number Theory introduces readers to the use of formal algebra in number theory. Through numerical experiments, participants learn how to use polynomial algebra as a bookkeeping mechanism that allows them to count divisors, build multiplicative functions, and compile multiplicative functions in a certain way that produces new ones. One capstone of the investigations is a beautiful result attributed to Fermat that determines the number of ways a positive integer can be written as a sum of two perfect squares.

Famous Functions in Number Theory is a volume of the book series "IAS/PCMI–The Teacher Program Series" published by the American Mathematical Society. Each volume in that series covers the content of one *Summer School Teacher Program* year and is independent of the rest.

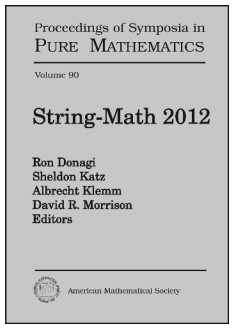
Titles in this series are co-published with the Institute for Advanced Study/Park City Mathematics Institute. Members of the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) receive a 20% discount from list price.

Contents: Problem sets; Facilitator notes; Teaching notes; Mathematical overview; Solutions.

IAS/PCMI–The Teacher Program Series, Volume 3

October 2015, approximately 216 pages, Softcover, ISBN: 978-1-4704-2195-3, 2010 *Mathematics Subject Classification:* 00-01; 00A07, **AMS members US$23.20**, List US$29, Order code SSTP/3

Mathematical Physics



String-Math 2012

Ron Donagi, *University of Pennsylvania, Philadelphia, PA*, **Sheldon Katz**, *University of Illinois, Urbana-Champaign, IL*, **Albrecht Klemm**, *Bethe Center for Theoretical Physics, Bonn, Germany*, and **David R. Morrison**, *University of California, Santa Barbara, CA*, Editors

This volume contains the proceedings of the conference String-Math 2012, which was held July 16–21, 2012, at the Hausdorff Center for Mathematics, Universität Bonn. This was the second in a series of annual large meetings devoted to the interface of mathematics and string theory. These meetings have rapidly become the flagship conferences in the field.

Topics include super Riemann surfaces and their super moduli, generalized moonshine and K3 surfaces, the latest developments in supersymmetric and topological field theory, localization techniques, applications to knot theory, and many more.

The contributors include many leaders in the field, such as Sergio Cecotti, Matthias Gaberdiel, Rahul Pandharipande, Albert Schwarz, Anne Taormina, Johannes Walcher, Katrin Wendland, and Edward Witten.

This book will be essential reading for researchers and students in this area and for all mathematicians and string theorists who want to update themselves on developments in the math-string interface.

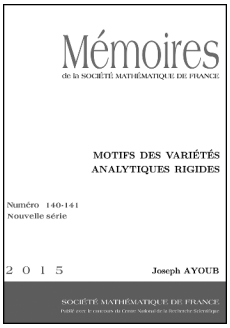
Contents: *Plenary talks:* **S. Cecotti**, The quiver approach to the BPS spectrum of a $4d\mathcal{N} = 2$ gauge theory; **R. Donagi** and **E. Witten**, Supermoduli space is not projected; **M. R. Gaberdiel**, **D. Persson**, and **R. Volpato**, Generalised moonshine and holomorphic orbifolds; **A. Marian**, **D. Oprea**, and **R. Pandharipande**, The first Chern class of the Verlinde bundles; **A. Schwarz**, **V. Vologodsky**, and **J. Walcher**, Framing the di-logarithm (over $\mathbb{Z}$); **A. Taormina** and **K. Wendland**, Symmetry-surfing the moduli space of Kummer K3s; **A. Torrielli**, Secret symmetries of AdS/CFT; *Contributed talks:* **I. Adam**, On the marginal deformations of general $(0, 2)$ non-linear sigma-models; **S. Alexandrov**, **J. Manschot**, **D. Persson**, and **B. Pioline**, Quantum hypermultiplet moduli spaces in $\mathcal{N} = 2$ string vacua: A review; **D. Andriot**, Non-geometric fluxes versus (non)-geometry; **C. I. Lazaroiu**, **E. M. Babalic**, and **I. A. Coman**, The geometric algebra of supersymmetric backgrounds; **N. Carqueville** and **D. Murfet**, A toolkit for defect computations in Landau-Ginzburg models; **W. Donovan**, Grassmannian twists, derived equivalences, and brane transport; **P. Fleig** and **A. Kleinschmidt**, Perturbative terms of Kac-Moody-Eisenstein series; **H. Fuji** and **P. Sułkowski**, Super-A-polynomial; **M. Huang**, On gauge theory and topological string in Nekrasov-Shatashvili limit; **A.-K. Kashani-Poor**, AGT and the topological string; **M. V. Movshev** and **A. Schwarz**, Generalized Chern-Simons action and maximally supersymmetric gauge theories.

Proceedings of Symposia in Pure Mathematics, Volume 90

October 2015, approximately 341 pages, Hardcover, ISBN: 978-0-8218-9495-8, LC 2015017523, 2010 *Mathematics Subject Classification:* 11G55, 14D21, 14F05, 14J28, 14M30, 32G15, 53D18, 57M27, 81T40, 83E30, **AMS members US$96**, List US$120, Order code PSPUM/90

New AMS-Distributed Publications

Algebra and Algebraic Geometry



Motifs des Variétés Analytiques Rigides

Joseph Ayoub, *Institut für Mathematik, Universität Zürich, Switzerland*

A note to readers: This book is in French.

In this work, the author extends the theory of motives, as developed by Voevodsky and Morel-Voevodsky, to the context of rigid analytic geometry over a complete nonarchimedean field.

The first chapter deals with the homotopical approach of Morel and Voevodsky. In this chapter the author discusses the construction of the motivic stable homotopy category of rigid analytic varieties and a complete description of this category in terms of algebraic motives when the base field has equal characteristic zero and its valuation is discrete.

The second chapter deals with Voevodsky's approach based on transfers. In this chapter the author discusses the construction of the triangulated category of rigid analytic motives, and an extension to rigid analytic geometry of a large number of Voevodsky's fundamental results such as his theory of homotopy invariants presheaves with transfers.

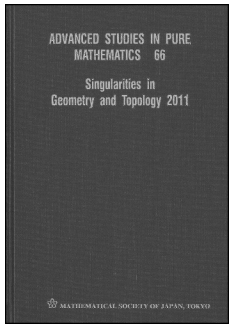
The present work is a lot more than just a mere copy of the classical theory and the reader will find a lot of results that are new and specific to rigid analytic geometry.

A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Go to www.ams.org/bookstore.

Mémoires de la Société Mathématique de France, Number 140/141

June 2015, 386 pages, Softcover, ISBN: 978-2-85629-811-4, 2010 *Mathematics Subject Classification:* 14C15, 14C25, 14F20, 14F35, 14F42, 14G22, **AMS members US$72**, List US$90, Order code SMFMEM/140/141



Singularities in Geometry and Topology 2011

Vincent Blanlœil, *Université de Strasbourg I, France*, and **Osamu Saeki**, *Kyushu University, Fukuoka, Japan*, Editors

This book contains original and survey papers on Singularities in Geometry and Topology, which resulted from the Sixth Franco-Japanese Symposium on Singularities, held in Fukuoka, from September 5–10, 2011.

Though singularity theory originated in the 19th century, this field of research became more popular in France after Heisuke Hironaka came to Paris. Then, many collaborations between Japanese and French mathematicians started, and the conferences on Singularities in Geometry and Topology continue to develop this collaboration between France and Japan.

This volume consists of two survey articles and 12 research articles whose topics include algebraic curves and varieties, line arrangements, mixed polynomials, algebraic local cohomology classes, stable maps, and mirror symmetry.

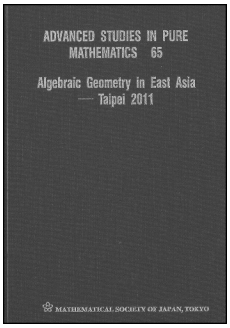
This item will also be of interest to those working in geometry and topology.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

Contents: *I. Survey Articles:* **M. R. Gonzalez-Dorrego**, Smooth double subvarieties on singular varieties. II; **T. Yamamoto**, Survey of apparent contours of stable maps between surfaces; *II. Research Articles:* **C. Beddani**, Valuations divisorielles et connexité en codimension 1; **A. Degtyarev**, The Alexander module of a trigonal curve. II; **A. Dimca**, Monodromy of triple point line arrangements; **K. Inaba**, On fibered links of singularities of polar weighted homogeneous mixed polynomials; **H. Ishida**, On classes in the classification of curves on rational surfaces with respect to logarithmic plurigenera; **A. Katanaga**, The links specific to hypersurface simple $K3$ singularities; **M. Kawashima**, On (4,3) line degenerated torus curves and torus decompositions; **K. Nabeshima** and **S. Tajima**, On the computation of algebraic local cohomology classes associated with semi-quasihomogeneous singularities; **V. K. Nguyen**, Some geometric-arithmetic aspects of separated variable curves; **M. Oka**, Mixed functions of strongly polar weighted homogeneous face type; **T. Okuda**, Singular fibers in barking families of degenerations of elliptic curves; **A. Takahashi**, Mirror symmetry between orbifold projective lines and cusp singularities.

Advanced Studies in Pure Mathematics, Volume 66

May 2015, 282 pages, Hardcover, ISBN: 978-4-86497-026-6, 2010 *Mathematics Subject Classification:* 57-06; 14-06, 32-06, 58-06, **AMS members US$52**, List US$65, Order code ASPM/66



Algebraic Geometry in East Asia—Taipei 2011

Jungkai Alfred Chen, *National Taiwan University, Taipei, Taiwan*, **Meng Chen**, *Fudan University, Shanghai, People's Republic of China*, **Yujiro Kawamata**, *University of Tokyo, Japan*, and **JongHae Keum**, *Korea Institute for Advanced Study, Seoul, South Korea*, Editors

Algebraic geometry is a traditional and fast-developing research area in East Asia. There are many world-leading algebraic geometers, and an increasing number of active mathematicians in related areas, in East Asia, including China, Japan, Korea, Taiwan and Vietnam. The purpose of the Algebraic Geometry in East Asia conference series is to provide a platform for algebraic geometers in or near East Asia.

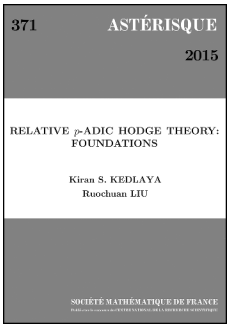
This volume contains the proceedings of the conference on Algebraic Geometry in East Asia, Taipei, which was held in November 2011 at the National Center for Theoretical Sciences (NCTS) in Taipei. The volume contains two survey articles and nine research articles. It provides the latest advances in algebraic geometry research in East Asia.

Published for the Mathematical Society of Japan by Kinokuniya, Tokyo, and distributed worldwide, except in Japan, by the AMS.

Contents: J. A. Chen, Three dimensional divisorial contractions; **Y. Kawamata**, Variation of mixed Hodge structures and the positivity for algebraic fiber spaces; **W. K. Cheong**, From GW invariants of symmetric product stacks to relative invariants of threefolds; **W.-Y. Chang**, ADHM sheaf theory and wallcrossing; **Y. Gongyo**, Remarks on the non-vanishing conjecture; **C. D. Hacon**, Singularities of pluri-theta divisors in Char $p > 0$; **J.-M. Hwang**, Dual cones of varieties of minimal rational tangents; **J. Keum**, $\mathbb{Q}$-homology projective planes with nodes or cusps; **Y. Lee** and **F. Polizzi**, Deformations of product-quotient surfaces and reconstruction of Todorov surfaces via $\mathbb{Q}$-Gorenstein smoothing; **K. Oguiso**, Free automorphisms of positive entropy on smooth Kähler surfaces; **M. Reid**, Gorenstein in codimension 4: the general structure theory.

Advanced Studies in Pure Mathematics, Volume 65

May 2015, 227 pages, Hardcover, ISBN: 978-4-86497-024-2, 2010 *Mathematics Subject Classification:* 14-06, **AMS members US$43.20**, List US$54, Order code ASPM/65



Relative p-adic Hodge Theory: Foundations

Kiran S. Kedlaya, *University of California, San Diego, La Jolla, CA*, and **Ruochuan Liu**, *University of Michigan, Ann Arbor, MI*

The authors describe a new approach to relative p-adic Hodge theory based on systematic use of Witt vector constructions and nonarchimedean analytic geometry in the style of both Berkovich and Huber. They give a thorough development of φ-modules over a relative Robba ring associated to a perfect Banach ring of characteristic p, including the relationship between these objects and étale $\mathbb{Z}_p$-local systems and $\mathbb{Q}_p$-local systems on the algebraic and analytic spaces associated to the base ring, and the relationship between (pro-)étale cohomology and φ-cohomology. They also make a critical link to mixed characteristic by exhibiting an equivalence of tensor categories between the finite étale algebras over an arbitrary perfect Banach algebra over a nontrivially normed complete field of characteristic p and the finite étale algebras over a corresponding Banach $\mathbb{Q}_p$-algebra. This recovers the homeomorphism between the absolute Galois groups of $\mathbb{F}_p((\pi))$ and $\mathbb{Q}_p(\mu_{p^\infty})$ given by the field of norms construction of Fontaine and Wintenberger, as well as generalizations considered by Andreatta, Brinon, Faltings, Gabber, Ramero, Scholl, and, most recently, Scholze.

Using Huber's formalism of adic spaces and Scholze's formalism of perfectoid spaces, the authors globalize the constructions to give several descriptions of the étale local systems on analytic spaces over p-adic fields. One of these descriptions uses a relative version of the Fargues–Fontaine curve.

This item will also be of interest to those working in number theory.

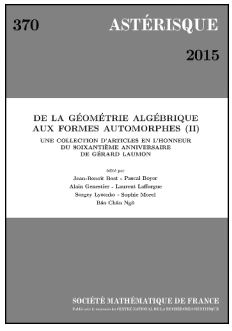
A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Contents: Go to www.ams.org/bookstore.

Astérisque, Number 371

May 2015, 239 pages, Softcover, ISBN: 978-2-85629-807-7, 2010 *Mathematics Subject Classification:* 11G25, 14G20, 14G22, **AMS members US$76.80**, List US$96, Order code AST/371

Discrete Mathematics and Combinatorics



De la Géométrie Algébrique aux Formes Automorphes (II)

Une collection d'articles en l'honneur du soixantième anniversaire de Gérard Laumon

Jean-Benoit Bost, *Université Paris-Sud, Orsay, France*, **Pascal Boyer**, *Université Paris 13, Villetaneuse, France*, **Alain Genestier**, *Université de Lorraine, Vandœuvre-lès-Nancy, France*, **Laurent Lafforgue**, *Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France*, **Sergey Lysenko**, *Université de Lorraine, Vandœuvre-lès-Nancy, France*, **Sophie Morel**, *Princeton University, NJ*, and **Báo Châu Ngô**, *University of Chicago, IL*, Editors

This volume contains the second part of the proceedings of the conference held at Paris-Sud University, Orsay, from June 25– June 29,

2012, to celebrate Gérard Laumon's 60th birthday. The range of subjects covered reflects the diversity and richness of the works and interests of Gérard Laumon: étale cohomology of schemes and stacks, l-adic sheaves and Fourier transform, character sheaves, classic and geometric Langlands correspondence, Grothendieck–Lefschetz trace formula, Arthur–Selberg trace formula, Shimura varieties, Higgs fibre bundles and Hitchin fibration.

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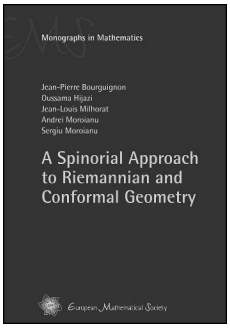
Contents: Go to www.ams.org/bookstore.

Astérisque, Number 370

May 2015, 304 pages, Softcover, ISBN: 978-2-85629-806-0, 2010 *Mathematics Subject Classification:* 05E05, 11G15, 11G18, 14C30, 14D05, **AMS members US$117.60**, List US$147, Order code AST/370

Geometry and Topology



A Spinorial Approach to Riemannian and Conformal Geometry

Jean-Pierre Bourguignon, *Institut des Hautes Études Scientifiques, Bures-sur-Yvette, France*, **Oussama Hijazi**, *Université de Lorraine, Vandœuvre-lés-Nancy, France*, **Jean-Louis Milhorat**, *Université de Nantes, France*, **Andrei Moroianu**, *Université de Versailles, St. Quentin, France*, and **Sergiu Moroianu**, *IMAR, Bucharest, Romania*

The book gives an elementary and comprehensive introduction to Spin Geometry, with particular emphasis on the Dirac operator, which plays a fundamental role in differential geometry and mathematical physics. After a self-contained presentation of the basic algebraic, geometrical, analytical and topological ingredients, a systematic study of the spectral properties of the Dirac operator on compact spin manifolds is carried out. The classical estimates on eigenvalues and their limiting cases are discussed next, highlighting the subtle interplay of spinors and special geometric structures. Several applications of these ideas are presented, including spinorial proofs of the Positive Mass Theorem or the classification of positive Kähler–Einstein contact manifolds. Representation theory is used to explicitly compute the Dirac spectrum of compact symmetric spaces.

The special features of the book include a unified treatment of Spin^c and conformal spin geometry (with special emphasis on the conformal covariance of the Dirac operator), an overview with proofs of the theory of elliptic differential operators on compact manifolds based on pseudodifferential calculus, a spinorial characterization of special geometries, and a self-contained presentation of the representation-theoretical tools needed in order to apprehend spinors.

This book will help advanced graduate students and researchers to get more familiar with this beautiful, though not sufficiently known, domain of mathematics with great relevance to both theoretical physics and geometry.

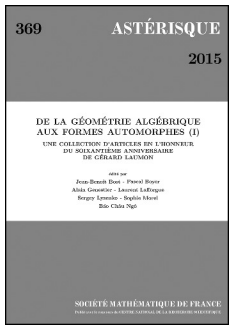
A publication of the European Mathematical Society (EMS). Distributed within the Americas by the American Mathematical Society.

Contents: Go to www.ams.org/bookstore.

EMS Monographs in Mathematics, Volume 6

June 2015, 462 pages, Hardcover, ISBN: 978-3-03719-136-1, 2010 *Mathematics Subject Classification:* 53C27, 53A30; 53C26, 53C55, 53C80, 17B10, 34L40, 35S05, **AMS members US$69.60**, List US$87, Order code EMSMONO/6

Number Theory



De la Géométrie Algébrique aux Formes Automorphes (I)

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A publication of the Société Mathématique de France, Marseilles (SMF), distributed by the AMS in the U.S., Canada, and Mexico. Orders from other countries should be sent to the SMF. Members of the SMF receive a 30% discount from list.

Astérisque, Number 369

May 2015, 374 pages, Softcover, ISBN: 978-2-85629-805-3, 2010 *Mathematics Subject Classification:* 11F23, 11F70, 11F72, 11G18, 11R39, **AMS members US$98.40**, List US$123, Order code AST/369

Classified Advertisements

Positions available, items for sale, services available, and more

CALIFORNIA

UNIVERSITY OF CALIFORNIA, LOS ANGELES
Department of Mathematics
Faculty Positions 2016–17

Tenured/Tenure-Track positions 2016–17

The Department of Mathematics at the University of California, Los Angeles, invites applications for tenure-track or tenured faculty positions starting July 1, 2016. Outstanding candidates in all areas of mathematics may be considered. Applicants must possess a PhD and should have outstanding accomplishments in both research and teaching. Duties include mathematical research, undergraduate and graduate teaching, and departmental and university service. Level of appointment will be based on qualifications, with appropriate salary per UC pay scales.

Applications will be accepted until the position is filled. To guarantee full consideration, the application should be received by November 15, 2015. Job Tracking #1010-1617-05

The Department of Mathematics at the University of California, Los Angeles, invites applications for temporary and visiting appointments in the categories 1–5 below. Depending on the level, candidates must give evidence of potential or demonstrated distinction in scholarship and teaching.

Temporary Positions:

(1) **E. R. Hedrick Assistant Professorships**: Salary range is $66,800–$70,100, and appointments are for three years. The teaching load is four one-quarter courses per year. **Job Tracking #1010-1617-01**

(2) **Computational and Applied Mathematics (CAM) Assistant Professorships**: Salary range is $66,800–$70,100, and appointments are for three years. The teaching load is normally reduced by research funding to two one-quarter courses per year. **Job Tracking #1010-1617-02**

(3) **Program in Computing (PIC) Assistant Adjunct Professorships**: Salary range is $73,100–$75,300. Applicants for these positions must show very strong promise in teaching and research in an area related to computing. The teaching load is four one-quarter programming courses each year and one additional course every two years. Initial appointments are for one year and possibly longer, up to a maximum service of four years. **Job Tracking #1010-1617-03**

(4) **Assistant Adjunct Professorships and Research Postdocs**: Appointments are normally for one year, with the possibility of renewal. Strong research and teaching background required. The salary is $62,900–$64,800. The teaching load for Adjuncts is six one-quarter courses per year. **Job Tracking #1010-1617-04**

(5) **RTG Assistant Adjunct Professorship in Analysis**: Salary is $59,300–$61,000, and appointments are for three years. This position is limited to US citizens or permanent residents who have received a PhD within 18 months of June 1, 2016. The successful recipient will receive a summer stipend of $10,000 for two summers and $9,000 over three years for travel, equipment, and supplies. The teaching load is three one-quarter courses per year. **Job Tracking #1010-1617-08**

Appointments will be effective July 1, 2016 or later. Applications will be accepted until all positions are filled. For fullest consideration, all application materials should be submitted on or before November 15, 2015.

Applications and supporting documentation must be submitted online via `www.mathjobs.org`.

All letters of evaluation are subject to UCLA campus policies on confidentiality. Refer potential reviewers to the UCLA statement of confidentiality at `https://www.apo.ucla.edu/policies/the-call/summary-of-procedures/summary-10-statement-of-confidentiality`

Lecturer Positions in Mathematics

The UCLA Department of Mathematics receives on an ongoing basis applications

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Suggested uses for classified advertising are positions available, books or lecture notes for sale, books being sought, exchange or rental of houses, and typing services. The publisher reserves the right to reject any advertising not in keeping with the publication's standards. Acceptance shall not be construed as approval of the accuracy or the legality of any advertising.

The 2015 rate is $3.50 per word with a minimum two-line headline. No discounts for multiple ads or the same ad in consecutive issues. For an additional $10 charge, announcements can be placed anonymously. Correspondence will be forwarded.

Advertisements in the "Positions Available" classified section will be set with a minimum one-line headline, consisting of the institution name above body copy, unless additional headline copy is specified by the advertiser. Headlines will be centered in boldface at no extra charge. Ads will appear in the language in which they are submitted.

There are no member discounts for classified ads. Dictation over the telephone will not be accepted for classified ads.

Upcoming deadlines for classified advertising are as follows: October 2015–July 29, 2015; November 2015–August 31, 2015; December 2015—September 29, 2015; January 2016—October 29, 2015; February 2016—December 7, 2015; March 2016 issue–January 1, 2016.

U.S. laws prohibit discrimination in employment on the basis of color, age, sex, race, religion, or national origin. "Positions Available" advertisements from institutions outside the US cannot be published unless they are accompanied by a statement that the institution does not discriminate on these grounds whether or not it is subject to US laws. Details and specific wording may be found on page 1373 (vol. 44).

Situations wanted advertisements from involuntarily unemployed mathematicians are accepted under certain conditions for free publication. Call toll-free 800-321-4AMS (321-4267) in the US and Canada or 401-455-4084 worldwide for further information.

Submission: Promotions Department, AMS, P.O. Box 6248, Providence, Rhode Island 02904; or via fax: 401-331-3842; or send email to `classads@ams.org`. AMS location for express delivery packages is 201 Charles Street, Providence, Rhode Island 02904. Advertisers will be billed upon publication.

for quarter positions (Fall/Winter/Spring or for Summer Session) for Lecturers to teach undergraduate mathematics or math education courses. Positions are very limited and temporary. Responsibilities include lecturing, conducting office hours, writing and grading exams and supervising teaching assistants. Previous teaching experience at the college level or experience as a Financial Actuary is required and a PhD is preferred. Salary is commensurate with experience. **Job Tracking #1010-1617-07**

Lecturer with Potential Security of Employment in the Department of Mathematics

The UCLA Department of Mathematics seeks applications for a full-time career Lecturer with Potential Security of Employment (similar to tenure-track) beginning July 1, 2016.

Qualifications: Candidates must possess a PhD in mathematics or a closely related field. The successful applicant will be a broadly trained mathematician who is dedicated to undergraduate teaching and pedagogy and is interested in belonging to a top research department.

Duties and Responsibilities: In addition to making significant contributions to lower and upper-division teaching (4.5 quarter-courses per year), the Lecturer will engage in a combination of: curriculum development, advisement of undergraduate students, mentoring visiting and junior faculty, participation in service activities, as well as research. In addition to teaching, specific duties may include the development and implementation of new courses and curricula at the undergraduate level, as well as leadership roles in undergraduate activities and advising, community outreach activities and in improving instructional resources. It is expected that the Lecturer will be involved in program development, attend relevant professional meetings, review programs, and be involved in mentoring of visiting and junior faculty. Level of appointment will be based on qualifications, with appropriate salary per UC pay scales. Further information about mathematics at UCLA can be found at www.math.ucla.edu.

Applicants should submit a letter of interest outlining experiences and qualifications including teaching philosophy and mathematical interests and accomplishments together with a curriculum vita and publication record, and arrange for at least three letters of recommendation to be sent. Materials should be submitted electronically via www.mathjobs.org. Applications received on or before **01/01/2016** will be given full consideration. **Job Tracking #1010-1617-10**

The department is especially interested in candidates who can contribute to the diversity & excellence of the academic community through teaching and service.

Applications and supporting documentation for all positions must be submitted online via www.mathjobs.org.

All letters of evaluation are subject to UCLA campus policies on confidentiality. Refer potential reviewers to the UCLA statement of confidentiality at https://www.apo.ucla.edu/policies/the-call/summary-of-procedures/summary-10-statement-of-confidentiality

UCLA statement of confidentiality at www.math.ucla.edu/people/confidentiality.pdf

The University of California is an Equal Opportunity/Affirmative Action Employer. All qualified applicants will receive consideration for employment without regard to race, color, religion, sex, sexual orientation, gender identity, national origin, disability, age or protected veteran status. For the complete University of California nondiscrimination and affirmative action policy see: UC Nondiscrimination and Affirmative Action Policy, policy.ucop.edu/doc/4000376/NondiscrimAffirmAct.

The University of California asks that applicants complete the Equal Opportunity Employer survey for Letters and Science at the following URL: cis.ucla.edu/facultysurvey/. Under Federal Law, the University of California may employ only individuals who are legally authorized to work in the United States as established by providing documents specified in the Immigration Reform and Control Act of 1986.

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SOUTH CAROLINA

UNIVERSITY OF SOUTH CAROLINA
Vasil Popov Prize, 2016
Call for Nominations

The Vasil Popov Prize is awarded every three years for outstanding research in fields related to the work of Vasil A. Popov, who is best known for his contributions to Approximation Theory. Candidates must have received their PhD within the previous six years. Nominations, to include a brief description of the relevant work and a vita of the nominee, should be sent to Pencho Petrushev, Chair, Popov Prize Selection Committee, Interdisciplinary Mathematics Institute, University of South Carolina, Columbia, SC 29208; email: popov.prize@gmail.com. The deadline for nominations is November 15, 2015. The Prize will be awarded in May of 2016 at the Fifteenth International Conference in Approximation Theory, in San Antonio, Texas. For further information, visit imi.cas.sc.edu/popov-prize-call-nominations/

000015

HONG KONG

THE UNIVERSITY OF HONG KONG
Tenure-Track Associate Professor/ Assistant Professor in the Department of Mathematics
(Ref.: 201500788)

Applications are invited for tenure-track appointment as Associate Professor/ Assistant Professor in the Department of Mathematics, to commence from September 1, 2016 or as soon as possible thereafter. The appointment will initially be made on a three-year term basis, with the possibility of renewal and with consideration for tenure before the expiry of the second three-year contract.

The Department of Mathematics provides a solid general undergraduate education in mathematics, offers supervision in graduate study for students with a strong interest in and a capacity for mathematics, and engages in teaching and research aiming at a high international standing. Information about the Department can be obtained at www.hku.hk/math/.

Candidates in all areas of Applied Mathematics and Mathematical Sciences will be considered, with preference given to those working in the areas of Scientific Computing, Computational Mathematics, Financial Mathematics, Operations Research, and Optimization. The appointee is expected to actively engage in outreach and service.

A globally competitive remuneration package commensurate with qualifications and experience will be offered. At current rates, salaries tax does not exceed 15 percent of gross income. The appointment will attract a contract-end gratuity and University contribution to a retirement benefits scheme, totalling up to 15 percent of basic salary, as well as annual leave, and medical benefits. Housing benefits will be provided as applicable.

Applicants should send a completed application form, together with an up-to-date CV containing information on educational and professional experience, a complete list of publications, a survey of past research and teaching experience, a research plan for the next few years, and a statement on teaching philosophy by email to scmath@hku.hk. They should also arrange for submission, to the same e-mail address as stated above, three reference letters from senior academics. One of these senior academics should be asked to comment on the applicant's ability in teaching, or the applicant should arrange to have an additional reference letter on his/her teaching sent to the same e-mail address as stated above. Please indicate clearly which level they wish to be considered for and the reference number in the subject of the email. Application forms (341/1111) can be downloaded at www.hku.hk/apptunit/form-ext.doc. Further particulars can be obtained at

ETH zürich

Assistant Professor of Mathematics

→ The Department of Mathematics at ETH Zurich (www.math.ethz.ch) invites applications for an assistant professor position in mathematics (non-tenure track).

→ Candidates should hold a PhD or equivalent and have demonstrated the ability to carry out independent research work. Willingness to teach at all university levels and to participate in collaborative work within or outside the school is expected. The new professor will be expected to teach undergraduate (in German or English) and graduate courses (in English) for students of mathematics, natural sciences and engineering.

→ Assistant professorships have been established to promote the careers of younger scientists. The initial appointment is for four years with the possibility of extension to six years.

→ **Please apply online at www.facultyaffairs.ethz.ch**

→ Applications should include a curriculum vitae, a list of publications, and a statement of future research and teaching interests. The letter of application should be addressed **to the President of ETH Zurich, Prof. Dr. Lino Guzzella. The closing date for applications is 30 September 2015.** ETH Zurich is an equal opportunity and family friendly employer and is further responsive to the needs of dual career couples. We specifically encourage women to apply.

jobs.hku.hk/. Review of applications will start from December 1, 2015 and continue until the post is filled.

The University thanks applicants for their interest, but advises that only candidates shortlisted for interviews will be notified of the application result.

The University is an equal opportunities employer and is committed to a No-Smoking Policy.

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TURKEY

BILKENT UNIVERSITY
Department of Mathematics

Bilkent University Department of Mathematics invites applications from faculty members at the level of full Professor for the position of Department Chair starting fall semester 2016, or earlier. Candidates should have a record of success in mathematical scholarship, teaching, and professional service, and should have outstanding interpersonal skills. Department of Mathematics has 16 full time faculty and 7 instructors and offers BS, MS and PhD degrees. Current research areas include algebra and arithmetic, analysis, applied mathematics, algebraic geometry and topology. For additional information, see the Department of Mathematics webpage at www.fen.bilkent.edu.tr/~cvmath/. Bilkent University has a large body of international faculty and students. The language of instruction is English; qualified applicants of any citizenship are welcome for this position. Bilkent University has a beautiful campus, conveniently located close to the city center of Ankara, in a pleasant neighborhood. The successful candidate will be expected to provide direction and leadership within the department, and to be an advocate for the department to the university and to society at large. The Chair reports to the Dean of the Faculty of Science and is responsible for hiring, supervising, mentoring, and evaluating faculty and staff, managing the budget, and organizing department's service course deliverance efficiently. Salary is internationally competitive and on-campus housing is provided. Applications will be reviewed beginning September 2015 and the review will continue until the position is filled. Applicants can apply for this position by sending an email to the chair of the search committee: Professor Dr. A. Bülent Özgüler, ozguler@ee.bilkent.edu.tr. Applicants should attach the following materials: a cover letter, curriculum vitae, description of research achievements and interests, and a brief statement of their vision for the department. At a later stage, names of at least three professional references will be required. All applications will be handled with strict confidentiality.

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Meetings & Conferences of the AMS

IMPORTANT INFORMATION REGARDING MEETINGS PROGRAMS: AMS Sectional Meeting programs do not appear in the print version of the *Notices*. However, comprehensive and continually updated meeting and program information with links to the abstract for each talk can be found on the AMS website. See www.ams.org/meetings/. Final programs for Sectional Meetings will be archived on the AMS website accessible from the stated URL.

Chicago, Illinois

Loyola University Chicago

October 3–4, 2015

Saturday – Sunday

Meeting #1112

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: June 2015
Program first available on AMS website: August 20, 2015
Issue of *Abstracts*: Volume 36, Issue 4

Deadlines

For organizers: Expired
For abstracts: Expired

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Julia Chuzhoy, Toyota Technological Institute at Chicago, *Title to be announced*.

Andrew Neitzke, The University of Texas at Austin, *Title to be announced*.

Sebastien Roch, University of Wisconsin-Madison, *Title to be announced*.

Peter Sarnak, Princeton University, *Title to be announced* (Erdős Memorial Lecture).

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Algebraic Methods Common to Association Schemes, Hopf Algebras, Tensor Categories, Finite Geometry, and Related Areas, **Harvey Blau**, Northern Illinois University, **Sung Y. Song**, Iowa State University, and **Bangteng Xu**, Eastern Kentucky University.

Algebraic Statistics and its Interactions with Combinatorics, Computation, and Network Science, **Sonja Petrovic**, Illinois Institute of Technology, and **Despina Stasi**, University of Cyprus and Illinois Institute of Technology.

Algebraic and Combinatorial Invariants of Knots, **Micah Chrisman**, Monmouth University, **Heather Dye**, McKendree University, **Aaron Kaestner**, North Park University, **Louis Kauffman**, University of Illinois at Chicago, and **Emily Peters**, Loyola University Chicago.

Analysis of Partial Differential Equations and Fluid Dynamics, **Mimi Dai**, University of Illinois at Chicago, **Vera Mikyoung Hur**, University of Illinois at Urbana-Champaign, and **Yao Yao**, University of Wisconsin-Madison.

Automorphic Forms and Representations, **Moshe Adrian**, University of Toronto, and **Shuichiro Takeda** and **Aaron Wood**, University of Missouri-Columbia.

Automorphisms of Riemann Surfaces and Related Topics, **S. Allen Broughton**, Rose-Hulman Institute of Technology, **Peter Turbek**, Purdue University Calumet, **Anthony Weaver**, Bronx Community College, the City University of New York, and **Aaron Wootton**, University of Portland.

Coding Theory and Its Applications, **W. Cary Huffman**, Loyola University Chicago.

Cohomology of Algebras and Deformation Theory, **Anthony Giaquinto**, Loyola University Chicago, **Mihai D. Staic**, Bowling Green State University, and **Alin Stancu**, Columbus State University.

Combinatorial and Computational Algebra, **David Cook II**, Eastern Illinois University, and **Sonja Mapes**, University of Notre Dame.

Combinatorial and Geometric Representation Theory, **Ben Salisbury**, Central Michigan University, and **Peter Tingley**, Loyola University Chicago.

Commutative Algebra, **Youngsu Kim** and **Paolo Mantero**, University of California, Riverside, and **Jonathan Montano**, Purdue University.

Computability Theory and Applications, **Denis Hirschfeldt**, University of Chicago, and **Steffen Lempp**, University of Wisconsin-Madison.

Enumerative Algebraic and Geometric Combinatorics, **Kyle Petersen**, DePaul University, and **Steven Klee**, Seattle University.

Enumerative Combinatorics and Graph Theoretic Applications, **Adam Goyt**, Minnesota State University, and **Lara Pudwell**, Valparaiso University.

Ergodic and Symbolic Actions of Amenable Groups, **Ayşe Şahin** and **Ilie Ugarcovici**, DePaul University.

Frontiers in Computational Mathematics, **Sou-Cheng (Terrya) Choi**, NORC at the University of Chicago, and Illinois Institute of Technology.

Generalized Derivatives, **J. Marshall Ash**, DePaul University, and **Paul Musial**, Chicago State University.

Geometric Partial Differential Equations, **Morgan Sherman**, California Polytechnic State University, and **Valentino Tosatti** and **Ben Weinkove**, Northwestern University.

Geometric Perspectives in Knot Theory, **David Krcatovich** and **Allison Moore**, Rice University.

Graduate Student Perspectives on Undergraduate Research, **Mindy Capaldi** and **Zsuzsanna Szaniszlo**, Valparaiso University.

Groups, Rings, Group Rings, and Hopf Algebras (celebrating the 75th birthday of Donald S. Passman), **Jeffrey Bergen**, **Stefan Catoiu**, and **William Chin**, DePaul University.

History of Mathematics, **Steven Jordan**, Loyola University Chicago.

Hopf Algebraic Combinatorics, **Marcelo Aguiar**, Cornell University, and **Aaron Lauve**, Loyola University Chicago.

K-loops, Neardomains, Loops, and Nonassociative Division Algebras, **Alper Bulut**, American University of the Middle East, **C. E. Ealy Jr.**, Western Michigan University, **Hubert Kiechle**, University of Hamburg, **Benjamin Phillips**, University of Michigan Dearborn, and **J. D. Phillips**, Northern Michigan University.

Mathematical Analysis and Computation of Nematic Liquid Crystals, **Patricia Bauman**, **Daniel Phillips**, and **Changyou Wang**, Purdue University.

Mathematics of Evolution, **Ruth Davidson**, University of Illinois Urbana-Champaign, and **Ruriko Yoshida**, University of Kentucky.

Metric Spaces: Geometry, Group Theory, and Dynamics, **Tullia Dymarz**, University of Wisconsin-Madison, and **Anton Lukyanenko**, University of Michigan.

Model Theory, **Uri Andrews**, University of Wisconsin-Madison, **Isaac Goldbring**, University of Illinois at Chicago, and **Maryanthe Malliaris**, University of Chicago.

Nonlinear PDEs and Calculus of Variations, **Emmanuel Barron**, **Marian Bocea**, and **Robert Jensen**, Loyola University Chicago.

Nonlocal Diffusions, **Jinqiao Duan**, **Xiaofan Li**, and **Xiaoxia Xie**, Illinois Institute of Technology.

Probability Theory, **Antonio Auffinger**, Northwestern University, **Jian Ding**, University of Chicago, and **Sebastien Roch**, University of Wisconsin-Madison.

Recent Advances in Non-Commutative Analysis, **Hari Bercovici**, Indiana University, and **John Williams**, Universität des Saarlandes.

Recent Developments in Graph and Matroid Theory, **Sergei Bezrukov**, University of Wisconsin-Superior, **Dalibor Froncek**, University of Minnesota Duluth, and **Xiaofeng Gu** and **Steven Rosenberg**, University of Wisconsin-Superior.

Recent Developments in the Theory and Applications of Reaction Network Models, **Carsten Conradi**, Max Planck Institute, and **Casian Pantea**, West Virginia University.

Singularities in Algebra, Geometry and Topology, **Manuel Gonzalez Villa** and **Laurentiu Maxim**, University of Wisconsin-Madison.

Stochastic Analysis With Applications to Quantitative Finance, **Igor Cialenco** and **Ruoting Gong**, Illinois Institute of Technology.

The Langlands Program and Related Topics, **Andrei Jorza**, University of Notre Dame, and **Martin Luu**, University of Illinois at Urbana-Champaign.

Topics in Graph Theory, Hypergraphs and Set Systems, **John Engbers**, Marquette University, and **David Galvin**, University of Notre Dame.

Variational Analysis, Optimization, and Control (Dedicated to Terry Rockafellar on the occasion of his 80th birthday), **Rafal Goebel**, Loyola University Chicago.

Memphis, Tennessee

University of Memphis

October 17–18, 2015

Saturday – Sunday

Meeting #1113

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: August 2015
Program first available on AMS website: September 3, 2015
Issue of *Abstracts*: Volume 36, Issue 3

Deadlines

For organizers: Expired
For abstracts: August 25, 2015
The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Mark van Hoeij, Florida State University, *Solving problems with the LLL algorithm.*

Vaughan Jones, Vanderbilt University, *Are all subfactors related to quantum field theory?.*

Mette Olufsen, North Carolina State University, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `www.ams.org/cgi-bin/abstracts/abstract.pl`.

Advances in Operator Theory and Applications, in memory of James Jamison (Code: SS 5A), **Fernanda Botelho**, University of Memphis, and **T.S.S.R.K. Rao**, Indian Statistical Institute Bangalore.

Analysis of Differential and Integral Equations (Code: SS 18A), **D.P. Dwiggins** and **T. Hagen**, University of Memphis.

Banach Spaces and Applications (Code: SS 4A), **Anna Kaminska**, **Peikee Lin**, and **Bentuo Zheng**, University of Memphis.

Cahn-Hilliard and Related Equations and Applications. (Code: SS 11A), **Giséle Ruiz Goldstein**, University of Memphis, and **Alain Miranville**, Université de Poitiers.

Computational Analysis (Code: SS 1A), **George Anastassiou**, University of Memphis.

Control and Inverse Problems for Partial Differential Equations (Code: SS 6A), **Matthias Eller**, Georgetown University, **Shitao Liu**, Clemson University, and **Roberto Triggiani**, University of Memphis.

Difference Equations and Applications. (Code: SS 12A), **Michael A. Radin**, Rochester Institute of Technology, and **Youssef Raffoul**, University of Dayton.

Ergodic Theory (Code: SS 8A), **James T. Campbell** and **Mate Wierdl**, University of Memphis.

Evolution Equations and Partial Differential Equations (Code: SS 19A), **Jerome A. Goldstein**, University of Memphis, **Rainer Nagel**, Universitaet Tuebingen, and **Guillermo Reyes**, University of Southern California.

Extremal Graph Theory (in memory of Ralph Faudree) (Code: SS 3A), **Paul Balister**, University of Memphis, **Béla Bollobás**, University of Cambridge UK, and University of Memphis, and **Vladimir Nikiforov**, University of Memphis.

Fractal Geometry and Dynamical Systems (Code: SS 2A), **Mrinal Kanti Roychowdhury**, University of Texas-Pan American.

Probabilistic Combinatorics (Code: SS 17A), **Paul Balister**, University of Memphis, and **Béla Bollobás**, University of Cambridge UK, and University of Memphis.

Recent Advances in Commutative Algebra. (Code: SS 13A), **Sandra Spiroff**, University of Mississippi, and **Lance Miller**, University of Arkansas.

Recent Developments in the Statistical Analysis of Large Clustered Data (Code: SS 10A), **E. Olusegun George**, University of Memphis.

Spectra of Graphs and Hypergraphs (Code: SS 9A), **Vladimir Nikiforov**, University of Memphis.

Stabilization, Control, and Analysis of Evolutionary Partial Differential Equations (Code: SS 7A), **George Avalos**, University of Nebraska Lincoln, **Scott Hansen**, Iowa State University, and **Justin Webster**, North Carolina State University & College of Charleston.

The Analysis, Geometry, and Topology of Groupoids (Code: SS 15A), **Emily Proctor**, Middlebury College, and **Christopher Seaton**, Rhodes College.

Topological Combinatorics (Code: SS 14A), **Eric Gottlieb**, Rhodes College, and **Russ Woodroofe**, Mississippi State University.

von Neumann Algebras (Code: SS 16A), **Vaughan Jones**, Vanderbilt University, and **David Penneys**, University of California Los Angeles.

Fullerton, California

California State University, Fullerton

October 24–25, 2015

Saturday – Sunday

Meeting #1114

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: August 2015
Program first available on AMS website: September 10, 2015
Issue of *Abstracts*: Volume 36, Issue 4

Deadlines

For organizers: Expired
For abstracts: September 1, 2015

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Mina Aganagic, University of California, Berkeley, *Refined Chern-Simons Index and Knot Homology*.

John Lott, University of California, Berkeley, *3D Ricci flow since Perelman*.

Eyal Lubetzky, Microsoft Research, Redmond, *Title to be announced*.

Zhiwei Yun, Stanford University, *Title to be announced*.

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `www.ams.org/cgi-bin/abstracts/abstract.pl`.

Algebraic and Combinatorial Structures in Knot Theory (Code: SS 9A), **Allison Henrich**, Seattle University, **Aaron M. Kaestner**, North Park University, **Sam Nelson**, Claremont McKenna College, and **Matt Rathbun**, California State University, Fullerton.

Analysis on Metric Spaces (in honor of Fred Gehring on the occasion of his 90th birthday) (Code: SS 23A), **Zair Ibragimov**, California State University, Fullerton.

Applied Mathematics in Industry: In Memory of Professor John G. Pierce (1942-2015) (Code: SS 8A), **Charles H. Lee** and **Angel R. Pineda**, California State University, Fullerton.

Fixed Point Theory and Applications (Code: SS 10A), **Clement B. Ampadu**, **Talat Nazir**, Malardalen University, and **Xavier A. Udo-Utun**, University of Uyo.

Geometric Analysis (Code: SS 1A), **John Lott**, University of California, Berkeley, and **Aaron Naber**, Northwestern University.

History and Philosophy of Mathematics (Code: SS 15A), **Jim Tattersall**, Providence College, and **Shawn McMurran**, California State University, San Bernardino.

Homological Methods in Commutative Algebra (Code: SS 22A), **Amanda Croll**, Concordia University, Irvine, and **Jack Jeffries**, University of Michigan.

Humanistic Mathematics (Code: SS 20A), **Mark Huber**, Claremont McKenna College, and **Gizem Karaali**, Pomona College.

Mathematical Techniques in Quantum Theories and Quantum Finance, with applications (Code: SS 11A), **Alfonso F. Agnew**, California State University at Fullerton, and **David Carfi**, University of Messina, Italy.

Mathematical/Statistical modeling and its applications to science and engineering (Code: SS 19A), **Kanadpriya Basu**, University of Texas at El Paso.

Mathematicians and Outreach Programs (Code: SS 2A), **Olga Radko**, University of California Los Angeles, and **Bogdan D. Suceava**, California State University, Fullerton.

Recent Advances in Computational and Mathematical Biology (Code: SS 16A), **Fengzhu Sun**, University of Southern California, and **Jianjun Paul Tian** and **Mary Ballyk**, New Mexico State University.

Recent Advances in Finite Groups and their Representations (Code: SS 5A), **Adam Glesser**, California State University, Fullerton, and **Mandi Schaeffer Fry**, Metropolitan State University of Denver.

Recent Advances in Number Theory (Code: SS 18A), **Christopher Lyons**, California State University, Fullerton, and **Karl Rubin** and **Alice Silverberg**, University of California, Irvine.

Recent Developments in Nonlinear Partial Differential Equations (Code: SS 12A), **Changyou Wang**, Purdue University, and **Yifeng Yu**, University of California at Irvine.

Recent results in Operator Theory and Operator Algebras (Code: SS 14A), **Asuman G. Aksoy**, Claremont McKenna College, **Don Hadwin**, University of New Hampshire, and **Hassan Yousefi**, California State University, Fullerton.

Research in Mathematics by Early Career Graduate Students (Code: SS 7A), **Tamas Forgacs**, **Carmen Caprau**, and **Oscar Vega**, California State University, Fresno.

Spatial Graphs (Code: SS 13A), **Erica Flapan**, Pomona College, **Thomas Mattman**, California State University, Chico, **Blake Mellor**, Loyola Marymount University, **Ramin Naimi**, Occidental College, and **Ryo Nikkuni**, Tokyo Women's Christian University.

Spatio-Temporal Modeling of Neuronal Data (Code: SS 6A), **Reza Ramezan** and **Sam Behseta**, California State University, Fullerton.

Spectral Asymptotics of Large Matrices (Code: SS 3A), **Alain Bourget** and **Tyler McMillen**, California State University, Fullerton.

Spectral Theory of Ergodic Schrödinger Operators and related models (Code: SS 21A), **S. Jitomirskaya**, University of California, Irvine, and **Christoph Marx**, Oberlin College.

Stochastic modeling and statistical inference (Code: SS 17A), **Qidi Peng**, Claremont Graduate University.

Strategies of Training Pre-Service Teachers (Code: SS 4A), **Margaret Kidd**, **Cherie Ichinose**, **David Pagni**, and **Bogdan D. Suceava**, California State University, Fullerton.

New Brunswick, New Jersey

Rutgers University

November 14–15, 2015

Saturday – Sunday

Meeting #1115

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: September 2015
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 36, Issue 4

Deadlines

For organizers: Expired
For abstracts: September 22, 2015

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Lee Mosher, Rutgers University, *The geometry and dynamics of the outer automorphism group of a free group.*

Jill Pipher, Brown University, *Title to be announced.*

David Vogan, Massachusetts Institute of Technology, *Matrices (nearly) of order two.*

Wei Zhang, Columbia University, *Euler product and Taylor expansions of L-functions.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `www.ams.org/cgi-bin/abstracts/abstract.pl`.

Advances in Valuation Theory (Code: SS 6A), **Samar El Hitti**, New York City College of Technology, City University of New York, **Franz-Viktor Kuhlmann**, University of Saskatchewan, and **Hans Schoutens**, New York City College of Technology, City University of New York.

Algebraic Geometry and Combinatorics (Code: SS 9A), **Elizabeth Drellich**, University of North Texas, **Erik Insko**, Florida Gulf Coast University, **Aba Mbirika**, University of Wisconsin-Eau Claire, and **Heather Russell**, Washington College.

Applications of CAT(0) Cube Complexes (Code: SS 1A), **Sean Cleary**, City College of New York and the City University of New York Graduate Center, and **Megan Owen**, Lehman College of the City University of New York.

Aspects of Minimal Surfaces in Riemannian Manifolds (Code: SS 4A), **Zheng Huang** and **Marcello Lucia**, City University of New York, Staten Island and Graduate Center.

Aspects of Resolutions and Syzygies in Commutative Algebra (Code: SS 12A), **Courtney Gibbons**, Hamilton College, and **Denise Rangel Tracy**, Syracuse University.

Commutative Algebra (Code: SS 2A), **Laura Ghezzi**, New York City College of Technology, City University of New York, and **Jooyoun Hong**, Southern Connecticut State University.

Difference Equations and Applications (Code: SS 5A), **Manos Drymonis**, Providence College, **Evelina Lapierre**, Johnson and Wales University, and **Michael Radin**, Rochester Institute of Technology.

Geometric Analysis (Code: SS 22A), **Paul Feehan**, **Manos Maridakis**, and **Natasa Sesum**, Rutgers University.

Geometric Topology: A Celebration of Jim West's 70th Birthday (Code: SS 3A), **Alexandre Dranishnikov**, University of Florida, **Steve Ferry**, Rutgers University, and **Boris Goldfarb**, State University of New York at Albany.

Geometry and Combinatorics of Polytopes (Code: SS 19A), **Egon Schulte**, Northeastern University, and **Asia Ivić Weiss**, York University.

Geometry of Groups, Surfaces and 3-manifolds (Code: SS 14A), **Abhijit Champanerkar**, College of Staten Island

and The Graduate Center, City University of New York, **Feng Luo**, Rutgers University, and **Joseph Maher**, College of Staten Island and The Graduate Center, City University of New York.

Invariants of Knots, Links and 3 Manifolds (Code: SS 16A), **Ilya Kofman**, College of Staten Island and The Graduate Center, City University of New York, and **Adam Lowrance**, Vassar College.

Modern Schubert Calculus (Code: SS 17A), **Anders Buch** and **Chris Woodward**, Rutgers University.

Multiple Combinatorial Numbers and Associated Identities (Code: SS 8A), **Hasan Coskun**, Texas A&M University-Commerce.

Multiscale Methods in Cell and Developmental Biology (Code: SS 15A), **Anastasios Matzavinos**, Brown University, and **Chuan Xue**, Ohio State University.

Nonlinear Waves in Differential Equations (Code: SS 10A), **Linghai Zhang**, Lehigh University.

Number Theory, Spectral Theory, and Homogeneous Dynamics (Code: SS 13A), **Dubi Kelmer**, Boston College, and **Alex Kontorovich**, Rutgers University.

Partial Differential Equations in Geometric Analysis (Code: SS 23A), **Jeffrey Case** and **Alice Chang**, Princeton University, and **Yi Wang**, Johns Hopkins University and Institute for Advanced Study.

Probability, Combinatorics and Statistical Mechanics (Code: SS 20A), **Nayantara Bhatnagar**, University of Delaware, **Brian Rider**, Temple University, and **Douglas Rizzolo**, University of Delaware.

Representation Theory, Vertex Operator Algebras, and Related Topics (Code: SS 7A), **Corina Calinescu**, New York City College of Technology, City University of New York, **Andrew Douglas**, New York City College of Technology and Graduate Center, City University of New York, and **Joshua Sussan**, Medgar Evers College, City University of New York.

Representations of Reductive Groups (Code: SS 11A), **Jeffrey Adams**, University of Maryland, **Stephen D. Miller**, Rutgers University, and **David Vogan**, Massachusetts Institute of Technology.

Smooth and Symbolic Ergodic Theory (Code: SS 21A), **Andrey Gogolev**, State University of New York at Binghamton, and **Federico Rodriguez Hertz** and **Zhiren Wang**, Pennsylvania State University.

Topological Data Analysis: Computations, Statistics, and Applications (Code: SS 18A), **Miroslav Kramar** and **Rachel Levanger**, Rutgers University.

Accommodations

Participants should make their own arrangements directly with the hotel of their choice. Special discounted rates were negotiated with the hotels listed below. Rates quoted do not include the New Jersey hotel tax (15%). Participants must state that they are with the **American Mathematical Society (AMS) Meeting at Rutgers University** to receive the discounted rate. The AMS is not responsible for rate changes or for the quality of the accommodations. **Hotels have varying cancellation and early checkout penalties; be sure to ask for details.**

Days Hotel Conference Center, 195 State Route 18, East Brunswick, NJ, 732-828-6900; www.dayshoteleastbrunswick.com. Rates are US$79.95 per night for single/double occupancy. Amenities include complimentary daily newspaper, complimentary breakfast, highspeed WiFi, exercise room, on-site business center, and parking. This property is located approximately 5 miles (8 minutes) driving distance from the campus. Cancellation and early check-out policies vary and penalties exist at this property; be sure to check when you make your reservation. The deadline for reservations at this rate is **October 13, 2015**.

Hampton Inn, 841 Georges Road, North Brunswick, NJ, 732-246-3555; hamptoninn3.hilton.com/en/hotels/new-jersey/hampton-inn-north-brunswick-new-brunswick-EWRNBHX/index.html. Rates are US$109 per night for a single or double occupancy deluxe room. Amenities include complimentary hot breakfast and all-day beverage service, complimentary highspeed WiFi, exercise room, on-site business center, pool and parking. This property is located approximately 5 miles (8 minutes) driving distance from the campus. Cancellation and early check-out policies vary and penalties exist at this property; be sure to check when you make your reservation. The deadline for reservations at this rate is **October 23, 2015.**

Holiday Inn Express & Suites Tower Center New Brunswick, 4 Tower Center Blvd., East Brunswick, NJ, 732-247-6800; www.ihg.com/holidayinnexpress/hotels/us/en/east-brunswick/ebknj/hoteldetail. Rates are US$99 per night for single/double occupancy in a room with one king or two double beds. Amenities include complimentary hot breakfast, complimentary highspeed WiFi, microwave and mini fridge in each sleeping room, exercise room, on-site business center, indoor heated pool, and parking. This property is located approximately 6.63 miles (11 minutes) driving distance from the campus. Cancellation and early check-out policies vary and penalties exist at this property; be sure to check when you make your reservation. The deadline for reservations at this rate is **October 13, 2015**.

Holiday Inn South Plainfield-Piscataway, 4701 Stelton Road, South Plainfield, NJ, 908-753-5500; 202-293-2100; www.ihg.com/holidayinn/hotels/us/en/south-plainfield/pnfnj/hoteldetail. Rates are US$119 per night for a single or double occupancy room. Amenities include complimentary hot breakfast, complimentary highspeed WiFi throughout the hotel, mini fridge in each sleeping room, exercise room, on-site business center, indoor heated pool, on-site *Ruby Tuesday's* restaurant, and parking. This property is located approximately 6.6 miles (12 minutes) driving distance from the campus. Cancellation and early check-out policies vary and penalties exist at this property; be sure to check when you make your reservation. The deadline for reservations at this rate is **October 13, 2015**.

Homewood Suites by Hilton - Somerset, 101 Pierce St., Somerset, NJ, 732-868-9155; homewoodsuites3.hilton.com/en/hotels/new-jersey/homewood-suites-by-hilton-somerset. Rates are US$129 per night for single/double occupancy in a studio suite or US$159 for single/double occupancy in a one bedroom suite. Amenities include complimentary all-day beverage service and complimentary hot breakfast, complimentary

highspeed WiFi, fully equipped kitchen, exercise room, on-site business center, indoor heated pool, convenience store, and parking. This property is located approximately 6.63 miles (11 minutes) driving distance from the campus. Cancellation and early check-out policies vary and penalties exist at this property; be sure to check when you make your reservation. The deadline for reservations at this rate is **October 13, 2015**.

The University also recommends the following properties for lodging while in New Brunswick. However, it is anticipated that there may be limited availability at these properties, a reduced rate has not been established, and there is not a block of rooms specifically reserved for the meeting.

The Heldrich, 10 Livingston Ave, New Brunswick, NJ, 732-729-4670; www.theheldrich.com.

The Rutgers University Inn and Conference Center, 178 Ryders Lane, New Brunswick, NJ, 732-932-6952; ruicc.rutgers.edu.

Food Services

On Campus: Campus dining options may be limited on the weekend and are subject to change; please watch the web, review the printed program, and visit the registration desk on-site for more complete details.

For those wishing to stay on campus, there is a food court located nearby at the College Avenue Student Center. At the time of publication, vendors located at the Center included *Wendy's, Gerlanda's Pizza Cafe, Subway, Pita King Palace, au bon pain*, and *Currito*.

Off Campus: There are many dining choices for casual dining and "grab and go"options convenient to campus. Some inexpensive options, suitable for lunch or dinner include:

Destination Dogs, gourmet sausages and hot dogs; 101 Paterson Street, New Brunswick, NJ; (732-993-1016); www.destinationdogs.com

Efes Grill, Mediterranean and Turkish cuisine; 32 Easton Avenue, New Brunswick, NJ; (732-249-4100); www.efesgrill.com

Evelyn's Restaurant, Mediterranean and Lebanese cuisine; 45 Easton Ave, New Brunswick, NJ; (732-246-8792); www.evelynsrestaurant.com

Harvest Moon Brewery, Handcrafted beers and unique American cuisine; 392 George Street, New Brunswick, NJ; (732-249-6666); www.harvestmoonbrewery.com

Old Man Raffertys, Classic American fare; 106 Albany St, New Brunswick, NJ; (908-904-9731); www.oldmanraffertys.com

Some more expensive options, suitable for dinner, include:

Clydz, Creative American cuisine featuring game, seafood, and some vegetarian options; 55 Patterson St., New Brunswick, NJ; (732-846-6521); www.clydz.com

Due Mari, Fresh seafood and Italian cusine; 78 Albany St., New Brunswick, NJ; (732-296-1600); duemarinj.com

Hotoke, Contemporary Asian restaurant, lounge and sushi bar; 350 George St., New Brunswick, NJ; (732-246-8999); www.hotokerestaurant.com

Frog and Peach, Locally sourced take on Modern American cuisine; 29 Dennis St., New Brunswick, NJ; (732-846-3216); frogandpeach.com

More information on restaurants located in the Rutgers area can be found at www.newbrunswick.com.

Registration and Meeting Information

Advance Registration: Advance registration for this meeting opened on August 3. Advance registration fees will be US$57 for AMS members, US$80 for nonmembers, and US$5 for students, unemployed mathematicians, and emeritus members.

On-site Information and Registration: The registration desk, the AMS book exhibit, all Special Sessions, and Invited Addresses will all be located in Scott Hall. For further information on building locations, a campus map is available at rumaps.rutgers.edu/location/scott-hall.

The registration desk will be open on Saturday, November 14, 7:30 a.m.-4:00 p.m. and Sunday, November 15, 8:00 a.m.-12:00 p.m. Fees are US$57 for AMS members, US$80 for nonmembers, and US$5 for students, unemployed mathematicians, and emeritus members. Fees are payable on-site via cash, check, or credit card.

Special Needs: It is the goal of the AMS to ensure that its conferences are accessible to all, regardless of disability. The AMS will strive, unless it is not practicable, to choose venues that are fully accessible to the physically handicapped.

If special needs accommodations are necessary in order for you to participate in an AMS Sectional Meeting, please communicate your needs in advance to the AMS Meetings Department by:

- Registering early for the meeting
- Checking the appropriate box on the registration form, and
- Sending an email request to the AMS Meetings Department at mmsb@ams.org or meet@ams.org.

Other Activities

Book Sales: Stop by the on-site AMS bookstore and review the newest titles from the AMS, enjoy up to 25% off all AMS publications, or take home an AMS t-shirt!

Complimentary Coffee will be served courtesy of AMS membership services.

AMS Editorial Activity: An acquisitions editor from the AMS book program will be present to speak with prospective authors. If you have a book project that you wish to discuss with the AMS, please stop by the book exhibit.

Local Information and Maps

This meeting will take place on the College Avenue campus of Rutgers University. An interactive campus map can be found at maps.rutgers.edu/campus/collegeave. Information about the Rutgers Department of Mathematics can be found at math.rutgers.edu. Please watch the website available at www.ams.org/meetings/sectional/sectional.html for additional information on this meeting. Please visit the Rutgers University website at www.rutgers.edu for additional information on the campus. Wi-Fi will be available for meeting participants in Scott Hall. Details about accessing this network will be available

on-site at the registration desk. Wi-Fi access via Eduroam will also be available in the nearby College Avenue Student Center.

Parking

Arrangements will be made for designated parking lots for meeting participants for the dates of the meeting. Please visit the AMS website in the fall for more details about parking on campus and information about specific approved locations for parking.

Travel

Rutgers University's College Ave. Campus is located in the historic heart of Rutgers University—New Brunswick. The meeting will take place in Scott Hall located at 43 College Avenue, New Brunswick, NJ.

By Air: Newark Liberty International Airport (www.panynj.gov/airports/newark-liberty) is the closest and most convenient airport to the University.
From the airport, you can use AirTrain Newark to travel by train to New Brunswick. AirTrain connects NJ TRANSIT and Amtrak with Newark Liberty International Airport. More information is available here: www.panynj.gov/airports/ewr-airtrain.html. Passengers are required to use the AirTrain Newark system to connect to a NJ TRANSIT or an Amtrak train. There is a US$5.50 ticket fee. Public Bus Service is available through NJ Transit Bus Lines 28, 37, 62, 67, 107. For schedules and information, visit the NJ TRANSIT website at www.njtransit.com. Private shuttle service is available through Carmel Super Saver (www.carmellimo.com), ETS Airport Shuttle (www.etsairportshuttle.com), and Dial 7 Car and Limousine Service (www.dial7.com). Taxi stands are located at the airport—to obtain ground transportation information, please visit the Port Authority Welcome Center located in the arrivals area of each terminal, where uniformed staff will be happy to assist you. A sample one-way taxi fare from Newark Liberty International Airport to New Brunswick may average US$59.

By Train: New Jersey Transit operates a major station in New Brunswick on the Northeast Corridor line; the station is a short trip from a main Amtrak rail station at Metropark in Iselin. For information about Amtrak please visit their website at www.amtrak.com. This may require changing trains in Trenton or NY/Penn Station. Amtrak info is also available at 1-800-USA-RAIL; NJ Transit can be reached at 1-800-772-2222 from inside NJ and from out of state at 1-973-762-5100.

By Bus: The Newark region is served by Greyhound Lines; reservations can be made at www.greyhound.com. Suburban Transit also services the area. For more information about schedules, please visit their website at www.coachusa.com/suburban/.

By Car: Please note that Rutgers University has five campuses in New Brunswick. Road signs marked "Rutgers University" may lead to the wrong campus—please look for the College Avenue Campus.

From the New Jersey Turnpike (North or South): Turn off at Exit 9, bear right after the toll booths and follow signs for "Route 18 North–New Brunswick." Stay to the left to continue on Route 18 North. Proceed along Route 18 North and stay in the Route 18 North–Piscataway lane. Take the "George Street–Rutgers University–College Avenue Campus" exit (approximately 2.6 miles from the Turnpike).

At the traffic light at the top of the exit ramp, bear right on George Street to head toward the Student Activities Center and Alexander Library, or turn left on George Street to head toward the Zimmerli Art Museum, Old Queens, and downtown New Brunswick.

From the Garden State Parkway (Southbound): Turn off at Exit 129 for the New Jersey Turnpike and head south. Then follow the directions listed above for the New Jersey Turnpike.

From the Garden State Parkway (Northbound): Turn off at Exit 105 and follow signs for Route 18 North. After approximately 24 miles, you will pass the entrance for the New Jersey Turnpike. Then follow the directions listed above for the New Jersey Turnpike.

For alternate driving directions using other routes (including Route 1 and Route 287), please visit the Rutgers website at newbrunswick.rutgers.edu/visit/directions-rutgers-university#PublicTransit.

Car Rental: Hertz is the official car rental company for the meeting. To make a reservation accessing our special meeting rates online at www.hertz.com, click on the box "I have a discount", and type in our convention number (CV): 04N30005. You can also call Hertz directly at 800-654-2240 (US and Canada) or 1-405-749-4434 (other countries). At the time of reservation, the meeting rates will be automatically compared to other Hertz rates and you will be quoted the best comparable rate available.

For directions to campus, inquire at your rental car counter.

Local Transportation

Taxi Service: Licensed, metered taxis are available in the New Brunswick/Piscataway area. Some providers listed on the Rutgers website include ABC Taxi and Limo (848-247-1200), Franklin Taxi and Limo (845-545-6060), and Victory Taxi Association (848-545-6666).

Bus and Train Service: Public transportation options to travel to and from the New Brunswick Campus include bus, light rail and commuter rail options. Information on public transportation can be found on the NJ Transit website at www.njtransit.com.

One option on campus for transportation is BrunsQuick Shuttles (rudots.rutgers.edu/campusbuses.shtml). This is a free service provided by Rutgers University, the city of New Brunswick, and the New Brunswick Parking Authority (NBPA) which provides transportation for the Rutgers/New Brunswick communities to parts of the College Avenue Campus, the New Brunswick Train Station, the College of Nursing/Institute for Health, parts of the Fifth & Sixth Wards of New Brunswick, and to the Colony House at Buccleuch Park. The New BrunsQuick Shuttle 1 route travels around in a loop that services the New Brunswick Train Station (starting from the bus stop on the Somerset Street side of the Train Station), the College of Nursing, the Fifth & Sixth Wards, the Colony House (between 6–9 AM and 4–7 PM only), the Rutgers Student Center (RSC), Scott Hall, then back to the Train Station in

that order. These times and this schedule are subject to change. Please visit the Rutgers Department of Transportation website for more information.

Weather

The average high temperature for November is approximately 55 degrees Fahrenheit, and the average low is approximately 35 degrees Fahrenheit. Visitors should be prepared for inclement weather and check weather forecasts in advance of their arrival.

Information for International Participants

Visa regulations are continually changing for travel to the United States. Visa applications may take from three to four months to process and require a personal interview, as well as specific personal information. International participants should view the important information about traveling to the US found at travel.state.gov/content/visas/english.html and travel.state.gov/content/visas/english/general/all-visa-categories.html. If you need a preliminary conference invitation in order to secure a visa, please send your request to mac@ams.org.

If you discover you do need a visa, the National Academies website (see above) provides these tips for successful visa applications:

* Visa applicants are expected to provide evidence that they are intending to return to their country of residence. Therefore, applicants should provide proof of "binding" or sufficient ties to their home country or permanent residence abroad. This may include documentation of the following:

- family ties in home country or country of legal permanent residence
- property ownership
- bank accounts
- employment contract or statement from employer stating that the position will continue when the employee returns;

* Visa applications are more likely to be successful if done in a visitor's home country than in a third country;

* Applicants should present their entire trip itinerary, including travel to any countries other than the United States, at the time of their visa application;

* Include a letter of invitation from the meeting organizer or the US host, specifying the subject, location and dates of the activity, and how travel and local expenses will be covered;

* If travel plans will depend on early approval of the visa application, specify this at the time of the application;

* Provide proof of professional scientific and/or educational status (students should provide a university transcript).

This list is not to be considered complete. Please visit the websites above for the most up-to-date information.

Social Networking

Attendees and speakers are encouraged to tweet about the meeting using the hashtag #AMSmtg.

Seattle, Washington

Washington State Convention Center and the Sheraton Seattle Hotel

January 6–9, 2016

Wednesday – Saturday

Meeting #1116

Joint Mathematics Meetings, including the 122nd Annual Meeting of the AMS, 99th Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).

Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: October 2015
Program first available on AMS website: November 1, 2015
Issue of *Abstracts*: Volume 37, Issue 1

Deadlines

For organizers: Expired
For abstracts: September 22, 2015

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/national.html.

Joint Invited Addresses

Jennifer Chayes, Microsoft Research, *Title to be announced* (MAA-AMS-SIAM Gerald and Judith Porter Public Lecture).

Kristin Lauter, Microsoft Research, *Title to be announced* (AMS-MAA Invited Address).

Xiao-Li Meng, Harvard University, *Title to be announced* (AMS-MAA Invited Address).

Karen E. Smith, University of Michigan, *Title to be announced* (AWM-AMS Noether Lecture).

AMS Invited Addresses

Panagiota Daskalopoulos, Columbia University, *Title to be announced.*

Alex Eskin, University of Chicago, *The $SL(2,\mathbb{R})$ action on moduli space.*

Timothy A. Gowers, University of Cambridge, *Generalizations of Fourier analysis, and how to apply them (Part I)* (AMS Colloquium Lectures: Lecture I).

Timothy A. Gowers, University of Cambridge, *Generalizations of Fourier analysis, and how to apply them (Part II)* (AMS Colloquium Lectures: Lecture II).

Timothy A. Gowers, University of Cambridge, *Generalizations of Fourier analysis, and how to apply them (Part III)* (AMS Colloquium Lectures: Lecture III).

Marta Lewicka, University of Pittsburgh, *Title to be announced.*

Daniel A. Spielman, Yale University, *Title to be announced* (AMS Josiah Willard Gibbs Lecture).

David Vogan, Massachusetts Institute of Technology, *Conjugacy classes and group representations* (AMS Retiring Presidential Address).

Steven M. Zelditch, Northwestern University, *Title to be announced.*

AMS Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `jointmathematicsmeetings.org/meetings/abstracts/abstract.pl?type=jmm`.

Some sessions are cosponsored with other organizations. These are noted within the parentheses at the end of each listing, where applicable.

Advances in Free Analysis: the Theory and Applications of Noncommutative Functions, Inequalities, and Domains (Code: SS 26A), **Joseph A. Ball**, Virginia Polytechnic Institute, and **Paul S. Muhly**, University of Iowa, Iowa City.

Advances in the Theory and Application of Reaction Diffusion Models (Code: SS 38A), **Jerome Goddard, II**, Auburn University, and **Ratnasingham Shivaji**, University of North Carolina, Greensboro.

Algebraic Theory of Differential and Functional Equations (Code: SS 40A), **Taylor Dupuy**, Hebrew University of Jerusalem and University of Vermont, and **Alexey Ovchinnikov**, CUNY Queens College, New York.

Algebraic and Topological Methods in Combinatorics (Code: SS 3A), **Andrew Berget**, Western Washington University, **Steven Klee**, Seattle University, and **Isabella Novik**, University of Washington, Seattle.

Analysis and Geometry in Nonsmooth Metric Measure Spaces (Code: SS 5A), **Luca Capogna**, Worcester Polytechnic Institute, and **Jeremy Tyson**, University of Illinois at Urbana-Champaign.

Analysis, Geometry, and Data (Code: SS 43A), **Kevin R. Vixie**, Washington State University, Pullman, and **Bala Krishnamoorthy**, Washington State University, Vancouver.

Analytic Function Spaces and Operators on Them (Code: SS 62A), **Tim Ferguson** and **Hyun Kwon**, University of Alabama, Tuscaloosa.

Analytic Methods in Geometry (Code: SS 55A), **Eric Bahuaud** and **Dylan Helliwell**, Seattle University.

Applications of Logic, Model Theory, and Theoretical Computer Science to Systems Biology (Code: SS 20A), **James Lynch**, Clarkson University, and **Leo Marcus**, Santa Monica, CA (AMS-ASL).

Applied and Computational Topology (Code: SS 23A), **Pawel Dlotko**, INRIA Saclay, France, **Nicholas Scoville**, Ursinus College, and **Matthew Wright**, IMA University of Minnesota.

Arithmetic Dynamics (Code: SS 8A), **Matthew Baker**, Georgia Institute of Technology, and **Joseph Silverman**, Brown University.

Big Demand for Big Data: How Do We Create the Big Supply? (Code: SS 74A), **Rick Cleary**, Babson College, and **Xiao-Li Meng**, Harvard University.

Classification Problems in Operator Algebras (Code: SS 45A), **Marcel Bischoff** and **Ben Hayes**, Vanderbilt University.

Combinatorial Design Theory (Code: SS 60A), **Esther R. Lamken**, California Insitute of Technology.

Commutative Algebra (Code: SS 37A), **Karen Smith**, University of Michigan, Ann Arbor, **Emily Witt**, University of Utah, and **Irena Swanson**, Reed College (AMS-AWM).

Commutative Algebra and Its Interactions with Algebraic Geometry (Code: SS 47A), **Daniel Hernández**, University of Utah, **Jack Jeffries**, University of Michigan, Ann Arbor, and **Karl Schwede**, University of Utah (AMS-AWM).

Commutative Algebra, I (a Mathematics Research Communities Session) (Code: SS 75A), **Linquan Ma**, University of Utah, **Sarah Mayes-Tang**, Quest University, and **Jonathan Moñtano**, University of Kansas.

Current Areas of Interest in the Mathematical Sciences of Medieval Islam (Code: SS 35A), **Mohammad K. Azarian**, University of Evansville, and **Mohammad Javaheri** and **Emelie A. Kenney**, Siena College.

Data-Intensive Modeling in Ecology (Code: SS 57A), **Nikolay Strigul**, Washington State University, Vancouver, and **Bala Krishnamoorthy**, Washington State University, Vancouver.

Difference Equations and Applications (Code: SS 6A), **Michael A. Radin**, Rochester Institute of Technology.

Distribution of Zeros of Entire Functions (Code: SS 48A), **Matthew Chasse**, Rochester Institute of Technology, **Tamás Forgács**, California State University, Fresno, and **Andrzej Piotrowski**, University of Alaska Southeast, Juneau.

Early Career Female Mathematicians in Algebra and Topology (Code: SS 33A), **Jocelyn Bell**, United States Military Academy, West Point, **Bethany Kubik**, University of Minnesota, Duluth, and **Candice Price**, Sam Houston State University.

Equations of Fluid Motion (Code: SS 63A), **Elaine Cozzi** and **Radu Dascaliuc**, Oregon State University, and **James P. Kelliher**, University of California, Riverside.

Essential Mathematical Structures and Practices in K–12 Mathematics (Code: SS 67A), **William McCallum**, University of Arizona, Tucson, **Kristin Umland**, University of New Mexico, and **Ellen Whitsides**, University of Arizona, Tucson.

Fractal Geometry and Dynamical Systems (Code: SS 13A), **John Rock**, Cal Poly Pomona, **Machiel van Frankenhuijsen**, Utah Valley University, and **Michel L. Lapidus**, University of California, Riverside.

Geometric and Categorical Methods in Representation Theory (Code: SS 11A), **Anthony Licata**, Australian National University, and **Julia Pevtsova**, University of Washington, Seattle.

Global Harmonic Analysis (Code: SS 70A), **Steven Zelditch**, Northwestern University, **Hart Smith**, University of Washington, Seattle, and **Chris Sogge**, Johns Hopkins University.

Graduate Mathematics Courses and Programs for Secondary Mathematics Teachers (Code: SS 36A), **James J. Madden**, Louisiana State University, Baton Rouge, and **James A. Mendoza Epperson**, University of Texas, Arlington.

Graph Products (Code: SS 9A), **Richard Hammack** and **Dewey Taylor**, Virginia Commonwealth University.

Higher Genus Curves and Fibrations of Higher Genus Curves in Mathematical Physics and Arithmetic Geometry (Code: SS 49A), **Andreas Malmendier**, Utah State University, Logan, and **Tony Shaska**, Oakland University, Rochester.

Innovative Ideas in Enhancing Success in Mathematics Classes (Code: SS 19A), **Natali Hritonenko**, Prairie View A&M University, **Ellina Grigorieva**, Texas Woman's University, and **Michael A. Radin**, Rochester Institute of Technology (AMS-MAA).

Integrable Systems, Painlevé Equations, and Random Matrices (Code: SS 64A), **Anton Dzhamay**, University of Northern Colorado, **Christopher M. Ormerod**, California Institute of Technology, and **Virgil U. Pierce**, University of Texas-Pan American.

Interactions between Noncommutative Algebra, Algebraic Geometry, and Representation Theory (Code: SS 2A), **Ellen Kirkman**, Wake Forest University, and **James Zhang**, University of Washington.

Knots in Washington (State) (Code: SS 41A), **Allison Henrich**, Seattle University, **Sam Nelson**, Claremont McKenna College, **Jozef Przytycki**, George Washington University, and **Radmila Sazdanovic**, North Carolina State University, Raleigh.

Mathematical Information in the Digital Age of Science (Code: SS 65A), **Patrick Ion**, University of Michigan, Ann Arbor, **Olaf Teschke**, zbMATH, Berlin, and **Stephen Watt**, University of Western Ontario.

Mathematical Programming on Integral Invexity (Code: SS 7A), **Ram Verma**, Texas State University, San Marcos, and **Alexander Zaslavski**, Israel Institute of Technology.

Mathematics and Public Policy (Code: SS 54A), **Paul Dreyer**, RAND Corporation.

Mathematics in Natural Resource Modeling (Code: SS 29A), **Catherine A. Roberts**, College of the Holy Cross, and **Shandele M. Henson**, Andrews University.

Metrical and Topological Fixed Point Theory with Applications (Code: SS 69A), **Clement Boateng Ampadu**, Boston, MA, **Talat Nazir**, Mälardalen University, Sweden, and **Hudson Akewe**, University of Lagos, Nigeria.

Modular Forms, q-Series, and Mathematics Inspired by Ramanujan (Code: SS 51A), **Chris Jennings-Shaffer**, University of Florida, Gainesville, and Oregon State University, Corvallis, and **Holly Swisher**, Oregon State University, Corvallis.

Moduli Spaces in Algebraic Geometry (Code: SS 66A), **Yaim Cooper**, Harvard University.

Moduli Spaces in Symplectic Geometry (Code: SS 50A), **Nathaniel Bottman**, MIT, **Joel Fish**, IAS, Princeton, and the University of Massachusetts, Boston, **Sheel Ganatra**, Stanford University, and **Katrin Wehrheim**, University of California, Berkeley.

Nonlinear Algebra (Code: SS 4A), **Bernd Sturmfels**, University of California, Berkeley, and **Rekha Thomas**, University of Washington, Seattle.

Nonlinear Waves and Coherent Structures (Code: SS 24A), **Natalie Sheils** and **Chris Swierczewski**, University of Washington, Seattle.

Number Theory and Cryptography (Code: SS 72A), **Matilde Lalin**, University of Montreal, **Michelle Manes**, University of Hawaii, Honolulu, and **Christelle Vincent**, University of Vermont.

Operators, Function Spaces, and Models (Code: SS 22A), **Alberto Condori**, Florida Gulf Coast University, Fort Myers, and **William Ross**, University of Richmond.

Origami Methods and Applications (Code: SS 44A), **Erik Demaine**, MIT, **Thomas C. Hull**, Western New England University, and **Robert J. Lang**, Lang Origami.

Parabolic Geometries, Twistor Theory, and the AdS/CFT Correspondence (Code: SS 39A), **Jonathan Holland** and **George Sparling**, University of Pittsburgh, and **Daniela Mihai**, Carnegie Mellon University.

Partial Differential Equations in Complex Analysis (Code: SS 28A), **Debraj Chakrabarti**, Central Michigan University, and **Yunus Zeytuncu**, University of Michigan, Dearborn.

Problems and Challenges in Financial Engineering and Risk Management (Code: SS 30A), **Matthew Lorig**, University of Washington, Seattle, and **Haijun Li** and **Hong-Ming Yin**, Washington State University, Pullman.

Problems in Geometry and Design of Materials (Code: SS 71A), **Marta Lewicka**, University of Pittsburgh, and **Petronela Radu**, University of Nebraska.

Pseudorandomness and Its Applications (Code: SS 73A), **Timothy Gowers**, University of Cambridge, and **Jozsef Solymosi**, University of British Columbia.

Quantum Walks, Quantum Markov Chains, Quantum Computation and Related Topics (Code: SS 15A), **Chaobin Liu**, Bowie State University, **Takyua Machida**, Japan Sociey for the Promotion of Science, **Salvador E. Venegas-Andraca**, Technológico de Monterrey, Mexico, and **Nelson Petulante**, Bowie State University.

Random and Complex Dynamics of Reaction-Diffusion Systems (Code: SS 27A), **Michael Anton Hoegele**, Universidad de Los Andes, Bogota, Colombia, and **Yuncheng You**, University of South Florida, Tampa.

Recent Advances in Dynamical Systems and Mathematical Biology (Code: SS 46A), **Guihong Fan**, Columbus State University, **Jing Li**, California State University Northridge, and **Hongying Shu**, Tongji University, China.

Recent Advances in Orthogonal Polynomials and Special Functions (Code: SS 17A), **Xiang-Sheng Wang**, Southeast Missouri State University, Cape Girardeau.

Recent Developments in Dispersive Partial Differential Equations and Harmonic Analysis (Code: SS 52A), **William Green**, Rose-Hulman Institute of Technology, Terre Haute, and **Jennifer Beichman**, University of Wisconsin, Madison.

Representation Theory of Algebraic Groups (Code: SS 10A), **Daniel K. Nakano**, University of Georgia, and **Cornelius Pillen**, University of South Alabama.

Research by Posdocs of the Alliance for Diversity in Mathematics (Code: SS 53A), **Aloysius Helminck**, North Carolina State University, Raleigh, and **Michael Young**, Iowa State University, Ames.

Research from the 2014 and 2015 Rocky Mountain-Great Plains Graduate Research Workshop in Combinatorics (Code: SS 58A), **Michael Ferrera**, University of Colorado, Denver, Greeley, **Leslie Hogben**, Iowa State University, Ames, **Paul Horn**, University of Denver, and **Derrick Stolee**, Iowa State University, Ames.

Research in Mathematics by Undergraduates and Students in Post-Baccalaureate Programs (Code: SS 25A), **Dar-**

ren A. Narayan and **Jobby Jacob**, Rochester Institute of Technology, **Tamas Forgacs**, California State University, Fresno, and **Ugur Abdulla**, Florida Institute of Technology (AMS-MAA-SIAM).

Set-Valued Optimization and Variational Problems with Applications (Code: SS 14A), **Baasansuren Jadamba** and **Akhtar A. Kahn**, Rochester Institute of Technology, **Mau Nam Nguyen**, Portland State University, **Miguel Sama**, Universidad Nacional de Educacion a Distancia, Spain, and **Chirstiane Tammer**, Martin Luther University of Halle-Wittenberg.

Special Functions and q-Series (Code: SS 31A), **Richard Askey**, University of Wisconsin, Madison, **Mourad E. H. Ismail**, University of Central Florida and King Saud University, Riyadh, and **Erik Koelink**, Radboud University, Nijmegen, The Netherlands.

Stochastic Effects in Models for Mathematical Biology and Ecology (Code: SS 42A), **Olcay Akman**, Illinois State University, **Timothy D. Comar**, Benedictine University, and **Daniel Hrozencik**, Chicago State University.

Stochastic Models in Population Biology (Code: SS 61A), **Brian Dennis**, University of Idaho, Moscow, and **Eddy Kwessi**, Trinity University.

Surreal Numbers (Code: SS 16A), **Philip Ehrlich**, Ohio University, Athens, and **Ovidiu Costin**, Ohio State University, Columbus (AMS-ASL).

Tensor Decompositions and Secant Varieties (Code: SS 68A), **Zach Teitler**, Boise State University.

The History of Mathematics (Code: SS 34A), **Patti Hunter**, Westmont College, **Adrian Rice**, Randolph-Macon College, **Sloan Despeaux**, Western Carolina University, and **Deborah Kent**, Drake University (AMS-MAA).

The Mathematics of Computation (Code: SS 78A), **Susanne C. Brenner**, Louisiana State University.

Topological Graph Theory: Structure and Symmetry (Code: SS 1A), **Jonathan L. Gross**, Columbia University, and **Thomas W. Tucker**, Colgate University.

Topological Representation Theory (Code: SS 56A), **Charles Frohman**, University of Iowa, Iowa City, and **Helen Wong**, Carelton College.

Water Waves (Code: SS 21A), **John Carter**, Seattle University, **Bernard Deconinck**, University of Washington, Seattle, and **Katie Oliveras**, Seattle University.

What's New in Group Theory? (Code: SS 32A), **Arturo Magidin**, University of Louisiana at Lafayette, and **Elizabeth Wilcox**, Oswego State University of New York.

Athens, Georgia

University of Georgia

March 5–6, 2016

Saturday – Sunday

Meeting #1117

Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: January 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 2

Deadlines

For organizers: Expired
For abstracts: January 19, 2016

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Michele Benzi, Emory University, *Title to be announced.*

Frank Garvan, University of Florida, *Title to be announced.*

William Graham, University of Georgia, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at `www.ams.org/cgi-bin/abstracts/abstract.pl`.

Elliptic Curves (Code: SS 1A), **Abbey Bourdon** and **Pete L. Clark**, University of Georgia.

Lie Theory, Representation Theory, and Geometry (Code: SS 3A), **Shrawan Kumar**, University of North Carolina, and **Daniel K. Nakano** and **Paul Sobaje**, University of Georgia.

Mathematical Physics and Spectral Theory (Code: SS 4A), **Stephen Clark**, Missouri University of Science and Technology, and **Roger Nichols**, The University of Tennessee at Chattanooga.

Probabilistic and Analytic Tools in Convexity (Code: SS 2A), **Joseph Fu**, University of Georgia, **Galyna Livshyts**, Georgia Institute of Technology, and **Elisabeth Werner**, Case Western Reserve University.

Structures in Knot Theory (Code: SS 5A), **Sam Nelson**, Claremont McKenna College, and **Mohamed Elhamdadi**, University of South Florida.

Stony Brook, New York

State University of New York at Stony Brook

March 19–20, 2016

Saturday – Sunday

Meeting #1118

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: January 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 2

Deadlines

For organizers: August 19, 2015
For abstracts: February 2, 2016

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Simon Donaldson, Stony Brook University, *Title to be announced.*

Dmitry Kleinbock, Brandeis University, *Title to be announced.*

Irena Lasiecka, University of Memphis, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Geometric Measure Theory and Its Applications (Code: SS 2A), **Matthew Badger**, University of Connecticut, and **Christopher J. Bishop** and **Raanan Schul**, Stony Brook University.

Invariants of Closed Curves on Surfaces (Code: SS 1A), **Ara Basmajian**, Hunter College and Graduate Center, City University of New York.

Salt Lake City, Utah

University of Utah

April 9–10, 2016

Saturday – Sunday

Meeting #1119

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: January 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 2

Deadlines

For organizers: September 9, 2015
For abstracts: February 16, 2016

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Ravi Vakil, Stanford University, *Cutting and pasting in algebraic geometry* (Erdős Memorial Lecture).

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Algebraic Geometry (association with the Erdős Lecture by Ravi Vakil) (Code: SS 1A), **Ravi Vakil**, Stanford University, and **Christopher Hacon** and **Karl Schwede**, University of Utah.

Inverse Problems (Code: SS 2A), **Hanna Makaruk**, Los Alamos National Laboratory (LANL), and **Robert Owczarek**, University of New Mexico, Albuquerque and UNM, Los Alamos.

Fargo, North Dakota

North Dakota State University

April 16–17, 2016

Saturday – Sunday

Meeting #1120

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: February 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 2

Deadlines

For organizers: September 16, 2015
For abstracts: February 23, 2016

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Rodrigo Banuelos, Purdue University, *Title to be announced.*

Laura Matusevich, Texas A&M University, *Title to be announced.*

Jeff Viaclovsky, University of Wisconsin-Madison, *Title to be announced.*

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Commutative Algebra and Its Interactions with Combinatorics and Algebraic Geometry (Code: SS 4A), **Susan Cooper**, North Dakota State University, and **Adam Van Tuyl**, McMaster University.

Commutative Ring Theory (Code: SS 6A), **Catalin Ciuperca** and **Sean Sather-Wagstaff**, North Dakota State University.

Convexity and Harmonic Analysis (Code: SS 2A), **Maria Alfonseca-Cubero**, North Dakota State University, and **Dmitry Ryabogin**, Kent State University.

Ergodic Theory and Dynamical Systems (Code: SS 1A), **Dogan Comez**, North Dakota State University, and **Mrinal Kanti Roychowdhury**, University of Texas-Pan American.

Frames, Harmonic Analysis, and Operator Theory (Code: SS 7A), **Gabriel Picioroaga**, University of South Dakota, and **Eric Weber**, Iowa State University.

Integrable Dynamical Systems and Special Functions (Code: SS 5A), **Oksana Bihun**, Concordia College.

Mathematical Finance (Code: SS 3A), **Indranil SenGupta**, North Dakota State University.

Brunswick, Maine

Bowdoin College

September 24–25, 2016

Saturday – Sunday

Meeting #1121

Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: June 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 3

Deadlines

For organizers: February 24, 2016
For abstracts: July 19, 2016

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Tim Austin, New York University, *Title to be announced.*

Moon Duchin, Tufts University, *Title to be announced.*

Thomas Lam, University of Michigan, *Title to be announced.*

Denver, Colorado

University of Denver

October 8–9, 2016

Saturday – Sunday

Meeting #1122

Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: August 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 2

Deadlines

For organizers: March 8, 2016
For abstracts: August 16, 2016

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Special Sessions

If you are volunteering to speak in a Special Session, you should send your abstract as early as possible via the abstract submission form found at www.ams.org/cgi-bin/abstracts/abstract.pl.

Algebraic Logic (Code: SS 1A), **Nick Galatos**, University of Denver, and **Peter Jipsen**, Chapman University.

Analysis on Graphs and Spectral Graph Theory (Code: SS 2A), **Paul Horn** and **Mei Yin**, University of Denver.

Nonassociative Algebra (Code: SS 3A), **Izabella Stuhl**, University of Debrecen and University of Denver, and **Petr Vojtěchovský**, University of Denver.

Noncommutative Geometry and Fundamental Applications (Code: SS 4A), **Frederic Latremoliere**, University of Denver.

Operator Algebras and Applications (Code: SS 5A), **Alvaro Arias**, University of Denver.

Recent Trends in Semigroup Theory (Code: SS 6A), **Michael Kinyon**, University of Denver, and **Ben Steinberg**, City College of New York.

Set Theory of the Continuum (Code: SS 7A), **Natasha Dobrinen** and **Daniel Hathaway**, University of Denver.

Unimodularity in Randomly Generated Graphs (Code: SS 8A), **Florian Sobieczky**, University of Denver.

Vertex Algebras and Geometry (Code: SS 9A), **Andrew Linshaw**, University of Denver, and **Thomas Creutzig**, University of Alberta.

Zero Dimensional Dynamics (Code: SS 10A), **Nic Ormes** and **Ronnie Pavlov**, University of Denver.

Minneapolis, Minnesota

University of St. Thomas

October 28–30, 2016

Friday – Sunday

Meeting #1123

Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: August 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 3

Deadlines

For organizers: March 22, 2016
For abstracts: August 30, 2016

The scientific information listed below may be dated. For the latest information, see www.ams.org/amsmtgs/sectional.html.

Invited Addresses

Thomas Nevins, University of Illinois Urbana-Champaign, *Title to be announced.*

Charles Rezk, University of Illinois Urbana-Champaign, *Title to be announced.*

Christof Sparber, University of Illinois at Chicago, *Title to be announced.*

Samuel Stechmann, University of Wisconsin-Madison, *Title to be announced.*

Raleigh, North Carolina

North Carolina State University at Raleigh

November 12–13, 2016
Saturday – Sunday

Meeting #1124
Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: September 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 37, Issue 4

Deadlines
For organizers: April 12, 2016
For abstracts: September 13, 2016

The scientific information listed below may be dated. For the latest information, see `www.ams.org/amsmtgs/sectional.html`.

Invited Addresses

Ricardo Cortez, Tulane University, *Title to be announced.*

Jason Metcalfe, University of North Carolina at Chapel Hill, *Title to be announced.*

Agnes Szanto, North Carolina State University, *Title to be announced.*

Atlanta, Georgia

Hyatt Regency Atlanta and Marriott Atlanta Marquis

January 4–7, 2017
Wednesday – Saturday

Meeting #1125
Joint Mathematics Meetings, including the 123rd Annual Meeting of the AMS, 100th Annual Meeting of the Mathematical Association of America, annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic, with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: October 2016
Program first available on AMS website: To be announced
Issue of *Abstracts*: Volume 38, Issue 1

Deadlines
For organizers: April 1, 2016
For abstracts: To be announced

Charleston, South Carolina

College of Charleston

March 10–12, 2017
Friday – Sunday

Meeting #1126
Southeastern Section
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: November 10, 2016
For abstracts: To be announced

Bloomington, Indiana

Indiana University

April 1–2, 2017
Saturday – Sunday

Meeting #1127
Central Section
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

Pullman, Washington

Washington State University

April 22–23, 2017
Saturday – Sunday

Meeting #1128
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

New York, New York

Hunter College, City University of New York

May 6–7, 2017
Saturday – Sunday

Meeting #1129
Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: September 14, 2016
For abstracts: March 21, 2017

Montréal, Quebec Canada

July 24–28, 2017
Monday – Friday

Meeting #1130
Associate secretary: Brian D. Boe
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

Buffalo, New York

State University of New York at Buffalo

September 16–17, 2017
Saturday – Sunday
Eastern Section
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: February 14, 2017
For abstracts: To be announced

Riverside, California

University of California, Riverside

November 4–5, 2017
Saturday – Sunday
Western Section
Associate secretary: Michel L. Lapidus
Announcement issue of *Notices*: To be announced
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: To be announced
For abstracts: To be announced

San Diego, California

San Diego Convention Center and San Diego Marriott Hotel and Marina

January 10–13, 2018
Wednesday – Saturday
Joint Mathematics Meetings, including the 124th Annual Meeting of the AMS, 101st Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM) and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Georgia Benkart
Announcement issue of *Notices*: October 2017
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: April 1, 2017
For abstracts: To be announced

Baltimore, Maryland

Baltimore Convention Center, Hilton Baltimore, and Baltimore Marriott Inner Harbor Hotel

January 16–19, 2019
Wednesday – Saturday
Joint Mathematics Meetings, including the 125th Annual Meeting of the AMS, 102nd Annual Meeting of the Mathematical Association of America (MAA), annual meetings of the Association for Women in Mathematics (AWM)and the National Association of Mathematicians (NAM), and the winter meeting of the Association of Symbolic Logic (ASL), with sessions contributed by the Society for Industrial and Applied Mathematics (SIAM).
Associate secretary: Steven H. Weintraub
Announcement issue of *Notices*: October 2018
Program first available on AMS website: To be announced
Issue of *Abstracts*: To be announced

Deadlines
For organizers: April 2, 2018
For abstracts: To be announced

Meetings and Conferences of the AMS

Associate Secretaries of the AMS

Central Section: **Georgia Benkart**, University of Wisconsin-Madison, Department of Mathematics, 480 Lincoln Drive, Madison, WI 53706-1388; e-mail: benkart@math.wisc.edu; telephone: 608-263-4283.

Eastern Section: **Steven H. Weintraub**, Department of Mathematics, Lehigh University, Bethlehem, PA 18015-3174; e-mail: steve.weintraub@lehigh.edu; telephone: 610-758-3717.

Southeastern Section: **Brian D. Boe,** Department of Mathematics, University of Georgia, 220 D W Brooks Drive, Athens, GA 30602-7403, e-mail: brian@math.uga.edu; telephone: 706-542-2547.

Western Section: Michel L. Lapidus, Department of Mathematics, University of California, Surge Bldg., Riverside, CA 92521-0135; e-mail: lapidus@math.ucr.edu; telephone: 951-827-5910.

The Meetings and Conferences section of the *Notices* gives information on all AMS meetings and conferences approved by press time for this issue. Please refer to the page numbers cited in the table of contents on this page for more detailed information on each event. Invited Speakers and Special Sessions are listed as soon as they are approved by the cognizant program committee; the codes listed are needed for electronic abstract submission. For some meetings the list may be incomplete. Information in this issue may be dated. Up-to-date meeting and conference information can be found at www.ams.org/meetings/.

Meetings:

2015

October 3–4	Chicago, Illinois	p. 1009
October 17–18	Memphis, Tennessee	p. 1010
October 24–25	Fullerton, California	p. 1011
November 14–15	New Brunswick, New Jersey	p. 1012

2016

January 6–9	Seattle, Washington Annual Meeting	p. 1016
March 5–6	Athens, Georgia	p. 1019
March 19–20	Stony Brook, New York	p. 1019
April 9–10	Salt Lake City, Utah	p. 1020
April 16–17	Fargo, North Dakota	p. 1020
September 24–25	Brunswick, Maine	p. 1021
October 8–9	Denver, Colorado	p. 1021
October 28–30	Minneapolis, Minnesota	p. 1021
November 12–13	Raleigh, North Carolina	p. 1022

2017

January 4–7	Atlanta, Georgia Annual Meeting	p. 1022
March 10–12	Charleston, South Carolina	p. 1022
April 1–2	Bloomington, Indiana	p. 1022
April 22–23	Pullman, Washington	p. 1022
May 6–7	New York, New York	p. 1023
July 24–28	Montréal, Quebec, Canada	p. 1023
September 16–17	Buffalo, New York	p. 1023
November 4–5	Riverside, California	p. 1023

2018

January 10–13	San Diego, California Annual Meeting	p. 1023

2019

January 16–19	Baltimore, Maryland Annual Meeting	p. 1023

Important Information Regarding AMS Meetings

Potential organizers, speakers, and hosts should refer to page 200 in the February 2015 issue of the *Notices* for general information regarding participation in AMS meetings and conferences.

Abstracts

Speakers should submit abstracts on the easy-to-use interactive Web form. No knowledge of LaTeX is necessary to submit an electronic form, although those who use LaTeX may submit abstracts with such coding, and all math displays and similarly coded material (such as accent marks in text) must be typeset in LaTeX. Visit www.ams.org/cgi-bin/abstracts/abstract.pl. Questions about abstracts may be sent to abs-info@ams.org. Close attention should be paid to specified deadlines in this issue. Unfortunately, late abstracts cannot be accommodated.

Conferences in Cooperation with the AMS: (See www.ams.org/meetings/ for the most up-to-date information on these conferences.)

December 16–19, 2015: Amrita School of Engineering hosts the International Conference on Graph Theory and its Applications, Tamil Nadu, India (For further information see https://www.amrita.edu/site/icgta15/.)

AMERICAN MATHEMATICAL SOCIETY

Mathematical Reviews/MathSciNet®
Associate Editor

Applications are invited for a full-time position as an Associate Editor of Mathematical Reviews/MathSciNet, to commence as early as possible in late spring/early summer 2016. The Mathematical Reviews (MR) division of the American Mathematical Society (AMS) is located in Ann Arbor, Michigan, in a beautiful, historic building close to the campus of the University of Michigan. The editors are employees of the AMS; they also enjoy certain privileges at the university. At present, the AMS employs approximately seventy-eight people at Mathematical Reviews, including sixteen mathematical editors. MR's mission is to develop and maintain the MR Database, from which MathSciNet is produced.

An Associate Editor is responsible for broad areas of the mathematical sciences. Editors select articles and books for coverage, classify these items, determine the type of coverage, assign selected items for review to reviewers, and edit the reviews on their return.

The successful applicant will have mathematical breadth with an interest in current developments, and will be willing to learn new topics in pure and applied mathematics. In particular, we are looking for an applicant with expertise in algebraic geometry, or related areas of mathematics, such as commutative rings and algebras or group theory. The ability to write well in English is essential. The applicant should normally have several years of relevant academic (or equivalent) experience beyond the Ph.D. Evidence of written scholarship in mathematics is expected. The twelve-month salary will be commensurate with the experience that the applicant brings to the position. Applications (including a curriculum vitae; bibliography; and the names, addresses, phone numbers, and email addresses of at least three references) should be sent to:

Dr. Edward Dunne
Executive Editor
Mathematical Reviews
P. O. Box 8604
Ann Arbor, MI 48107-8604

email: egd@ams.org
Tel: (734) 996-5257
Fax: (734) 996-2916
URL: www.ams.org/mr-database
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The review of the applications will begin on February 15, 2016 and will continue until the position is filled.

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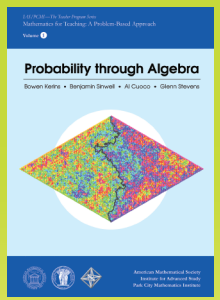


Probability through Algebra

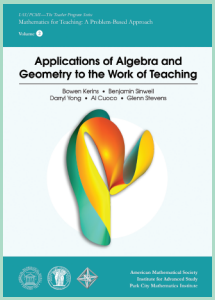
Bowen Kerins, *Education Development Center Inc., Waltham, MA*, **Benjamin Sinwell,** *Pendleton High School, Anderson, SC*, **Al Cuoco,** *Education Development Center Inc., Waltham, MA*, **and Glenn Stevens,** *Cambridge, MA*

This book introduces readers to the algebraic properties of expected value and variance through a collection of problem sets designed to develop interconnected mathematical themes.

IAS/PCMI–The Teacher Program Series, Volume 1; 2015; approximately 175 pages; Softcover; ISBN: 978-1-4704-1925-7; List US$29; AMS members US$23.20; Order code SSTP/1

IAS/PCMI-The Teacher Program Series

This series presents materials from the IAS/PCMI Secondary School Teachers Program, an annual professional development program for teachers specializing in mathematics teaching for grades 3-12. Books in the series are designed to facilitate the SSTP program's goal of improving teacher knowledge via a problem-based approach to learning. Each volume includes a chapter on math concepts, a problem set, and facilitator notes, including solutions and practical tips for running a teacher training session. The series is invaluable for mathematics teacher training programs and for the continuing education of teachers already in practice.

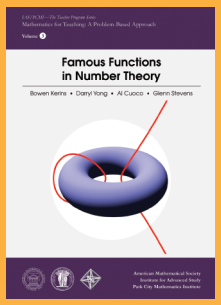


Applications of Algebra and Geometry to the Work of Teaching

Bowen Kerins, *Education Development Center Inc., Waltham, MA*, **Benjamin Sinwell,** *Pendleton High School, Anderson, SC*, **Darryl Yong,** *Harvey Mudd College, Claremont, CA*, **Al Cuoco,** *Education Development Center Inc., Waltham, MA*, **and Glenn Stevens,** *Cambridge, MA*

This book uses a collection of problem sets to develop the use of complex numbers to investigate some questions that are at the intersection of algebra and geometry.

IAS/PCMI–The Teacher Program Series, Volume 2; 2015; approximately 205 pages; Softcover; ISBN: 978-1-4704-1924-0; List US$29; AMS members US$23.20; Order code SSTP/2



Famous Functions in Number Theory

Bowen Kerins, *Education Development Center Inc., Waltham, MA*, **Darryl Yong,** *Harvey Mudd College, Claremont, CA*, **Al Cuoco,** *Education Development Center Inc., Waltham, MA*, **and Glenn Stevens,** *Cambridge, MA*

This book introduces readers to the use of formal algebra in number theory. Through numerical experiments, participants learn how to use polynomial algebra as a bookkeeping mechanism.

IAS/PCMI–The Teacher Program Series, Volume 3; 2015; approximately 216 pages; Softcover; ISBN: 978-1-4704-2195-3; List US$29; AMS members US$23.20; Order code SSTP/3

Titles in this series are co-published with the Institute for Advanced Study/Park City Mathematics Institute. Members of the Mathematical Association of America (MAA) and the National Council of Teachers of Mathematics (NCTM) receive a 20% discount from list price.