ORBIT AND SPECTRUM OF A DEEP-PENETRATING METEOR EVENT SPOTTED ON 2018 APRIL 1.

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Introduction: The SMART project (Spectroscopy of Meteoroids in the Atmosphere by means of Robotic Technologies) is currently performing a systematic monitoring of meteor and fireball activity by means of 10 observing stations located in Spain [1, 2]. The analysis of events simultaneously imaged from, at least, two different locations provides information about meteoroids ablating in the atmosphere. In this way, atmospheric trajectories, radiant, orbital data, and physico-chemical parameters such as meteoroid mass and tensile strength can be obtained [1-4]. Accurate orbital data are, for instance, of a paramount importance in order to infer information about the likely parent body of a given meteoroid stream. Spectroscopic techniques provide also very valuable data about the chemical nature of these particles of interplanetary matter [1, 2]. In this context, we present here the analysis of a multi-station sporadic fireball recorded from four of our meteor-observing stations on 2018 April 1 (Figure 1).

Figure 1. Sum-pixel image of the 20180401_041702 bolide recorded from the SMART meteor-observing station located at the Sierra Nevada Astronomical Observatory.

Methods: The four meteor observing stations involved in this work (Calar Alto, Sierra Nevada, La Sagra and La Hita) have employed high-sensitivity CCD video cameras (models 902H and 902H Ultimate, from Watec Corporation) to monitor the night sky. The operation of these systems is explained in [3-5]. These automatic stations perform a systematic spectroscopic campaign by recording the emission spectrum produced by meteoroids ablating in the atmosphere. In this way, we can infer information about the chemical nature of these particles of interplanetary matter [1, 2].

Figure 2. Atmospheric trajectory of the 20180401_041702 fireball.

Results and discussion: The above-mentioned meteor observing stations recorded the fireball analyzed here on 2018 April 1, at 4h17m01.4±0.1s UT (Figure 1). Its atmospheric trajectory is shown in Figure 2. The absolute magnitude of this event (which was included in our fireball database with the code 20180401_041702), estimated from the photometric analysis of the images, was -8±1. The atmospheric trajectory and radiant were calculated with the AMALTHEA software, which was developed by J.M. Madiedo and employs the planes intersection method [5]. From this analysis we obtained that the luminous phase began at about 92.4±0.5 km above the sea level, with the terminal point located at about 30.8±0.5 km. The preatmospheric velocity was V_∞=16.1±0.3 km/s. With this information, the heliocentric orbit of the meteoroid was calculated (Figure 3). The radiant and orbital parameters (J2000) are summarized on Table 1.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	203.0±0.2	194.8±0.4	
Dec. (º)	12.9±0.1	7.3±0.3	
V_∞ (km/s)	16.1±0.3	12.0±0.4	32.0±0.1
Orbital parameters			
a (AU)	1.18±0.01	**ω (º)**	267.7±0.6
e	0.38±0.01	**Ω (º)**	11.14099±10^{-5}
q (AU)	0.734±0.008	**i (º)**	5.0±0.3

Table 1. Radiant and orbital data (J2000) calculated for the 20180401_041702 fireball.

These orbital data show that the event was produced by a sporadic meteoroid that followed an asteroid-like orbit before hitting the atmosphere (T_j=5.26±0.04).

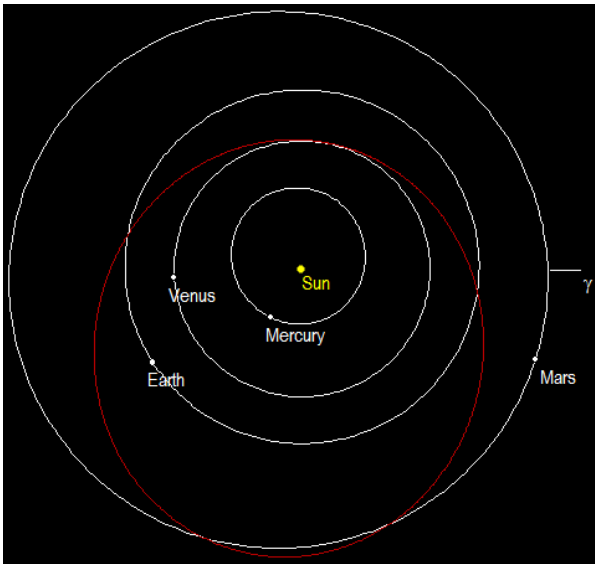

Figure 3. Projection on the ecliptic plane of the orbit of the meteoroid that gave rise to the 20180401_041702 fireball.

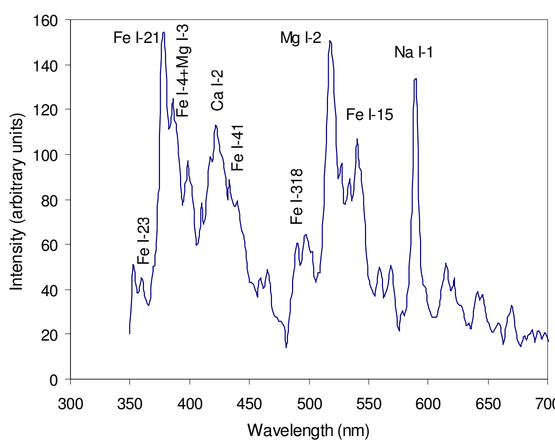

Figure 4. Calibrated emission spectrum of the 20180401_041702 fireball.

The emission spectrum of this fireball was recorded from two videospectrographs located at Calar Alto. This emission spectrum was analyzed with the CHIMET software, also developed by J.M. Madiedo, by following the method described in [1, 2]. Thus, the images containing the spectrum were dark-substracted and flat-fielded. Then, the signal was calibrated in wavelengths by using typical lines appearing in meteor spectra (Ca, Fe, Mg, and Na multiplets) and corrected by taking into account the spectral efficiency of the recording device. The result is shown in Figure 4, which contains the integrated spectrum. Most lines correspond to several Fe I multiplets. The signal has important contributions from the emission of Mg I-2 (516.7 nm) and Na I-1 (588.9 nm) multiplets. The contribution from Mg I-3 was also identified, but this is blended with the emission from Fe I-4. As has been done in previous works [1,2], the nature of the meteoroid will be investigated by comparing the relative intensities of Na I-1, Mg I-2 and Fe I-15 multiplets.

Conclusions: In the framework of our systematic fireball monitoring and spectroscopic campaign we have recorded a mag. -8±1 multiple-station sporadic fireball. The analysis of this event has shown that this was a deep-penetrating meteor which had its terminal point at a height of around 30 km. The meteoroid followed a low-inclination asteroidal like orbit before hitting the atmosphere. The emission spectrum of this bright meteor event is dominated by the emission from Na I-1, Mg I-2 and several neutral Fe multiplets.

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References: [1] Madiedo J.M. (2017), Planetary and Space Science, 143, 238. [2] Madiedo J.M. (2014), Earth, Planets & Space, 66, 70. [3] Madiedo J.M. and Trigo-Rodríguez J.M. (2007) *EMP* 102, 133-139. [4] Madiedo J.M. et al. (2010) *Adv.in Astron*, 2010, 1-5. [5] Madiedo J.M. et al. (2011), NASA/CP-2011-216469, 330.