The Southwestern Europe Meteor Network: development of new artificial intelligence tools and remarkable fireballs observed from January to February 2022

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In this work we focus on the development of an artificial intelligence in the framework of the Southwestern Europe Meteor Network (SWEMN) and the SMART project. This is named AIMIE and is capable of writing scientific contributions from fireball data included in the SWEMN database. As an example of the capabilities of AIMIE we also present in this work a report containing the analysis of some of the remarkable fireballs spotted from our meteor-observing stations from January to February 2022. These have been observed over the Iberian Peninsula, and their absolute magnitude ranges from –10 to –13. One of these bolides was a potential meteorite-dropper. The emission spectrum of one of the events is also discussed.

1 Introduction

The Southwestern Europe Meteor Network (SWEMN) is a research project coordinated in Spain from the Institute of Astrophysics of Andalusia (IAA-CSIC) with the aim to analyze the Earth's meteoric environment. This network is also integrated by researchers from the Complutense University of Madrid (UCM), the Public University of Navarre (UPNA), and the Calar Alto Observatory (CAHA). In 2021 we decided to open the project to the amateur community. This Pro-Am collaboration resulted in the deployment of new meteor stations in our country that provide their results to our network.

In order to identify and analyze meteors in the Earth's atmosphere, SWEMN develops the Spectroscopy of Meteoroids by means of Robotic Technologies (SMART) survey (Madiedo, 2014; Madiedo, 2017). And to improve our knowledge about the Earth-Moon meteoric environment, SMART works in close connection with another project conducted by IAA-CSIC: the MIDAS survey (Moon Impacts Detection and Analysis System). MIDAS uses the Moon as a laboratory that provides information about meteoroids hitting the lunar ground (Ortiz et al., 2015; Madiedo et al. 2015a, b). A strong synergy has been proved to exist between this survey and the SMART project (Madiedo et al. 2015a, b).

Recently, we announced the development of the first digital and interactive meteor database containing meteor events recorded over Spain and surrounding regions (Madiedo et al., 2021). And later on, we discussed the development of artificial intelligence (AI) tools designed to handle the contents of this database, and also capable of disseminating in social networks and media information about relevant fireballs recorded by our systems (Madiedo et al., 2022). Now we have gone one step further by developing an AI which is capable of writing a scientific work by employing the information contained in the above-mentioned database. We describe here the main features of this innovative tool, which has been named AIMIE (acronym for Artificial Intelligence with Meteoroid Environment Expertise). We also focus on the description of some of the most remarkable fireballs recorded by our systems from January to February 2022. The report describing these events has been fully written by AIMIE. So, this work is an example of the capabilities of the current version of this new software.

2 New applications of the SWEMN digital database: AIMEE

Software development has been a priority since the SMART project was started in 2006. Thus, this software was necessary in order to calculate meteor trajectories and meteoroid orbits. But also, to analyze meteor spectra and to automate the operation of remote meteor-stations (Madiedo, 2014). In addition, the lack of enough manpower made also necessary to create software tools that could accelerate different parts of the data processing and results dissemination pipeline. The first AI methods employed by the SWEMN network were implemented in the SAMIA software developed by the first author to handle the contents of the SWEMN meteor database and also to automatically derive valuable information from the events contained in it (Madiedo et al., 2021). Next, additional AI methods were implemented to disseminate our scientific results among the general public through social networks (mainly Twitter and Facebook), information media, our website, and also YouTube (Madiedo et al., 2022). Before these tools were available, the time consumed by this dissemination process was very significant, since all of the information necessary for this purpose was gathered manually, and the corresponding reports were also prepared by hand.

The AI in the SAMIA software was recently expanded to write autonomously scientific communications from the information stored in the SWEMN database. This includes abstracts for congresses, but also papers like this one. This AI was named AIMEE, which is the acronym for Artificial Intelligence with Meteoroid Environments Expertise. The user only needs to specify the author's list and, of course, which event(s) must be included in the work. The information stored for each event in the SWEMN database is so comprehensive (Madiedo et al., 2021), that in most cases AIMEE can find there all of the information necessary to prepare the communication. If some information is missing, the IA asks the user to provide it. But AIMEE can also try to find additional information on its own by using external databases. Thus, for instance, it can obtain data about meteoroid streams from the IAU meteor database[7]. And it can find bibliographic references by employing the SAO/NASA Astrophysics Data System (ADS)[8]. In addition, by employing geolocation services, AIMEE can also know the specific and precise geographic areas (country, region, province, city, seas, etc.) that a particular event overflew along its atmospheric trajectory.

The software contains a database with predefined templates for congresses and journals. In this way, AIMEE can compose the text by following the style and maximum length requested in each case. At this moment AIMEE is capable of writing communications for several congresses: EPSC, LPSC, and Meteoroids. But also, for the MeteorNews e-zine. In a near future, templates for peer-review journals will be implemented. The text created by AIMEE is written in MS-Word DOC format and covers the whole work: communication title, authors and their affiliations, abstract, materials and methods, figures, tables, etc. Even the conclusions and references. The user can perform modifications to this text manually or ask the IA to write again a given section of the communication in a different way.

Finally, AIMEE can provide feedback to the SWEMN meteor database if new information was obtained for a specific event during the preparation of the scientific communication.

As an example of the current capabilities of AIMEE, we present below a report prepared by this AI in relation to a series of remarkable bolides recorded by the SWEMN network along January and February 2022. The remaining text appearing in this work below this paragraph was written entirely by AIMEE.

3 Instrumentation and methods

To record the events analyzed in this work we have employed Watec 902H2 and Watec 902 Ultimate cameras. Their field of view ranges from 62 × 50 degrees to 14 × 11 degrees. To record meteor spectra we have attached holographic diffraction gratings (1000 lines/mm) to the lens of some of these devices. We have also employed digital CMOS color cameras (models Sony A7S and A7SII) operating in HD video mode (1920 × 1080 pixels). These cover a field of view of around 70 × 40 degrees. A detailed description of this hardware and the way it operates was given in previous works (Madiedo, 2017).

The atmospheric path and radiant of meteors, and also the orbit of their parent meteoroids, were obtained with the SAMIA software, developed by J. M. Madiedo. This program employs the planes-intersection method (Ceplecha, 1987). The emission spectrum presented in this work was analyzed with the CHIMET software (Madiedo, 2017).

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[7] http://www.astro.amu.edu.pl/~jopek/MDC2007/

[8] https://ui.adsabs.harvard.edu/

Figure 1 – Stacked image of the SWEMN20220102_060558 “Santa Margarida” bolide as recorded from Sevilla.

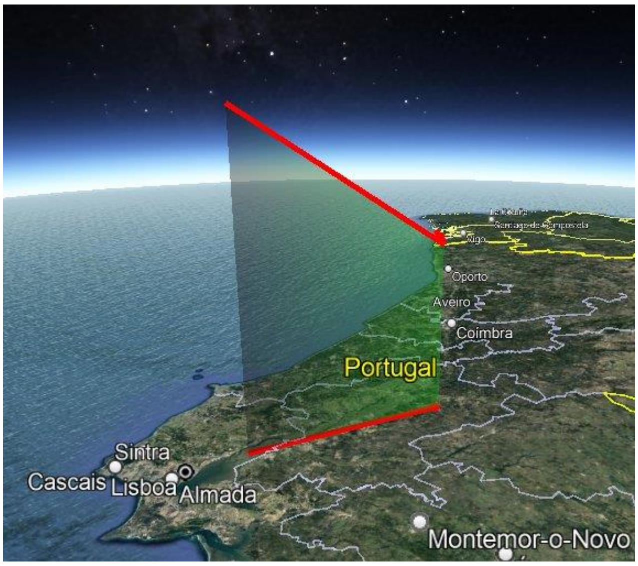

Figure 2 – Atmospheric path and projection on the ground of the trajectory of the SWEMN20220102_060558 meteor.

4 Description of the 2022 January 2 event

We spotted this bright fireball (*Figure 1*) from the meteor-observing stations located at Calar Alto, Sierra Nevada, Sevilla, La Sagra (Granada), Huelva, El Aljarafe, and La Hita (Toledo). The bright meteor was recorded on 2022 January 2, at $6^h05^m58 \pm 0.1^s$ UT. The event had a peak absolute magnitude of –12.0 ± 0.5, and was included in our meteor database with the code SWEMN20220102_060558. A video showing images of the bolide and its trajectory was uploaded to YouTube[9].

Atmospheric trajectory, radiant and orbit

The event overflew Portugal. It began at an altitude $H_b = 119.9 \pm 0.5$ km near from the zenith of the locality of Alhandra, and the terminal point of the luminous path was located at a height $H_e = 62.2 \pm 0.5$ km, over the locality of Santa Margarida. The apparent radiant was located at the equatorial coordinates $\alpha = 146.67°$, $\delta = -4.54°$. Besides, we found that the meteoroid stroke the atmosphere with a velocity $v_\infty = 58.1 \pm 0.4$ km/s. The trajectory in the Earth’s atmosphere of the bright meteor is shown in *Figure 2*.

Table 1 – Orbital data (J2000) of the progenitor meteoroid of the SWEMN20220102_060558 fireball before its encounter with our planet.

a (AU)	13.3 ± 5.8	ω (°)	123.8 ± 01.0
e	0.983 ± 0.006	Ω (°)	101.517026 ± 10^{-5}
q (AU)	0.224 ± 0.004	i (°)	121.0 ± 0.5

This event was named “Santa Margarida”, since the bright meteor was located over this locality during its final phase. The parameters of the heliocentric orbit of the parent meteoroid before its encounter with our planet are included in *Table 1*. The geocentric velocity of the meteoroid was $v_g = 57.3 \pm 0.4$ km/s. These parameters and the derived radiant confirm that the bright meteor was generated by the sigma Hydrids (IAU code HYD#0016) (Jenniskens et al., 2016). According to the value estimated for the Tisserand parameter with respect to Jupiter ($T_J = 0.09$), the meteoroid followed a cometary orbit before impacting the Earth’s atmosphere. *Figure 3* shows the orbit in the Solar System of the meteoroid.

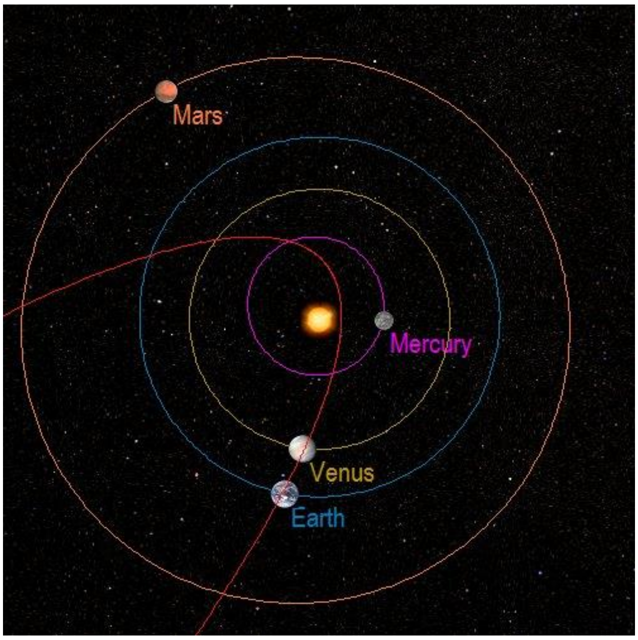

Figure 3 – Projection on the ecliptic plane of the orbit of the SWEMN20220102_060558 event.

5 The 2022 January 9 bolide

This stunning fireball (*Figure 4*) was recorded by our systems on 2022 January 9, at $0^h18^m08 \pm 0.1^s$ UT. The event had a peak absolute magnitude of –13.0 ± 0.5. The bolide was included in our meteor database with the code SWEMN20220109_001808.

Atmospheric path, radiant and orbit

By calculating the luminous path of the bolide we deduced that the event overflew the south of Spain. The ablation process of the meteoroid began at a height $H_b = 103.5 \pm 0.5$

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[9] https://youtu.be/xkLRm1WQNk4

km almost over the locality of Montecorto (province of Cádiz), and the bolide penetrated the atmosphere till a final height $H_e = 31.0 \pm 0.5$ km near from the zenith of the locality of Paradas (province of Sevilla). The apparent radiant was located at the equatorial coordinates $\alpha = 127.24°$, $\delta = –4.67°$. The meteoroid hit the atmosphere with an initial velocity $v_\infty = 41.7 \pm 0.4$ km/s. *Figure 5* shows the atmospheric path of the bright meteor. We named this bright meteor “Montecorto”, because the bolide passed near from the zenith of this locality during its initial phase.

The orbital parameters of the parent meteoroid before its encounter with our planet have been included in *Table 2*. The geocentric velocity obtained for the particle yields $v_g = 40.2 \pm 0.4$ km/s. These values and the calculated radiant confirm that the fireball was generated by the alpha Hydrids (IAU code AHY#0331) (Jenniskens et al., 2016).

Figure 4 – Stacked image of the SWEMN20220109_001808 “Montecorto” bolide as recorded from Calar Alto (CAHA).

Figure 5 – Atmospheric path and projection on the ground of the trajectory of the SWEMN20220109_001808 fireball.

According to the value calculated for the Tisserand parameter referred to Jupiter ($T_J = 1.13$), before striking our atmosphere the particle was moving on a cometary orbit. *Figure 6* shows the orbit in the Solar System of the meteoroid.

Table 2 – Orbital data (J2000) of the progenitor meteoroid before its encounter with our planet.

a (AU)	8.0 ± 1.8	ω (°)	114.7 ± 00.4
e	0.962 ± 0.008	Ω (°)	108.400679 ± 10^{-5}
q (AU)	0.299 ± 0.002	i (°)	44.3 ± 0.5

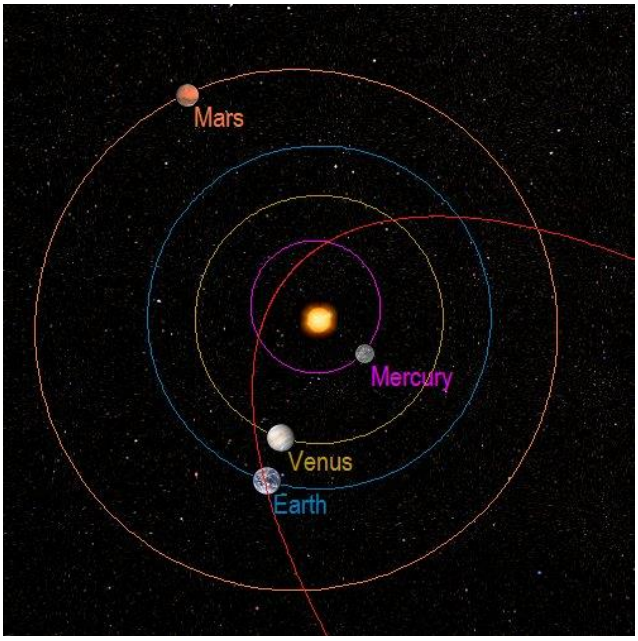

Figure 6 – Projection on the ecliptic plane of the orbit of the SWEMN20220109_001808 “Montecorto” meteor.

6 The 2022 January 14 fireball

We captured this stunning bolide from the meteor-observing stations located at Calar Alto, Sierra Nevada, Sevilla, La Sagra (Granada), Huelva, El Aljarafe, Madrid (Universidad Complutense), and La Hita (Toledo) (*Figure 7*). The fireball was spotted on 2022 January 14, at $21^h27^m07 \pm 0.1^s$ UT and had a peak absolute magnitude of –12.0 ± 0.5. It was included in our meteor database with the code SWEMN20220114_212707. This bright meteor can be viewed on this YouTube video[10].

Atmospheric path, radiant and orbit

According to our calculations, the fireball overflew the south of Spain. Its initial altitude was $H_b = 85.3 \pm 0.5$ km near from the vertical of the locality of Ventillas (province of Ciudad Real). The bolide penetrated the atmosphere till a final height $H_e = 23.6 \pm 0.5$ km near from the vertical of the locality of Solana del Pino (province of Ciudad Real). The position found for the apparent radiant correspond to the equatorial coordinates $\alpha = 63.68°$, $\delta = +39.26°$. The entry velocity in the atmosphere concluded for the parent meteoroid was $v_\infty = 13.6 \pm 0.3$ km/s. The atmospheric path of the luminous event is shown in *Figure 8*.

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[10] https://youtu.be/b7w2qdBY_R4

We named this bright meteor "Ventillas", because the bolide was located near the zenith of this locality during its initial phase. The orbital parameters of the parent meteoroid before its encounter with our planet are included in *Table 3*, and the geocentric velocity derived in this case was $v_g = 7.9 \pm 0.5$ km/s. By taking into account these orbital data and the radiant position, it was concluded that the fireball was generated by a sporadic meteoroid. From the value derived for the Tisserand parameter with respect to Jupiter ($T_J = 3.77$), we found that the meteoroid was moving on an asteroidal orbit before entering our atmosphere. This orbit is shown in *Figure 9*.

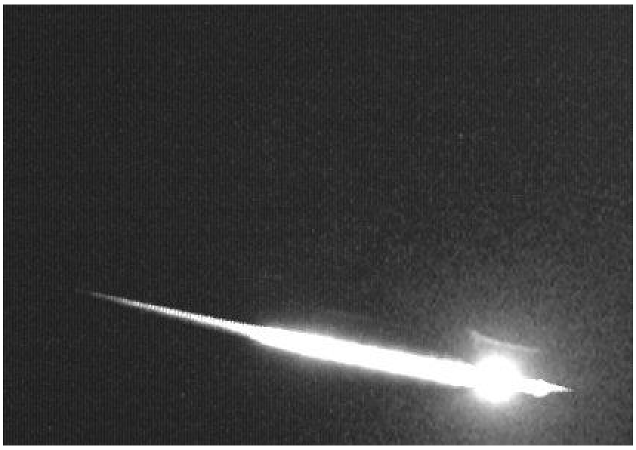

Figure 7 – Stacked image of the SWEMN20220114_212707 "Ventillas" meteor as recorded from La Hita.

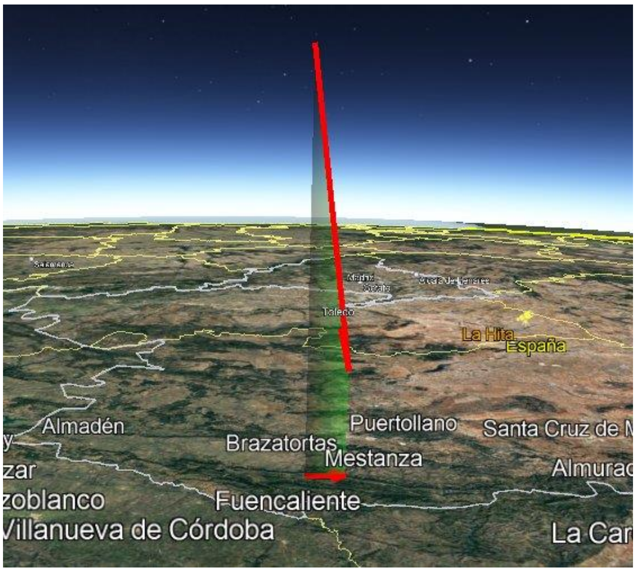

Figure 8 – Projection on the ground of the trajectory of the SWEMN20220114_212707 fireball.

Table 3 – Orbital data (J2000) of the progenitor meteoroid before its encounter with our planet.

a (AU)	1.9 ± 0.1	ω (°)	201.8 ± 00.5
e	0.49 ± 0.03	Ω (°)	294.433674 ± 10^{-5}
q (AU)	0.960 ± 0.001	i (°)	3.9 ± 0.2

Our analysis reveals that the meteoroid was not completely ablated in the atmosphere. Thus, we obtained a non-zero but small (below 50 grams) terminal mass. The dark flight was also analyzed and the landing area of the surviving mass was determined. An expedition was organized to that area by experts in meteorites in collaboration with the SWEMN network. However, the meteorite was not found.

Emission spectrum

The emission spectrum of the bolide was also recorded from the meteor-observing station located at La Hita. This signal was calibrated in wavelength by employing typical lines appearing in meteor spectra, and then corrected by taking into account the sensitivity of the recording device. The resulting calibrated emission spectrum is shown in *Figure 10*. This plot shows the most remarkable lines identified in the spectrum. These contributions correspond to Na I-1 (588.9 nm), Mg I-2 (516.7 nm), Fe I-4 (385.6 nm), Fe I-41 (441.5 nm), Fe I-42, Fe I-43 (414.3 nm), Fe I-15 (526.9 nm), and Fe I-318.

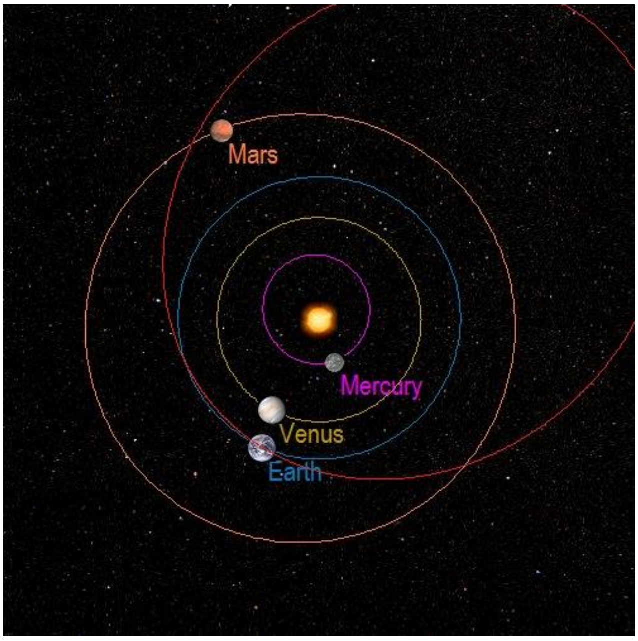

Figure 9 – Projection on the ecliptic plane of the orbit of the SWEMN20220114_212707 event.

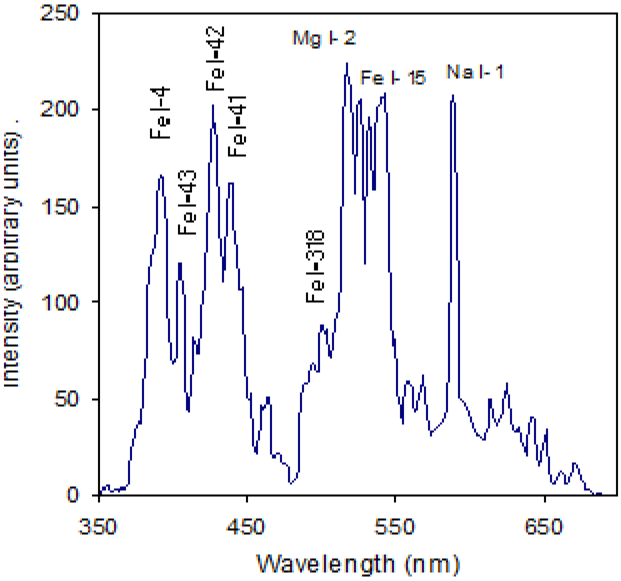

Figure 10 – Calibrated spectrum of the SWEMN20220114_212707 bolide.

7 Description of the 2022 January 18 event

We captured this bright bolide from the meteor-observing stations located at Calar Alto, Sierra Nevada, Sevilla, Huelva y La Sagra (Granada). The event was spotted on 2022 January 18, at $18^h20^m54 \pm 0.1^s$ UT (*Figure 11*). It had a peak absolute magnitude of –11.0 ± 0.5. The fireball was included in our meteor database with the code SWEMN20220118_182054. A video about this bolide can be viewed on YouTube[11]. A wide number of casual observers saw how the bright meteor crossed the sky and reported the event on social networks.

Atmospheric path, radiant and orbit

It was obtained by calculating the trajectory in the atmosphere of the event that the bright meteor overflew the Mediterranean Sea. Its initial altitude was $H_b = 77.1 \pm 0.5$ km over the sea. The bolide penetrated the atmosphere till a final height $H_e = 29.6 \pm 0.5$ km over the sea. From the analysis of the atmospheric path, we also found that the apparent radiant was located at the position $\alpha = 321.69°$, $\delta = +78.04°$. The pre-atmospheric velocity inferred for the meteoroid yields $v_\infty = 14.0 \pm 0.3$ km/s. The path in the atmosphere of the event is shown in *Figure 12*.

Figure 11 – Stacked image of the SWEMN20220118_182054 meteor.

Table 4 – Orbital data (J2000) of the progenitor meteoroid before its encounter with our planet.

a (AU)	1.13 ± 0.02	*ω* (°)	186.8 ± 00.4
e	0.13 ± 0.02	Ω (°)	298.346236 ± 10^{-5}
q (AU)	0.9830 ± 0.0001	*i* (°)	15.6 ± 0.7

The parameters of the heliocentric orbit of the progenitor meteoroid before its encounter with our planet are contained in *Table 4*. The calculated value of the geocentric velocity of this particle is $v_g = 8.6 \pm 0.4$ km/s. With these data and the radiant position, we inferred that the parent meteoroid belonged to the sporadic background. The Tisserand parameter with respect to Jupiter yields $T_J = 5.4$, which shows that this meteoroid was moving on an asteroidal orbit before entering the atmosphere. This orbit is shown in *Figure 13*.

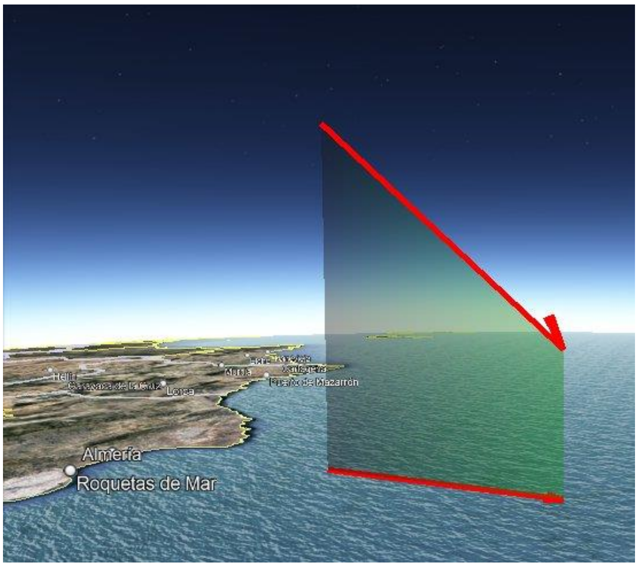

Figure 12 – Atmospheric path and projection on the ground of the trajectory of the SWEMN20220118_182054 bolide.

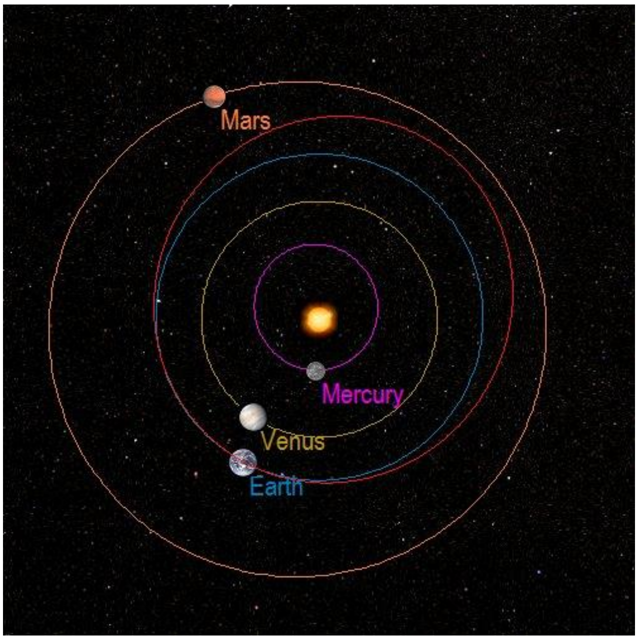

Figure 13 – Projection on the ecliptic plane of the orbit of the SWEMN20220118_182054 event.

8 The 2022 January 19 meteor

This gorgeous event was spotted on 2022 January 19, at $4^h11^m03 \pm 0.1^s$ UT. The bolide (*Figure 14*) had a peak absolute magnitude of –11.0 ± 1.0. We listed it in our meteor database with the code SWEMN20220119_041103. A video showing images of this bolide and its atmospheric trajectory was uploaded to YouTube[12].

Atmospheric path, radiant and orbit

According to the analysis of the trajectory in the atmosphere of the bright meteor we inferred that the bolide overflew Spain. Its initial altitude was $H_b = 126.6 \pm 0.5$ km near the

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[11] https://youtu.be/XHlPdXjbNvY

[12] https://youtu.be/ce_7i6AMMnI

zenith of the location of Orea (province of Guadalajara). The fireball penetrated the atmosphere till a final height $H_e = 69.0 \pm 0.5$ km near from the zenith of the location of Peñalen (province of Guadalajara). The apparent radiant was located at the equatorial coordinates $\alpha = 219.61°$, $\delta = +16.65°$. Besides, we obtained that the meteoroid entered the atmosphere with a velocity $v_\infty = 64.9 \pm 0.5$ km/s. *Figure 15* shows the projection on the ground and the path in the atmosphere of the event.

Figure 14 – Stacked image of the SWEMN20220119_041103 "Orea" event as recorded from Calar Alto.

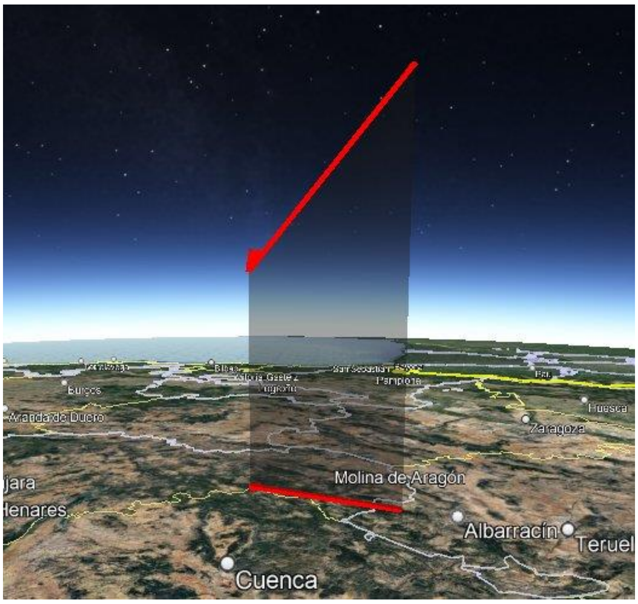

Figure 15 – Atmospheric path and projection on the ground of the trajectory of the SWEMN20220119_041103 meteor.

We named this bright meteor "Orea", because the fireball passed near the zenith of this locality during its initial phase. The parameters of the orbit of the progenitor meteoroid before its encounter with our planet are included in *Table 5*, and the geocentric velocity yields $v_g = 63.2 \pm 0.5$ km/s. By taking into account this orbit and the radiant position, we concluded that the fireball was generated by the 12 Bootids (IAU meteor shower code TBO#0607). The value calculated for the Tisserand parameter with respect to Jupiter ($T_J = 0.21$) indicates that the meteoroid was moving on a cometary orbit before striking the atmosphere. This orbit in the Solar System is drawn in *Figure 16* (Segon et al., 2014).

Table 5 – Orbital data (J2000) of the progenitor meteoroid before its encounter with our planet.

a (AU)	5.6 ± 1.3	ω (°)	173.2 ± 00.4
e	0.82 ± 0.04	Ω (°)	298.752428 ± 10^{-5}
q (AU)	0.9808 ± 0.0003	i (°)	127.6 ± 0.2

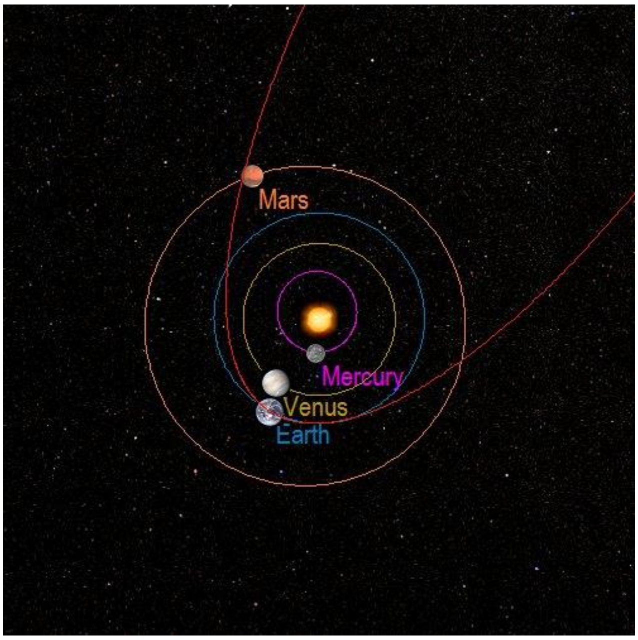

Figure 16 – Projection on the ecliptic plane of the orbit of the SWEMN20220119_041103 "Orea" fireball.

9 The 2022 February 11 fireball

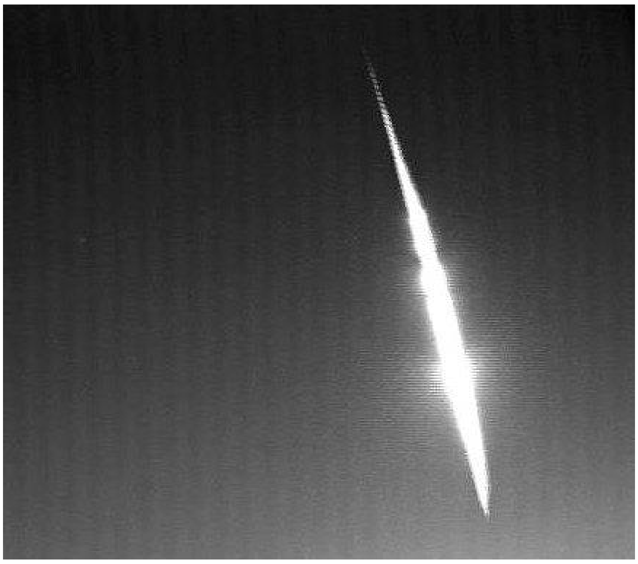

Figure 17 – Stacked image of the SWEMN20220211_022400 "Daimiel" event as recorded from Madrid (Universidad Complutense).

On 2022 February 11, at $2^h24^m00 \pm 0.1^s$ UT, our cameras recorded this bright event (*Figure 17*). The peak luminosity of the bright meteor was equivalent to an absolute magnitude of –10.0 ± 1.0. The event was listed in the SWEMN meteor database with the code

SWEMN20220211_022400. A video containing images of the bolide and its atmospheric trajectory was uploaded to YouTube[13].

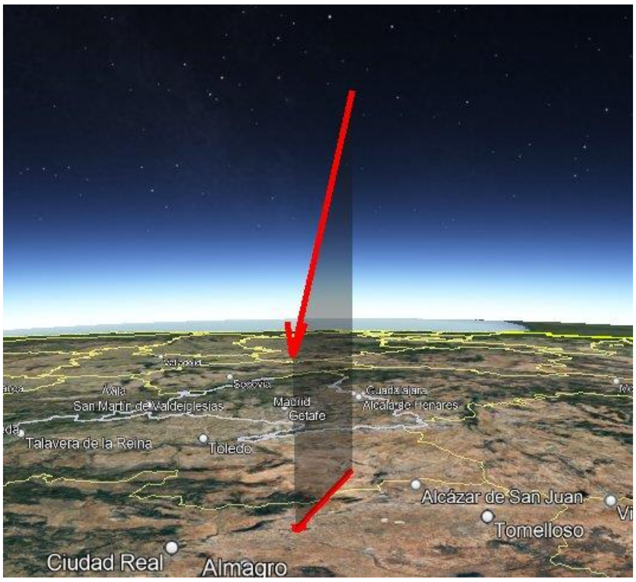

Figure 18 – Atmospheric path and projection on the ground of the trajectory of the SWEMN20220211_022400 bolide.

Atmospheric path, radiant and orbit

The bolide overflew the center of Spain. Its initial altitude was H_b = 114.5 ± 0.5 km, near the vertical of the locality of Villacañas (province of Toledo). The fireball penetrated the atmosphere till a final height H_e = 45.8 ± 0.5 km, near the zenith of the locality of Daimiel (province of Ciudad Real). The equatorial coordinates inferred for the apparent radiant are $\alpha = 210.67°$, $\delta = +72.60°$. The entry velocity in the atmosphere found for the parent meteoroid was v_∞ = 24.2 ± 0.3 km/s. *Figure 18* shows the luminous path of the event.

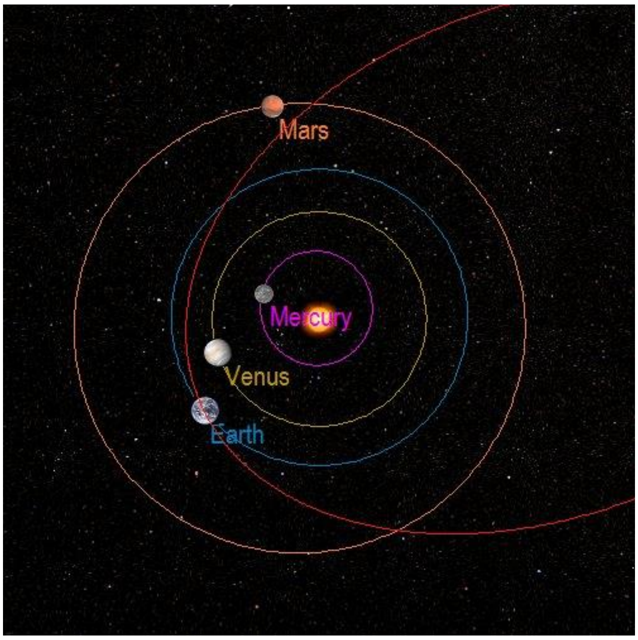

Figure 19 – Projection on the ecliptic plane of the orbit of the SWEMN20220211_022400 "Daimiel" meteor.

Table 6 – Orbital data (J2000) of the progenitor meteoroid before its encounter with our planet.

a (AU)	2.5 ± 0.1	ω (°)	206.52 ± 00.04
e	0.63 ± 0.01	Ω (°)	322.034733 ± 10^{-5}
q (AU)	0.9466 ± 0.0004	i (°)	32.5 ± 0.3

The fireball was named "Daimiel", because the bright meteor was located near the zenith of this locality during its final phase. The orbital parameters of the progenitor meteoroid before its encounter with our planet have been can be found in *Table 6*, and the geocentric velocity yields v_g = 21.4 ± 0.3 km/s. These values and the derived radiant confirm that the bright meteor was produced by the sporadic background. The Tisserand parameter (T_J = 2.93) led to the conclusion that before hitting our planet's atmosphere the progenitor particle was moving on a cometary (Jupiter family comet, JFC) orbit. This orbit in the Solar System is shown in *Figure 19*.

10 The 2022 February 18 fireball

On 2022 February 18, at $1^h02^m47 \pm 0.1^s$ UT, the systems operated by the SWEMN network spotted this remarkable bright meteor (*Figure 20*). The fireball had a peak absolute magnitude of –13.0 ± 1.0. It was included in our meteor database with the code SWEMN20220218_010247. A video about this fireball was uploaded to YouTube[14].

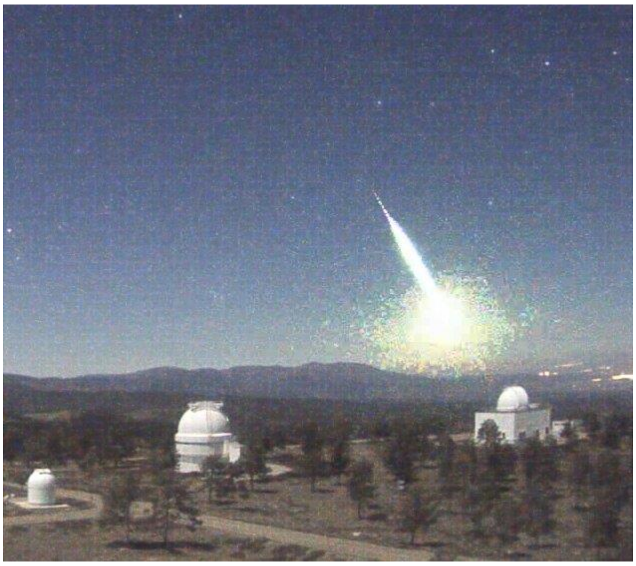

Figure 20 – Stacked image of the SWEMN20220218_010247 "Torremocha" bolide as recorded from Calar Alto.

Atmospheric path, radiant and orbit

The calculation of the atmospheric trajectory of the bright meteor allowed to deduce that the fireball overflew Spain. The initial altitude of the meteor yields H_b = 91.6 ± 0.5 km over the locality of Torremocha (province of Cáceres). It ended at a height H_e = 24.4 ± 0.5 km near the zenith of the locality of Aldea de Trujillo (province of Cáceres). From the analysis of the atmospheric path we also found that the apparent radiant was located at the position $\alpha = 144.02°$, $\delta = +15.93°$. The entry velocity in the atmosphere obtained

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[13] https://youtu.be/vMqcf9N8WvE

[14] https://youtu.be/SafR6jgGfXI

for the parent meteoroid was $v_\infty = 20.7 \pm 0.3$ km/s. *Figure 21* shows the trajectory of the bolide in our atmosphere.

Table 7 – Orbital data (J2000) of the progenitor meteoroid before its encounter with our planet.

a (AU)	2.22 ± 0.08	ω (°)	69.7 ± 00.1
e	0.67 ± 0.01	Ω (°)	148.939624 ± 10^{-5}
q (AU)	0.729 ± 0.004	i (°)	0.79 ± 0.03

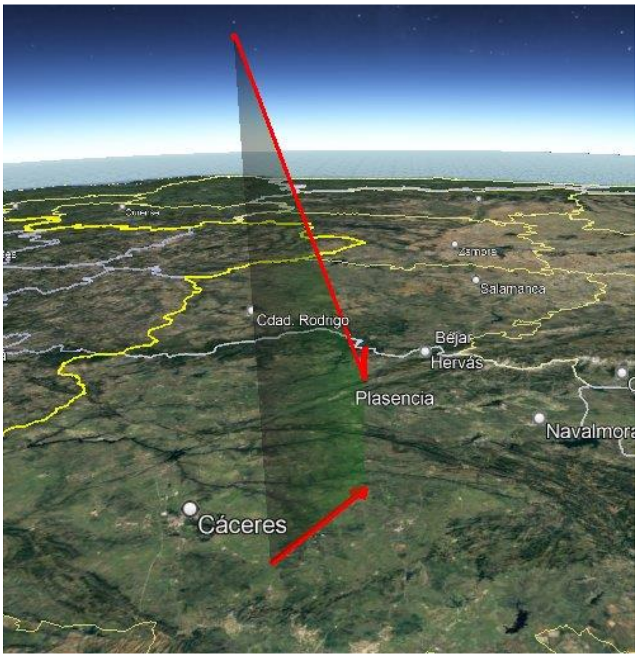

Figure 21 – Atmospheric path and projection on the ground of the trajectory of the SWEMN20220218_010247 "Torremocha" event.

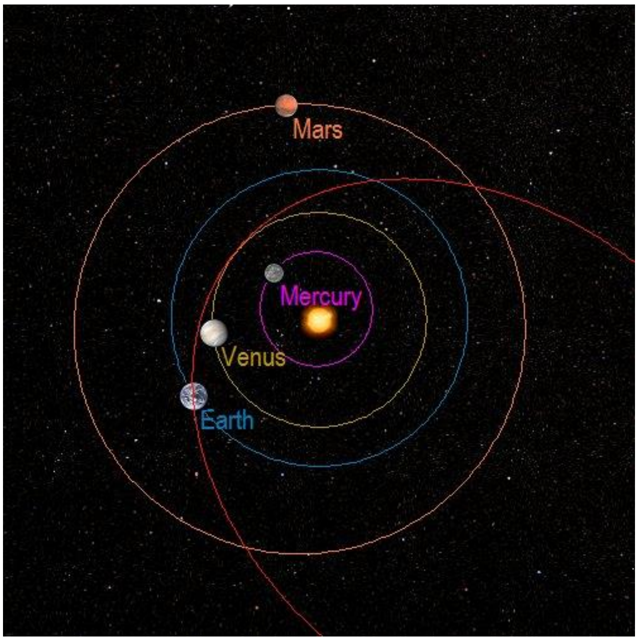

Figure 22 – Projection on the ecliptic plane of the orbit of the SWEMN20220218_010247 "Torremocha" fireball.

We named this bolide "Torremocha", because the fireball overflew this locality during its initial phase. The orbital parameters of the parent meteoroid before its encounter with our planet are listed in *Table 7*. The value calculated for the geocentric velocity was $v_g = 17.6 \pm 0.3$ km/s. By taking into account this orbit and the radiant position, we inferred that the bright meteor was generated by a meteoroid associated with the sporadic component. The Tisserand parameter with respect to Jupiter yields $T_J = 3.31$, which means that before striking the atmosphere the meteoroid was moving on an asteroidal orbit. This orbit is drawn in *Figure 22*.

11 Conclusions

We have focused in this work on the description of an innovative tool that employs artificial intelligence (AI) techniques to generate scientific contributions from the information stored in the SWEMN digital database. This AI was named AIMEE (Artificial Intelligence with Meteoroid Environment Expertise). AIMEE has been employed in this work to automatically generate a report about a series of events recorded in the framework of the SWEMN network and the SMART project. In this way, we have also presented here some of the brightest fireballs recorded by our meteor-observing stations from January to February 2022. Their peak absolute brightness ranges from mag. –10 to mag. –13. The text below, which summarizes the main conclusions derived from the analysis of these bolides, was written by AIMEE.

The "Santa Margarida" fireball was recorded on January 2. This sigma Hydrid (HYD#0016) meteor event had a peak absolute magnitude of –12.0 and overflew Portugal. The meteoroid followed a cometary orbit before hitting the Earth's atmosphere.

The second bright meteor discussed here was the "Montecorto" fireball. This was recorded on January 9. The peak magnitude of this alpha Hydrid (AHY#0331), which overflew the south of Spain, was –13.0. Before striking our planet's atmosphere the meteoroid was moving on a cometary orbit. The final height of this deep-penetrating meteor was of about 31 km.

The third fireball was the "Ventillas" bolide. This was recorded on January 14. It was associated with the sporadic background, its peak magnitude was –12.0, and overflew the south of Spain. The meteoroid was moving on an asteroidal orbit before striking our planet's atmosphere. At the final stage of its luminous phase this deep-penetrating bolide was located at a height of about 23 km. Since the analysis of the final stage revealed a non-zero mass, this meteor was considered as a potential meteorite-dropper. The emission spectrum of the bolide was also registered and analyzed. This exhibits the lines from Na I-1 (588.9 nm), Mg I-2 (516.7 nm), Fe I-4 (385.6 nm), Fe I-41 (441.5 nm), Fe I-42, Fe I-43 (414.3 nm), Fe I-15 (526.9 nm), and Fe I-318.

The next fireball analyzed here was a bolide recorded on January 18. Its peak magnitude was –11.0. The meteor was produced by a sporadic meteoroid and overflew the Mediterranean Sea. Before impacting our atmosphere, this meteoroid was moving on an asteroidal orbit. The ending height of this deep-penetrating fireball was of about 29 km.

The fifth bright meteor presented in this report was a fireball recorded on January 19 that was named “Orea”. Its peak magnitude was –11.0. The fireball was produced by a 12 Bootid (TBO#0607) meteoroid and overflew Spain. This meteoroid was moving on a cometary orbit before striking our atmosphere.

The next event was the “Daimiel” bright meteor. This was recorded on February 11 and its peak absolute magnitude was –10.0. The meteor event was produced by a sporadic meteoroid and overflew Spain. This meteoroid was moving on a cometary (JFC) orbit before entering the atmosphere. This deep-penetrating meteor reached a final altitude of about 45 km.

And the last event presented in this paper was the “Torremocha” bolide, that was recorded on February 18. It was also associated with the sporadic background. Its peak magnitude was –13.0 and overflew Spain. Before colliding with the atmosphere, the meteoroid was moving on an asteroidal orbit. This deep-penetrating meteor reached a terminal height of about 24 km.

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