EMISSION SPECTRUM AND ORBITAL ELEMENTS OF A SPORADIC FIREBALL IMAGED IN 2011

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Introduction: The characterisation of physical and chemical properties of meteoroids can be performed from the analysis of meteor and fireball events. This provides useful information about the origin and evolution of meteoroid streams and meteoroids of sporadic origin, but also about the mechanisms that deliver these materials to the Earth

One of the systems that the SPanish Meteor Network (SPMN) employs to study the activity of meteor streams is based on high-sensitivity CCD video cameras. These devices, which are commonly used to monitor the night sky, provide useful data for the determination, for instance, of radiant, orbital and photometric parameters [1, 2, 3]. They are also very useful for meteor spectroscopy [3]. As a matter of fact, the recording and analysis of meteor spectra is one of the goals of our network, and some of our observing stations perform a continuous spectroscopic campaign since 2006. In this context, we analyze here a mag. -10 sporadic fireball recorded from two of our meteor stations on October 4, 2011.

Methods: The double-station sporadic fireball analyzed here was imaged from our meteor observing stations in Sierra Nevada and La Murta. Both of them employ high-sensitivity 1/2" b&w CCD video cameras (Watec Co., Japan) whose operation has been explained elsewhere [1, 2]. Some of the cameras operating from Sierra Nevada employ holographic diffraction gratings (1000 lines/mm) to obtain the emission spectrum resulting from the ablation of meteoroids in the atmosphere. This provides information about the chemical composition of these particles of interplanetary matter [4, 5, 6, 7].

Results and discussion: The double-station fireball analyzed here (SPMN code 041011) was recorded on October 4, 2011, at 19h21m11.2±0.1s UT from the meteor observing stations operating from Sierra Nevada and La Murta, in Spain (Fig. 1). The absolute magnitude of this event, inferred from the photometric analysis of the images, was -10.±1. By using the method of planes intersection [8] we could obtain its atmospheric trajectory and radiant. The fireball, which exhibited several bright fulgurations along its trajectory, started its luminous path at a height of about 98.5±0.5 km. The preatmospheric velocity, obtained by extrapolating the velocities measured at the beginning of the meteor trail was V_∞=17.1.±0.3 km/s. The terminal point of the trajectory was reached at a height of 70.6±0.5 km. The radiant and orbital parameters (J2000) are summarized on table 1. The apparent trajectory as seen from both stations is shown on Fig. 2. The fireball suffered several flares along its trajectory, the main one at about 79.1 km over the ground level (Fig. 1) with a velocity of about 15.9 km/s. With this data we can obtain the aerodynamic strength at which the particle suffered this break-up [9]. Thus, by using the average atmospheric density from the US standard atmosphere [10] the aerodynamic strength yields $4.6\pm0.1\times10^3$ dyn/cm^2.

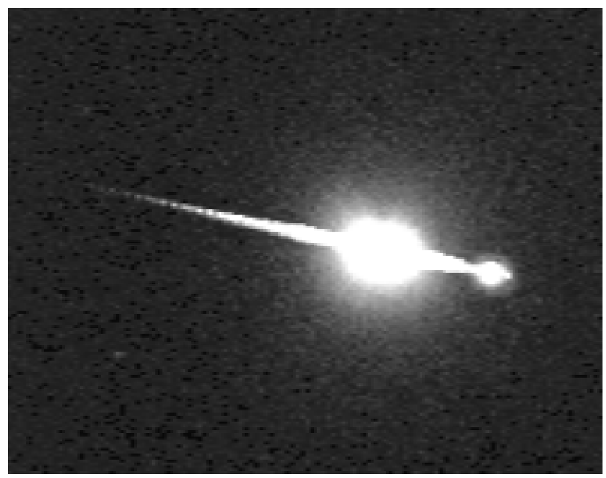

Figure 1. The SPMN041011 fireball imaged from Sierra Nevada.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	276.3±0.3	270.8±0.3	
Dec. (º)	35.8±0.2	34.7 ±0.2	
V_∞ (km/s)	17.1±0.3	13.2±0.3	38.3±0.3

Orbital parameters			
a (AU)	2.9 ±0.2	**ω (º)**	177.4±0.2
e	0.65 ±0.02	**Ω (º)**	191.0611 ± 10^{-4}
q (AU)	0.999 ±0.002	**i (º)**	17.0 ±0.4

Table 1. Radiant and orbital data (J2000) for the SPMN041011 fireball.

As a result of the continuous spectroscopic campaign we develop from our meteor observing station at

Sierra Nevada, we could obtain the emission spectrum of the bolide. The identification of several multiplets (mainly Na I-1 and Mg I-2) made the calibration in wavelengths possible. After this, the signal was corrected by using the spectral efficiency of the instrument. The raw spectrum is shown on Fig. 3, where the processed signal is also included in an upper window. The reduced main order with the most prominent lines is plotted on the top of the figure. The main emission lines correspond to multiplets Mg I-3 (382.9 nm), Ca I-2 (422.6 nm), Fe I-41 (440.4 nm), Mg I-2 (516.7 nm) and Na I-1 (588.9 nm). Atmospheric oxygen and nitrogen contributions were also identified.

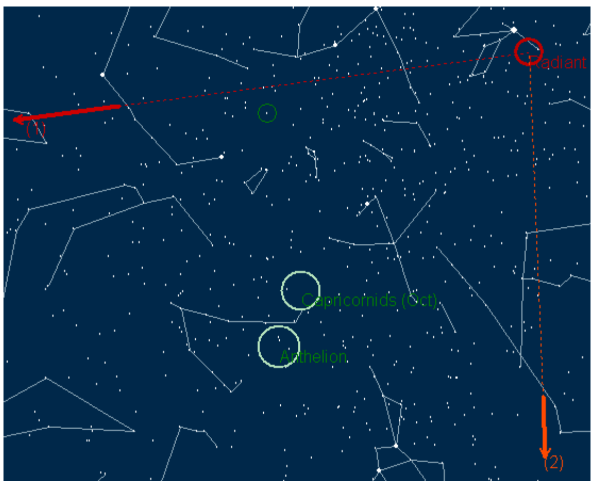

Figure 2. Apparent trajectory of the SPMN041011 fireball as recorded from Sierra Nevada (1) and La Murta (2) meteor observing stations.

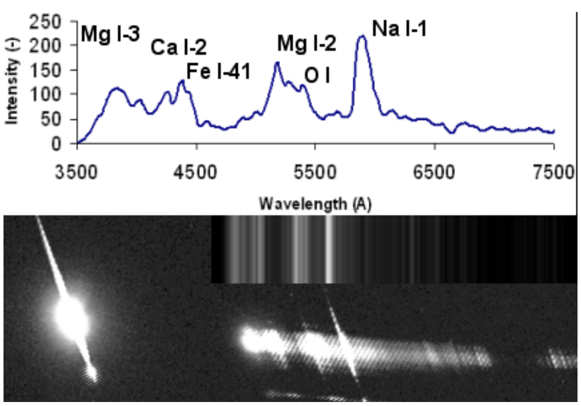

Figure 3. Raw and processed emission spectrum of the SPMN041011 fireball.

Conclusions: The recording of multi-station fireball events by means of high-sensitivity CCD video devices provides valuable information about meteoroids intersecting Earth's orbit. Thus, the analysis of the mag. -10±1 sporadic bolide studied here has allowed us to characterize its atmospheric trajectory and to calculate the orbit and the tensile strength of the meteoroid. Its spectrum has been also analyzed and the main emission lines have been identified. This has provided information about the chemical composition of this particle.

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References: [1] Madiedo J.M. and Trigo-Rodriguez J.M. (2010) *41st LPSC*, Abstract #1504. [2] Madiedo J.M. and Trigo-Rodríguez J.M. (2007) *EMP* 102, 133-139. [3] Madiedo J.M. et al. (2010) *Adv.in Astron*, 2010, 1-5. [4] Trigo-Rodriguez J.M. et al. (2009) *MNRAS*. 392, 367–375. [5] Trigo-Rodríguez J.M. et al. (2003) *MAPS* 38, 1283-1294. [6] Trigo-Rodríguez et al. (2004) *MNRAS* 348, 802-810. [7] Borovicka, J. (1993) *Astron. Astrophys*. 279, 627-645. [8] Ceplecha, Z. Bull. Astron. Inst. Cz. 38, 222-234, 1987. [9] U.S. Standard Atmosphere (1976), NOA-NASA-USAF, Washington. [10] Bronshten V. A., 1981, *Geophysics and Astrophysics Monographs*. Reidel, Dordrecht.