A METEORITE FALL OBSERVED IN 2021 IN THE FRAMEWORK OF THE SOUTHWESTERN EUROPE METEOR NETWORK. J. C. Toscano-Bermúdez[1]. J.M. Madiedo[2, 3]. [1]Escuela Técnica Superior de Ingeniería, Universidad de Sevilla, 41092 Sevilla, Spain. [2]Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada (Spain). [3]Observatorio Galileo, 41012 Sevilla, Spain.

Introduction: The Earth's atmosphere behaves as a very efficient shield that destroys most rocks that cross our planet's path around the Sun before these materials reach the ground. Thus, when large meteoroids enter the atmosphere these give rise to bright fireballs as a consequence of the so-called ablation process. Most meteoroids ablate completely at high altitude over the ground, but some fireballs may produce, under favorable conditions, a non-zero terminal mass. In these rare cases the surviving materials reach the ground as meteorites. These are unique samples coming from other celestial bodies that may provide helpful information about the origin and evolution of our Solar System. For this reason, the analysis of potential meteorite-producing fireballs is one of the goals of our meteor network. For this purpose we are running the SMART project (Spectroscopy of Meteoroids in the Atmosphere by means of Robotic Technologies). This survey employs an array of automated spectrographs deployed at meteor-observing stations placed at different locations in Spain, included the major astronomical observatories in this country [1, 2]. SMART also provides valuable information for our MIDAS project, which we conduct to study lunar impact flashes generated when large meteoroids hit the Moon [3-7]. With SMART we can determine the atmospheric trajectory of meteors and the orbit of their parent meteoroids, but also the evolution of the conditions in meteor plasmas from the emission spectrum produced by these events [1, 2, 10]. In this work we present a preliminary analysis of a meteorite-dropping bolide that overflew the south of Spain on 2021 September 15.

Instrumentation and methods: To record the fireball analyzed in this work and its emission spectrum we have employed an array of low-lux CCD video cameras manufactured by Watec Co. (models 902H and 902H2 Ultimate). Some of these devices are configured as spectrographs by means of 1000 lines/mm diffraction gratings. CMOS color cameras were also employed to record this event [8]. These cameras monitor the night sky and operate in a fully autonomous way by means of software developed by J.M. Madiedo [1, 2, 9]. The atmospheric trajectory and orbital data of the event were obtained with the Amalthea and SAMIA software packages, which were also written by the same researcher [1, 2, 10].

Description of the 2021 September 15 event: An stunning bolide was recorded by SWEMN systems on 2021 September 15, at 20h25m53±1s. After this recording date and time, we included it in the new SWEMN digital database [9] under the code SWEMN20210915_202553. Its emission spectrum was also recorded by means of the videospectrographs employed by the SMART project

The event was also observed by numerous casual eyewitnesses that reported the phenomenon on social networks. Most of them were located in the southwest of Spain. The peak luminosity of this event corresponded to an absolute stellar magnitude of –12±1. The bolide exhibited several flares along its trajectory as a consequence of the sudden breakup of the meteoroid.

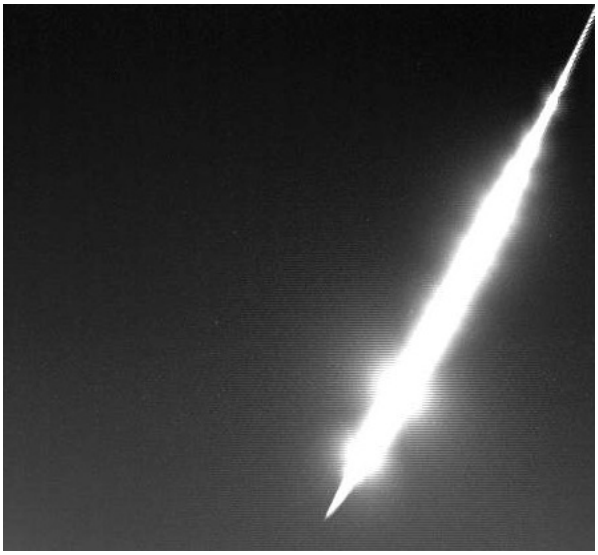

Figure 1. Sum-pixel image of the fireball analyzed in this work, as recorded from the SWEMN meteor station located in Sevilla.

a (AU)	2.6±0.1	**ω (º)**	246.6±0.1
e	0.71±0.01	**Ω (º)**	172.91443 ± 10^{-5}
q (AU)	0.753±0.002	**i (º)**	8.0±0.1

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

Atmospheric trajectory, radiant and orbit: According to our analysis, the fireball started at an altitude H_b=91.9±0.5 km over the south of the province of Badajoz (southwest of Spain). The meteoroid stroke the atmosphere with an observed velocity V_∞ of about 21 km/s and the apparent radiant was located at the equatorial coordinates α=335.5º, δ=9.7º. The bolide penetrated till a final height H_e=21.2±0.5 km over the

same province. The orbital parameters of the parent meteoroid before its encounter with our planet are listed in Table 1. The projection on the ecliptic of this heliocentric orbit is shown in Figure 2. According to the value of the Tisserand parameter with respect to Jupiter (T_J=2.9), the meteoroid followed a Jupiter family comet (JFC) orbit.

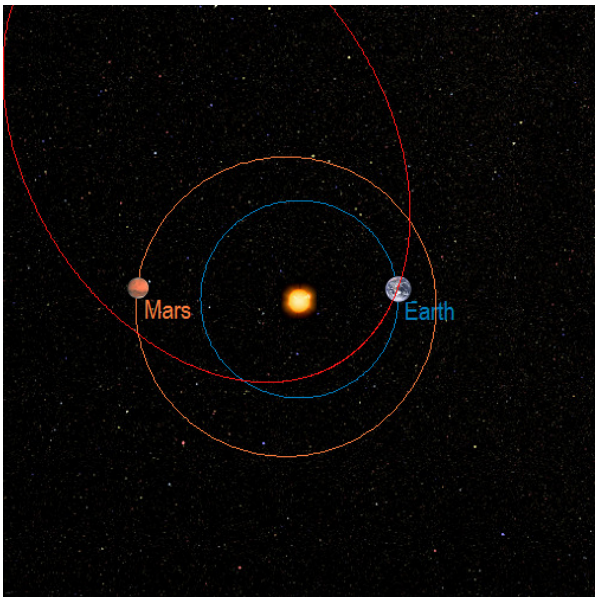

Figure 2. Projection on the ecliptic plane of the heliocentric orbit of the parent meteoroid of the fireball discussed in the text.

We have analyzed the terminal point of the luminous trajectory of this event. According to our results, the meteoroid was not completely destroyed in the atmosphere. Thus, a fragment with a mass of the order of 100 g survived the ablation process and landed as a meteorite in the province of Badajoz. Once the strewnfield was determined, an expedition was organized by the SWEMN meteor network to find the specimen. However, the meteorite could not be located.

Emission spectrum: The emission spectrum of the fireball was recorded by means of three videospectrographs operated by SWEMN in the framework of the SMART project. The most important contributions found in this signal correspond to the emissions from the Na I-1 doublet (588.9 nm), the Mg I-2 triplet (516.7 nm), and several neutral iron multiplets. The detailed conditions in the meteor plasma are currently under analysis. For this purpose, the relative intensities of Mg I-2, Na I-2 and Fe I-15 will be compared, as has been done with in previous works [1, 2]. This will provide an insight into the chemical nature of the progenitor meteoroid.

Conclusions: We have presented a preliminary analysis of a potential meteorite-dropping fireball that overflew the south of Spain on 2021 September 15. The atmospheric trajectory of the event was calculated, and the orbital elements of the meteoroid were obtained. The meteoroid followed JFC orbit before its encounter with our planet. The progenitor meteoroid penetrated the atmosphere till and ending altitude of about 21 km. This reveals that the particle, despite its likely cometary nature, had a high tensile strength. This was confirmed by our calculations.

The terminal surviving mass was or the order of 100 g and landed in the province of Badajoz. The surviving meteorite(s), however, were not found. The emission spectrum of the fireball was recorded, and the main contributions to this signal were identified.

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