

FROM ANTI-GRAVITY TO ZERO-POINT ENERGY:
A TECHNICAL REVIEW OF ADVANCED PROPULSION CONCEPTS

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ABSTRACT

With the general failure of Grand Unification Theories so far to incorporate gravity into electromagnetics, it would appear to the casual observer that little real progress is being made toward truly advanced electrical, or EM-stimulated propulsion. That this is not the case is evidenced by the large number of serious researchers, both theoretical and experimental, who believe that there are other avenues to explore outside the mainstream which will lead to workable systems. This paper is an introduction to the field of advanced and non-conventional propulsion systems which summarizes and correlates the research in an attempt to show that we are closer to truly advanced propulsion technologies than most scientists believe. It should provide sufficient detail to initiate the necessary scientific and engineering peer review to assess the validity of the various approaches outlined.

INTRODUCTION

Conventional propulsion technologies include chemical or ion rockets, rail guns, and acoustic, electrostatic, magnetic or ballistic means for providing motive impulse and may or may not employ aerodynamic means for sustaining lift. They need either a fixed medium or reaction plane (eg. photon sail) or fixed energy source (eg. electromagnetic RF levitation, rail gun) or shed mass during flight (eg. jet engine, rocket). Advanced or non-conventional propulsion technologies generally need no physical medium/reaction plane nor shed mass and may or may not carry their own energy source. They can also be termed Space Coupling or Field Propulsion systems.

Since the mid-1960s world-wide funding for non-classified projects attempting to electrically interact with the local gravitational field for propulsive purposes (originally called 'electro-gravitics') has virtually ceased. Only in the past several years have equally advanced propulsion concepts started to be taken seriously. Examples of experiments from which data has been forthcoming include inducing anisotropy in the local gravitational field by "bucking" EM waves (Zinsser), pulsed high-voltage high-K dielectric propulsion (Woodward/Brown), the motional electric field concept (Hooper), and gravitational coupling

by precessed spinning masses (Wallace). If we extend the idea of electro-gravitics to the electronic and nuclear régimes, several other hypotheses have been put forward. Stimulating super- or anti-gravitational properties by nuclear oscillation phase-locking (Aspden), radiation reaction and self-acceleration of a dipole (Griffiths), gravitation as a function of the time derivative of the Poynting vector (Vallée), 5-D theories including gravitational components in extended Maxwell equations (Williams), paramagnetic (electron) spin resonance-induced gravity decoupling (Alzofon), and charge phase-coherent van der Waals-like gravitational interaction (Dragone) all fit into this category. Proceeding beyond the limits of physical detection, investigations into the so-called Zero-Point Fluctuations (ZPF) have led some researchers to speculate on the use of such energy to power future cosmic ships. Recent theoretical work by Puthoff has indicated the possibility of directly stimulating the local gravitational field by interaction with the ZPF, which may in fact be the mediating agent in gravitational attraction.

This paper does not specifically address the issue of the prime energy source used to drive many of these advanced propulsion systems (eg ZPF) except where postulated by the individual researcher involved.

Several excellent general presentations of advanced propulsion systems have been published.^{1,2,3,4,5,6} The U.S. Dept. of Defense is soliciting proposals for advanced propulsion concepts⁷ and uses the term "Non-Conventional Propulsion" to include:

"all propulsion concepts other than conventional chemical rocket propulsion which is presently used by the Air Force and NASA."

Of a number of areas in which the Air Force is interested, one stands out as relevant to the current paper:

...6) Esoteric energy-sources for propulsion including the zero point quantum dynamic energy of vacuum space and various multi-dimensional theoretical developments offering sources of new energies previously unknown."

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CONSERVATION LAWS

A common objection to such propulsion schemes is the apparent violation of Conservation of Momentum. Upon what do the proposed systems act to enable a ponderable mass to be transferred from one location to another with respect to the fixed stars? In the general case, Millis⁸ has provided an excellent analysis of the situation, arguing that momentum can be conserved by several mechanisms, including

- noting that space is not empty, but filled with radiation including the microwave background, and the very fabric of "empty" space, as well as gravity, may be a manifestation of zero-point vacuum electromagnetic fluctuations
- coupling to distant masses using gravity or Mach's Principle as it relates to the definition of Inertial Frames coupled to distant and local (starship) masses.
- expelling non-mass momentum, eg. photons, gravitons, or hypothetical "space waves"
- negative mass

It is the first two which will govern most of the propulsion schemes described in this paper.

Regarding Conservation of Angular Momentum in particular, Cravens⁹ states

"...the homogeneity of space and time is close enough to preclude determining instantaneous displacement in time and space, but the isotropy of space is not uniform enough to preclude determination of an instantaneous rotation... To break the symmetry of space, a system merely has to rotate... Although energy and linear momentum are true tensors, both parity and angular momentum are psuedotensors. Angular momentum is thus not required to be conserved under inversions and in non-inertial reference frames... This gives a theoretical opening for possible departures from conservation of angular momentum."

CATEGORIZING THE TECHNOLOGIES

The most obvious division of the many technologies and systems described is whether they remain as theoretical constructs or whether actual hardware realizations been built and tested. A division based roughly on physical scale is provided in the Introduction. However, a division more useful to the present paper is an attempt to group technologies by postulated operating principle. Within these divisions, those which have been built and from which experimental data is available will be highlighted.

Such categorization is very difficult as the majority of the systems described remains unproven. Mead¹⁰ and Cravens¹¹ have provided an initial breakdown including

Space Warps

- tunnels, wormholes or additional hyperspace dimension(s) through which travellers or starships might pass

Inductive Field Theories

- gravitation, inertial and EM fields inductively coupled and inseparable

Field Propulsion

- field-field or field-vacuum interaction where the fields can be EM and/or gravity

Structure of Matter

- inductive coupling via certain atomic arrangements eg hypercharge

Spin Coupling

- coupling of EM fields to gravitation and/or inertial frames via spinning matter

Inertial Frames

- coupling to distant masses via referencing position and acceleration

In a sense, all of these categories can be considered variants of "Field Propulsion" as they all will likely rely on the presence of EM fields for their initiation and sustenance or whose analysis can be reduced to such interactions. However, there is enough of a distinction in how these fields would be applied to allow the present division. Although this breakdown is tentative, it may be useful in highlighting parallels from which constructive inferences can be drawn.

SPACE WARPS

Generally considered as the most advanced transportation concept, these schemes suggest travel over intergalactic distances may be possible through a "resonant field" or "hyperspace jump" approach utilizing a bizarre universal interconnectedness resulting from relativistic cosmology whereby if enough energy was concentrated in one small region of space, a wormhole may be formed. This would tunnel through hyperspace to make a distant point in the universe seem only "around the corner".

California Institute of Technology scientists¹² recently proved that stable structures of this type can exist given certain EM configurations and that they may even result in a kind of time machine!

Holt¹³ envisions hyperspace currents flowing between every point in the universe and every other. By "riding" these currents, nearly effortless instantaneous interstellar travel might be possible. To interact with these energy currents, Holt would generate extremely coherent electromagnetic energy patterns thereby reducing or amplifying the ship's local gravitational field. Extensions of this effect may include establishment of field structures which may resonate with similar structures at distant points in space, allowing physical material to be "teleported" thereto. He suggests these coherent patterns of radiation might

be generated in a toroidal configuration containing devices such as high energy lasers, superconducting magnets and electron beams.

Froning¹⁴ has investigated an extra or deeper dimensionality to space from within the context and limitations of General Relativity and Forward¹⁵ has suggested using electric fields of highly charged nuclei in an excited and rapidly spinning state.

INDUCTIVE FIELD THEORIES

Inductive field theories are exemplified by Maxwell equations wherein electric and magnetic fields are inductively coupled (ie derivable one from the other) and manipulation of one effects the other. Small but increasing emphasis has been placed recently on non-Einsteinian, multi-dimensional theories incorporating EM phenomena and gravity.

Williams/Cravens

Cravens¹⁶ has provided an excellent summary and analysis of several inductive field theories and relies heavily on the "Dynamic Theory" of Williams^{17,18,19}, derived generally from thermodynamic considerations. The Dynamic Theory adds a 5th dimension, that of mass density, to the 3 space and 1 time dimensions. This allows consideration of inertia and gravity and results in modifications of Maxwell equations.

The electrostatic divergence equation becomes

$$\nabla \cdot \mathcal{E} - 4\pi \rho = \frac{\partial V_4}{\partial \xi} \quad (1)$$

where ξ is the mass density variable and V_4 are the linear mass effects with respect to the 4 normal dimensions. This means that flux through a closed surface is proportional to the enclosed charge only if there is no mass density change inside the volume and thus calculation of mass density must consider EM flow (including ZPF energy) within the volume.

The magnetodynamic curl equation becomes

$$\nabla \times B - 4\pi J - \frac{\partial \mathcal{E}}{\partial t} = - \frac{\partial V}{\partial \xi} \quad (2)$$

where V is related to the gravitational potential. Hereby, the magnetic field can arise from time varying electric flux and charge flux as well as mass effects resulting in changes in V .

Cravens develops the equivalent Poynting expression

$$\nabla \cdot S + \frac{1}{2} \frac{\partial}{\partial t} (B^2 + \mathcal{E}^2) = \mathcal{E} \cdot (\dot{\mathcal{E}} - \nabla \times B) \quad (3)$$

with the right hand side term being of particular interest. Anomalous energy and momentum should therefore be seen associated with rapidly changing electric fields (Brown/Woodward) or where the curl of the magnetic field reacts with electric fields.

Mass-related terms also enter into the charge conservation (continuity) expression so that

$$\frac{\partial \rho}{\partial t} + \nabla \cdot J + a_0 \frac{\partial J_4}{\partial \xi} = 0 \quad (4)$$

where the additional (third) term is the differential of the mass density "current" multiplied by an EM/gravity coupling constant. This means a mass flow may result from a divergence in the charge current flow and thus possibly lead to antigravitational effects.

Cravens has yet to estimate the coupling constant but work by Woodward and Vallée may help in this regard.

Woodward

By taking an empirical approach to gravity involving changes in mass density and energy density, Woodward²⁰ is attempting to estimate the value of the gravitational/EM coupling constant, which can be likened to a gravitational susceptibility. Early attempts involved updated versions of original suggestions by Faraday that, analogous to the electric-magnetic induction law, perhaps gravity could be detected by time-varying (accelerated) motions of masses. Coupling coefficients on the order of 5×10^{-11} statcoulombs/dyne were found which varied with material. Woodward remarked that it was strange that these values were close c^{-1} but Vallée has addressed this connection. Recently, Woodward²¹ has employed strain gages to measure the gravitational attraction of a rapidly charged 350 gm capacitor having plastic dielectrics switching approx. 10^6 V/m in 100 msec. Evidently, force changes on the order of a few hundredths of a gram were detected. These forces may be accountable within the Poynting derivation (3).

Vallée

Vallée's²² "Synergetic" theory incorporates vacuum energy and gravitation by postulating the existence of an energized medium and calculating an upper limit to the electric field above which pair production (positron/electron) occurs spontaneously. By assigning a momentum to EM phenomena it is shown that the velocity of light is merely a statistical average depending on the medium of propagation, as assumed also by Alzofon. When the velocity of EM radiation is limited to c , the energy of the mass equivalent of the medium allows Vallée to assume that the electric field at any point in space (and thus the vacuum energy density) cannot go to infinity but must have an upper limit \mathcal{E}_d . Within an incremental volume $\delta\tau$ the divergence $\nabla \cdot D$ is non-zero but does not exceed \mathcal{E}_d , which is approx. 4×10^{16} V/m and associated with a cutoff frequency approx. 10^{20} Hz. This is analogous to the process of cavitation in fluids where the physical properties of the medium (space) are modified by the passage of a wave. Note that Cravens estimates frequencies of approx. 10^{22} Hz associated with V_4 representations of stable elementary particles. From optical refraction considerations it is possible to estimate the

energy density of the vacuum ZPF at the earth's surface as 2×10^{20} J/m³. Roos²³ has provided independent verification of this figure using a fluid dynamic analogy.

Regarding gravitation, if we examine differences in velocity of EM radiation in space versus at the earth's surface, the only difference is due to gravitational potential. Using the earth's radius and gravitational constant, this difference in velocities $c - v$ is only .1 m/s. This tiny, virtually unmeasurable difference in c results from the same phenomenon responsible for the gravitational potential. (Millis has approached this gravitational refractive index by considering distance as "stiff" and the speed of light variable with respect to gravity.) This leads to an energetic equivalent of the gravitational field as

$$\frac{\partial E}{\partial \tau} = \rho_0 - \frac{\gamma^2}{8\pi k} \quad (5)$$

where the left side represents the energy density at a point in the gravitational field, ρ_0 represents the vacuum energy density when $\gamma = 0$, γ is the gravitational field and k is the gravitational constant.

Vallée proceeds by suggesting that if mass is equivalent to EM energy bound up in divergent zones, then we can relate gravitation to electromagnetism by showing that gravitational forces are due to differences in density of vacuum energy and consequently of permittivity and permeability. Using Poynting's theory for plane waves, it is possible to calculate the gravitational field associated with an EM wave in the direction of the Poynting vector energy flow as

$$\gamma = \frac{1}{\rho} \frac{d}{dt} (\vec{E} \times \vec{H}) \quad (6)$$

The associated gravitational field is tiny compared to the earth's field due to the inverse dependence on the huge energy density. It is dependent on the time rate of change of the Poynting cross product as well as the strengths of the fields, which must be extremely high for the phenomenon to be measurable, as calculations below will indicate.

One surprising way of looking at this result is to note that if a way is found to extract energy from the ZPF, thus lowering the energy density in a localized region of space, a locally reduced gravitational field will result, and conversely, stimulating a change in the local gravitational field electromagnetically will result in additional EM energy flow into the system from the ZPF.

Puthoff

Sakharov²⁴ first suggested a connection between the ZPF spectrum of an accelerated observer and gravity. Puthoff²⁵ has expanded this conjecture and shown that gravity can be considered equivalent to long-range van der Waals forces and due to radiation rather than induction fields, as also

pointed out by Vallée. Puthoff has recently been involved with the development of Condensed Charge Technology (CCT) an invention of Shoulders²⁶. In these devices, extremely high charge densities can be reached ($10^9 - 10^{12}$ electrons in micron-sized volumes) which, according to Puthoff, are created and maintained by radial Casimir pinch forces and cohere or entrain some additional energy from the ZPF. Puthoff has observed this additional energy generation in recent experiments.

He suggests that by using CCT together with his gravitational theories it may be possible to design a space drive based on controlling the thruster's interaction with the local gravitational field. In fact, according to his theory this type of propulsion, relying on ZPF/gravity interactions, may be a very primitive form when compared to other far more advanced systems based on other ZPF interactions. Froning has also described requirements for ZPF space drives.

Vallée/CCT EM-Gravity Interactions

It is instructive to estimate from the above considerations the charge concentrations, frequencies and characteristic dimensions which may give rise to EM induced gravitational effects. The charge density required to begin to see anomalous gravitational effects in high field strength radial charge concentrations can be derived from (5) and maximum energy density considerations as

$$q = 4\pi r^2 \sqrt{\epsilon \left[\rho - \frac{\gamma^2}{8\pi k} \right]} \quad (7)$$

Using Vallée's vacuum energy density and $r = 1$ micron gives a charge q on the order of 10^9 C. This would mean that approx. 10^{12} electrons would have to be pinched into micron-sized volumes before EM-induced gravitational effects would start to become detectable. This is on the order of current CCT technology.

With the help of equation (6) for linearly polarized plane waves in free space we can write an expression for the maximum value of the associated gravitational field as

$$\gamma_{\max} = \frac{\pi}{2\rho} \sqrt{\frac{\epsilon}{\mu} \mathcal{E}_0^2} \quad (8)$$

In air, the electric field strength for plane waves producing an associated gravitational acceleration equal to 9.81 m/s², is approx. 7×10^{11} V/m. The Dynamic Theory allows Cravens²⁷ to calculate the energetic equivalent of the earth's gravitational field as 4×10^{11} V/m, in agreement with the results of (8).

Finally, we can determine the characteristics of dipole oscillation which may give rise to measurable gravitational effects. Using (6) and following the development found in standard texts in spherical coordinates and extracting real parts and averaging over half cycles gives

$$\gamma = \frac{1}{\rho} \left\{ \frac{4q^2 s^2 \pi f^4}{c^3 r^2 \epsilon_0} \left[-\left(\frac{c}{2\pi r f}\right)^3 + \frac{1}{2} \left(\frac{c}{\pi r f}\right)^2 + \frac{c}{\pi r f} - 1 \right] \right\} \quad (9)$$

The frequency at which the maximum value of the gravitational field occurs turns out to be a constant depending on s and q divided by the distance r to the point of measurement. Knowing this, and using Vallée's value of the vacuum energy density, it is possible to calculate the associated gravitational field under a condition of charge approximately that found in CCT ($q = 10^{-6}$ C) when dipole separation $s = .1$ mm. The average value of the gravitational acceleration associated with the field of such a dipole oscillating at a frequency of 620 GHz felt at a distance of $r = .15$ mm from the dipole centre would be 7.3 m/s^2 compared to earth's 9.8 m/s^2 . At a distance of $r = .5$ mm and frequency of 186 GHz, the average value of the gravitational acceleration drops to $.005 \text{ m/s}^2$.

Although the charge systems described above require extremely high charge concentration as well as tiny dipole separation, they are possible with current technology. It is also apparent that the distances r and s are of the same order. However, assuming the dipoles are embedded in a dielectric, the resulting modification of the local gravitational field should be detectable throughout the dielectric down to very small r .

Radiation Reaction

When a charged particle moves, it accelerates less than a neutral one of the same mass. This is due to the fact that accelerating charges radiate energy and as this removes energy from the system, the kinetic acceleration is less. Most mathematical models of this phenomenon are only approximations, valid at small velocities, and do not address the cause of the radiation reaction. Studies of simple systems of particles, e.g. electric dipoles, has lead to solutions whereby the dipole experiences self-sustained motion with constant acceleration^{28,29}. Griffiths³⁰ notes that this leads to the possibility of self-levitation of such a particle system and invoked an observation of Boyer³¹ that electric field lines "droop" in a gravitational field. Griffiths notes that according to classical theory this phenomenon is unlikely to be witnessed in the laboratory, for if the particles are electrons, their separation would have to be approx. 10^{-15} m before the effect would occur. However, recent work by Whitney and Roos³² may provide alternate mechanisms which would allow this levitation to be measured and used. In addition, CCT charge densities may prove to be sufficient to enlarge the separation distance to physically realizable dimensions.

Soviet Theories

Inductive, 5-D theories have been gaining considerable emphasis in the Soviet Bloc with some researchers treating additional dimensions as physically real as opposed to a mathematical projection³³. An unclassified U.S. report³⁴ states in the summary:

"The Soviets appear to have made significant theoretical progress in dealing with unified field theories... Advancement in this work may provide the basis for whole new concepts in weapons systems, transportation, propulsion, space travel, and others."

One Soviet approach to repulsive gravitational forces involves quantum field theory allowing false vacuum states of matter which can be created by super-rapid cooling of matter from ultra-high temperatures (10^{14} geV). This is analogous to super cooling liquids to well below their freezing point while still remaining liquid. The mechanism theorized for this strong repulsive force is the Higgs scalar field resulting from such a condensation coupled to the gravitational field.

FIELD PROPULSION

Hooper

Of three types of electric fields, namely electrostatic, motional $B \times v$ and transformer induction, Hooper³⁵ investigated the motional field and developed a theory linking it to gravity. He found that with his specially-constructed coils he could produce a field that could not be shielded and had other features in common with the gravitational field. One such coil is constructed from a long conductor folded at its midpoint then coiled into a non-inductive flat pancake form. Hooper states

"...an electronic generator of...the ultra-high frequency direct pulsing motional electric fields...with its $B \times v$ field acting in the opposite direction to the earth's $B \times v$ gravity field on the already polarized atoms in the [generator] would proceed to depolarize them and release them from the earth's gravitational pull."³⁶

Hooper was granted U.S. patent #3,610,971 on the "All-Electric Motional Field Generator" in 1971 and claimed to have witnessed anomalous forces when high currents and electrostatic shielding were used.

Zinsser

Zinsser³⁷ has invented a unique propulsion system based, he claims, on creating a local gravitational anisotropy. His apparatus consists of a special RF ramp generator whose output is fed into a transmission line, and then via capacitive coupling to electrodes in a small vessel of water. The water vessel is mounted on one end of a beam balance which is exactly counterbalanced by an equal weight on the opposite arm. By capacitive means he is able to detect and measure the vertical impulses generated within the water sample. To initiate the propulsive impulses, he sends a high frequency train of sharp pulses down the transmission line

and into the water. A reflected wave of electric and magnetic field components travels back up the line to the generator. By careful design, these components exactly cancel the incident components and the resulting (longitudinal) stress wave travels into the water, which is the electrical "load" of the system. It may be that the phenomenon is describable in terms of equation (3).

It is this resultant field that, according to Zinsser, interacts with the local gravitational field in and around the water and produces tiny unidirectional impulses in the sample. Zinsser's critical speculation is that these induced stresses are cumulative because the metric does not snap back to its former state instantaneously. This means that the load can accumulate a series of impulses if their frequency is high enough. Typical pulse widths are 2.5 nsec or shorter with repetition rates of 100 MHz or higher. If these resulting motive impulses are used to heat water, for instance, the energy transferred to the water, measured calorimetrically, exceeds the input energy by several orders of magnitude.

This "kineto-baric" effect, as he calls it, has produced long lasting impulse trains of several hours duration with peak forces of several thousand dynes (several ounces force) when simulated by a few milliwatts of input power of a few seconds' duration. His most recent observations have confirmed at least a newton-second impulse strength per watt-second energy input. That is, in each second, a force of at least 100 gm is sustained for every RF watt input. If scaled up, this would be equivalent to supporting a man's weight (approx. 100 kg or 1000 newton) using only 1 kW of electrical energy. In terms of simple propulsive efficiency based on newtons per watt, this system can be compared to modern conventional electrical thrusters. These are the Resistojet at .0007 N/W, the Arcjet at .0002 N/W, the Xenon ion thruster at .00005 N/W and the MPD (magnetoplasmadynamic) thruster at .00004 N/W. Based purely on this performance criteria, the Zinsser system is well above 1000 times more efficient than its nearest conventional rival. As well, all the conventional thrusters shed mass during flight.

Consideration of scale must be taken into account, however. So far Zinsser is operating in the tens of gram force (gmf) thrust régime whereas conventional thrusters are operating from 100 gmf (Resistojet) to close to 1,000 gmf (approx. 10 N) for advanced, high-power MPD thrusters. These latter, however, consume several hundred electrical kilowatts.

Brown

Brown^{38,39} discovered what has been called the Biefeld-Brown effect which is usually manifest as a unidirectional thrust in the direction of the positive plate of a capacitor charged to a high DC potential of 50-250 kV. Many other configurations were found to exhibit this thrust, which amounted to about 1 newton force at 150 kV for a 10 kg "gravitor", not including power supply. Brown's investigations led him in many directions including methods of improving the performance of his

gravitors by means of new, high-K dielectrics, the possible use of AC, and new geometries. It seems certain, however, that his basic idea of high voltage across massive dielectrics was essential.

In a recent effort to substantiate Brown's earlier findings, Talley⁴⁰ set up a delicate experiment in high vacuum conditions to determine, amongst other parameters, whether ion wind was primarily responsible for the effect. Talley's negative result casts great doubt on the Biefeld-Brown effect when operated at DC up to 19 kV with no current flow. However, he did note anomalous impulses on certain electrode arrangements when abrupt electrical arcing occurred (ie pulsed current flow at high voltage) around piezoelectric and/or selected dielectric materials. Although the impulses were transient and difficult to quantify, Talley believes they warrant additional research.

It is interesting to note that Cravens⁴¹ predicted this result a year earlier in extending his field theory to include time varying and divergent electric fields as resulting in propulsive impulses.

Wachspress

The Wachspress⁴² concept, although not exotic, is an advanced form of essentially ballistic propulsion based on interaction solely with the earth's magnetic field.

Many others have considered means for accomplishing flight within the earth's magnetic field⁴³ but most have suffered from the classical double dipole instability. This would be observed if a simple north-south dipolar magnet attempted to remain stable while being repelled by the earth's field. It would simply flip over so as to be attracted to the earth instead. Wachspress's invention consists of a tripolar north-south-north electromagnet wound with superconducting wire. This can be envisioned as two cones joined at their tips with the wire coils wound oppositely so as to form one strong south (or north) pole in the centre, ie at the joined tips of the cones, and a north pole at each larger extremity. Three of these double cones are mounted at right angles to each other to provide omnidirectional thrust control. Evidently, this device is to be used as a payload booster to be launched from the surface after being energised by a ground-based power supply of approx. 6 kW for a 170 gm payload providing 250 gm force at liftoff. It will accelerate to a height of 50 miles attaining a velocity of 2500 mph. It is not clear whether LEO will be achieved or whether there will be any possibility of ground-based control during flight.

STRUCTURE OF MATTER

Fischbach/Brush

Fischbach⁴⁴ re-examined the Eotvos experiments and showed that the original observation, that all matter regardless of composition fell with the same acceleration, was in error. He found that depending on the number of protons and neutrons in an atomic nucleus, different elements and different

compositions of elements fall at different rates to one part in 10^9 . Experimental work along these lines carried out by Brush⁴⁵ in the early part of this century determined that certain complex silicates and basalts accelerated at a rate different than 9.8 m/s^2 by one part in 10^4 . Not so far-out speculation might suggest that certain compositions could be engineered and stimulated in such a way as to enhance the effect, thus creating material which requires less, or perhaps even zero thrust to lift it.

Aspden

By postulating a simple lattice model of the ZPF background, Aspden⁴⁶ has been able to derive the basic universal physical constants such as the fine structure constant and the gravitational constant. Observation of the scarcity of the naturally occurring elements promethium and technetium, predicted by his theory, suggested a method of gravity control based on artificially altering the nuclear structure and makeup of certain elements to stimulate super-gravitational or antigravitational properties within them.

He is currently investigating techniques for developing a charge system synchronously locked in phase with harmonics of the gravity (ZPE) oscillations⁴⁷ and controllably segregating the in and out of phase contributors to such oscillations in a concept similar to that of Dragone. This will involve examining how specially-excited ferromagnetic and related materials such as samarium can be tuned into interaction with the gravity oscillations set up in space via earth's mass.

The ultimate product may be a cell which interacts with gravitation and develops a force which can be up or down depending on the cell's orientation, the force being thousands of times the cell's weight, and may be akin to the so-called "gravity shield" of science fiction.

Dragone

The basis of the concept is the mathematical model of the force between two oscillating electrical dipoles predicted by Dragone⁴⁸. This non-zero average force is manifest in the far field region and results from summing the average electric force and the average magnetic force.

Of critical importance is the correct adjustment of the phase of the dipoles' oscillations which results in an attractive force which precisely mimics gravity even in a large assemblage of neutral matter consisting of countless numbers of individual dipoles. According to this view, gravitation is that force which arises from the correlation (ie. coherence) of charges in motion (ie. dipoles) in two distinctly neutral bodies. He therefore suggests that this represents the far-field component of the van der Waals force. The same conclusion was independently reached several years later by Puthoff.

If EM dipole-like radiation in the 10^{12} to 10^{14} Hz frequency range is directed at a "van der Waal's"

solid for a period of time, it might disrupt the chemical bonds and destroy the solid. The same radiation over a long period of time might interfere with the long range coherence between the body's charge motion and that of a nearby locale on the earth and so temporarily disrupt the earth's gravitational hold on the body. The radiation must be maintained long enough to cohere a sufficient population of the body's charges out of phase for de-gravitation to occur, perhaps in a manner similar to Zinsser.

Related experiments have been proposed^{49,50} to study ZPF interactions using intense laser light, a technique also proposed by Dragone, as well as using Rydberg atoms and free electrons.

SPIN COUPLING

Wallace

Wallace^{51,52} believes he has discovered an inertial radiation or "kinemassic field" as he calls it, resulting from rapid spinning and forced precessing of 1/2 integral spin nuclei material, eg brass. As he describes in U.S. patents 3,626,606 and 3,626,605:

"The interaction of the spin nuclei angular momentum with inertial space causes the spin nuclei axes of the respective nuclei of the material being spun to tend to reorient parallel with the [rotating] axis...which [resulting] force field exhibits itself in the form of an induced secondary gravitational force."

He predicts the use of kinemassic field as a propulsion means or a gravity shield or both. Most importantly, he has built and tested apparatus which apparently proves his hypotheses. Recent and controversial evidence from Japan of a weight reduction of a simple spinning flywheel may be further evidence of the kinemassic field as discussed in detail by Aspden⁵³.

Alzofon

Alzofon has developed a unified gravitational theory^{54,55} which led him to propose several experimental tests. The theory is based on a single main assumption that light signals are noisy and what we measure is really only the RMS value of an EM signal that has a noise component derived from random field intensity fluctuations. In contrast to current ZPF and related theories, Alzofon shows that the energy of these fluctuations cannot be infinite.

According to the theory, the propagation of light is accompanied by a continual process of intensity fluctuations which may include particle pair production (positron/ electron), annihilation, etc. An altered metric of space-time due to these processes results in new field equations of motion and four new potentials. The behaviour of EM propagation and fluctuation effects due to vacuum processes is radically different on average from

classically-defined effects even though the mean energy and momentum associated with vacuum processes is zero. The range of fluctuation effects is on the order of the Compton wavelength, h/mc , and negligible beyond, thus eliminating the sharp distinction between matter and radiation as well as eliminating the infinities introduced when $r \rightarrow 0$.

Proceeding by coupling the equations of motion of the free Fermi-Dirac matter-radiation field with the Bose-Einstein field with sources and averaging, he arrives at a non-relativistic expression for the energy

$$E = \frac{1}{2m} (\bar{p} - \frac{e}{c} \bar{A})^2 - \frac{\hbar}{2mc} (e \bar{\sigma} \bar{H} + q' \bar{\zeta} \bar{H}_0) \quad (10)$$

of a particle with magnetic moment $\frac{eh^2}{2mc}$ interacting with the "classical" magnetic field \bar{H} , and magnetic moment $\frac{q'h^2}{2mc}$ interacting with magnetic field \bar{H}_0 due to vacuum fluctuation processes. In this expression

\bar{A} = vector potential of matter-radiation field

$\bar{p} = m \frac{dr}{dt}$ momentum in proper time interval t'

$\bar{\sigma}$ = Hermitian matrix for 1/2 integral particle spin

$\bar{\zeta}$ = Hermitian spin matrix from fluctuations

q' = effective charge due to virtual processes

The field \bar{H}_0 is a high frequency vacuum fluctuation magnetic field not directly observable, but whose RMS effects are observable and associated with the gravitational attraction.

According to (10) it should be possible to alter the gravitational attraction between two bodies by effecting a change in the energy E by means of \bar{H} and \bar{H}_0 . This leads us to consider what effect altering the spin magnetic resonance of atomic nuclei would have on this energy and thus to a consideration of the process of dynamic nuclear orientation (DNO). DNO involves a well-known analytical process used in studies of molecular structure called Electron Paramagnetic (or Spin) Resonance spectroscopy which causes the normally randomly-oriented nucleon spins to align in a magnetic field. By so aligning the spins, the nuclei are magnetically "cooled" in a process analogous to adiabatic demagnetization.

Upon removal of the DNO fields, there is rapid decay into a disordered state due to thermal fluctuations as well as fluctuations in the field giving rise to gravitation. According to (10) during this process the interaction energy between the nuclei's matter-radiation field and that of the earth is reduced resulting in a reduction of the gravitational attraction. Energy is transferred from the earth's field to that of the nuclei in the

process of disorienting the nuclei.

A pulsed oscillating magnetic field is required. During the "off" time of the pulse, fluctuation processes due to the earth's gravitational field will do work on the oriented nuclei to disorient them. Alzofon proposes that an aluminum alloy pulsed at low ghz frequencies in a DNO configuration will lead to a lessening of its gravitational attraction to the earth. A fixed magnetic field of a few hundred oersteds and pulse widths of a few microseconds are required. About 1 J of gravitational energy can be removed from the earth's 6×10^4 J/gm field energy per pulse. Thus an appreciable part of it would be removed in several seconds. A concomitant energy gain to the system from the earth's gravitational field may ensue.

INERTIAL FRAMES

Vance

Vance⁵⁶ has postulated a controversial space drive based on an unique property of the magnetic field. The concept underlying the system is termed a "Force Sink". His system uses a magnetic field produced by Helmholtz coils to deflect a stream of charged particles (electrons or high-Z ions) from a gun onto a stationary target located at a critical point within the field. These charges, eg electrons are then fed back by wire through a power supply to the electron gun to close the electric circuit so no mass is shed. The external power supply provides the energy required to keep the charge flow going.

According to Vance, the unique feature of the magnetic field is that it is stationary in any frame of reference. As the electrons are deflected 90 degrees within the magnetic field, a reaction torque resulting from the change in angular momentum is felt on the coils producing the field and they rotate in response. Because the magnetic field is oriented perpendicular to the electrons' flight, it cannot alter their velocity and this remains unchanged in the stationary frame of the coil/gun assembly. However, with respect to the stationary frame, a net momentum change has occurred due to the deflection of the particles' path. Thus an unbalanced and unidirectional force can continue to exist in this reference frame and thrust results.

Vance has performed a simple mathematical analysis on the drive which shows that the overall power efficiency is at least 1.5 times that of the best available rocket engine. Added to this is the exceptional benefit of not shedding mass.

CONCLUSIONS

It appears likely in the medium term that the most practical advanced propulsion systems will come not from the current direction of high energy particle physics studying the weak and strong forces, but from electromagnetism and gravitational interactions along the lines described above. These EM/ZPF/gravity interactions point to several salient features relevant to realizable engineering solutions.

High rotational speeds, especially of certain kinds of matter, seem to effect both gravitational and inertial forces. Perhaps this is due to the production of certain EM fields by means of the accelerating charges in the spinning matter. Certain substances and compositions may exhibit greater or lesser coupling with the local gravitational field in which they are immersed. Perhaps it will be possible in the future to engineer special materials which, when stimulated by EM radiation and/or subjected to high relative spin rates, will be able to float free of the local gravitational field and even provide propulsive thrust. In this regard, it should be remembered that the gravitational field penetrates matter to a much higher degree than EM radiation. Thus it may be possible to produce extremely high field strengths in high-K dielectrics and still effect the local gravitational field even though the radiators are completely embedded within the dielectric. As well, dielectrics of varying permittivities and permeabilities may be fabricated to enhance the directionality of the resulting thrust. An important side benefit seems to be the release of vast amounts of additional energy from the field when this coupling occurs. Means must therefore be provided for transducing and transporting this excess energy away, perhaps to be recycled and used to augment the prime source.

There have been several significant advances in current technology which may have a direct bearing on the development of these non-conventional propulsion schemes. Micro-fabrication technology has advanced to the point where it will be possible to construct tiny motors less than a hair's width wide capable of extremely high rotational speeds. Why not use an array of millions of etched "micro-rotators" rather than one or two large rotating masses? These same techniques are now capable of etching millions of tiny dipoles on and within various substrates. High-power semi-conductors are capable of switching kilowatts at megahertz frequencies and new pulse-shaping circuits can produce the extremely fast rise times that will be needed (20 kV switched in 150 psec has been achieved). The advent of room-temperature superconductors may provide the required high current paths both to and from the thrust apparatus.

It is apparent that, within these formulations, there is a critical range of parameters from which it may be expected that we shall see EM-induced gravitational and vacuum energetic effects in the laboratory. As some of these parameters have already been achieved it is expected that such phenomena will soon be observed. Perhaps "cold fusion" and claims of other unusual energy systems⁵⁷ and apparent anti-gravitational effects⁵⁸ have some of these theoretical considerations as their bases. Gravitational engineering is currently in an embryonic stage. It is hoped that others skilled in theoretical physics and engineering practice will be able to review and expand on the work presented above and assist in producing a set of engineering principles from which commercial applications may result.

EPPUR SI MUOVE

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