METEORITE-PRODUCING METEOR EVENTS RECORDED FROM THE CALAR ALTO ASTRONOMICAL OBSERVATORY

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Abstract

This work presents a series of bright fireballs recorded in the framework of the Southwestern Europe Meteor Network (SWEMN) from the Calar Alto Astronomical Observatory. The analysis of these phenomena yields a non-zero terminal mass, which implies that these meteors gave rise to meteorites.

1. 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 Earth's atmosphere these produce bright fireballs during the so-called ablation process [1, 2]. Most meteoroids ablate completely, but some fireballs may produce, under favourable conditions, a non-zero terminal mass [3, 4, 5]. In these rare cases the surviving materials reach the ground as meteorites [6, 7, 8]. These meteorites are unique samples coming from other celestial bodies that may provide helpful information about the origin and evolution of our Solar System [9]. For this reason, the analysis of potential meteorite-producing fireballs is one of the main goals of the Southwestern Europe Meteor Network (SWEMN) and its SMART project (Spectroscopy of Meteoroids in the Atmosphere by means of Robotic Technologies). In this work we present three potential meteorite-dropping bolides spotted from the meteor-observing station that SMART operates at CAHA.

2. Instrumentation

The fireballs presented here were recorded by means of a cluster of CCD cameras and spectrographs operating at CAHA in the framework of the SMART project [10, 11, 12]. They were simultaneously spotted from other meteor-observing stations operated by the same survey. These devices work autonomously thanks to the MetControl software [13]. All of them are based on CCD video cameras (models Watec 902H and 902H Ultimate) covering fixed fields of view ranging from about 90ºx60º to 8ºx5º [14, 15, 16]. The atmospheric path and radiant of the fireball, and the orbital elements of the progenitor meteoroids were obtained by employing the Amalthea software [17, 18, 19].

3. Potential meteorite-producing events

The events presented here are shown in Figures 1-3. These were recorded from CAHA on 19 January 2016 at 23h59m07.2±0.1s UT, 22 May 2018 at 23h37m10±1s UT, and 22 December 2018 at 21h12m00±1s UT, respectively.

Figure 1. *Fireball spotted over the domes of CAHA on 19 January 2016 at 23h59m07.2±0.1s UT.*

The event on 19 January 2016 (Figure 1) was also recorded from the meteor-observing stations operated by SMART at La Sagra, La Hita and Sevilla. This mag. -12±1 fireball overflew the Mediterranean Sea. It began at an altitude of 89.1±0.4 km and ended at a height of 23.2±0.4 km over the sea. The progenitor meteoroid hit the atmosphere with a velocity of 14.3±0.2 km/s. The analysis of the terminal point of the luminous path reveals that the surviving mass was of about 200 g.

The mag. -12±1 fireball spotted on 22 May 2018 (Figure 2) also overflew the Mediterranean Sea. It was recorded from the meteor-observing stations operated by SMART at CAHA, La Sagra, La Hita and Sevilla. It began at an altitude of 89.6±0.5 km and ended at a height of 19.1±0.5 km over the sea. The progenitor meteoroid hit the atmosphere with a

velocity of 25.1±0.2 km/s. The analysis of the terminal point of the luminous path reveals that the surviving mass was of about 100 g.

In relation to the event on 22 Dec. 2018 (Figure 3), we have determined that this mag -14±1 fireball appeared in the images when it was located at an altitude of about 90 km over the ground. It moved southwest over the region of Navarra and penetrated the atmosphere till a final height of about 24 km over the south of Navarra. The analysis of the terminal point of this deep-penetrating fireball shows that the meteoroid was not completely destroyed in the atmosphere: several fragments survived the ablation process and reached the ground, and meteorite recovery expeditions are currently in progress. The preliminary estimate of the tensile strength σ of the meteoroid yields $\sigma > 8.7 \cdot 10^6$ dyn/cm^2.

Figure 2. *Fireball recorded from CAHA on 22 May 2018 at 23h37m10±1s UT.*

Figure 3. *Fireball recorded from CAHA on 22 December 2018 at 21h12m00±1s UT.*

4. Conclusions

We have presented a preliminary analysis of three deep-penetrating bright meteor events recorded in the framework of the SMART survey from CAHA between 2016 and 2018. Two of these fireballs overflew the Mediterranean Sea, and the third one overflew the province of Navarra (Spain). The analysis of the terminal point of their luminous path reveals that the progenitor meteoroids were not completely destroyed in the atmosphere, since these survived the ablation process and could reach the ground as meteorites.

5. Acknowledgements

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6. References

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