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Spectroscopy and orbital analysis of a sporadic fireball imaged in 2010

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Abstract
We report here the orbital and spectroscopic analysis of a mag. -7 sporadic fireball recorded in the framework of the SPanish Meteor Network (SPMN). The event was imaged by means of high-sensitivity CCD video cameras operating from three meteor observing stations. From such data the atmospheric trajectory of the bolide was reconstructed and the orbital elements were calculated. Information about the chemical composition of the meteoroid was also obtained.

1. Introduction

One of the main goals of our meteor network is the analysis of the physico-chemical properties of meteoroids from multiple station data. These include radiant and orbital parameters, but also chemical information obtained from the emission spectra produced during the ablation of these particles of interplanetary matter in the Earth's atmosphere. This continuous monitoring can provide useful data to improve our knowledge about meteoroid streams and meteoroids of sporadic origin, so that we can improve our understanding of the mechanisms that deliver these materials to the Earth.

We currently perform a continuous monitoring of the night sky from 25 meteor observing stations in the Iberian Peninsula. Some of these employ high-sensitivity CCD video devices with attached diffraction gratings to obtain the emission spectrum of meteoroids ablating in the Earth's atmosphere. In this context, we have imaged on October 15, 2010 a three-station sporadic fireball with an absolute magnitude of about -7±1. The analysis of this fireball is made here.

2. Instrumentation

Two of the SPMN stations involved in the detection of the sporadic fireball considered here (Sevilla and La Hita) work in an autonomous way by means of proper software [1]. The third station that recorded this event (La Cañada) operates from the province of Avila, in Spain. All of them employ high-sensitivity 1/2" monochrome CCD video cameras (Watec Co., Japan). A detailed description of these stations has been done elsewhere [2, 3]. The cameras operating from La Hita have attached holographic diffraction gratings (500 to 1000 lines/mm) to obtain the emission spectra resulting from the ablation of meteoroids in the atmosphere. This provides chemical information about these particles of interplanetary matter [4, 5, 6, 7].

2. Observations and results

The mag. -7 fireball analyzed here (code SPMN151010) was simultaneously recorded from three of our video meteor observing stations on October 15, 2010, at 0h31m27.2±0.1s UT (Fig. 1). The radiant and orbital parameters of the fireball are shown on table I. The preatmospheric velocity calculated from the velocities measured at the beginning of the meteor trail was V_∞=34.7 ±0.5 km/s.

We could also image the spectrum of this fireball from our meteor observing station operating from La Hita Astronomical Observatory. The signal obtained in the spectrum is corrected by taking into account the instrumental efficiency, and then calibrated in wavelengths by using typical metal lines (Ca, Fe, Mg, and Na multiplets). The raw spectrum is shown on Fig. 2, where the processed spectrum obtained by using the deinterlacing and the background removal filters implemented in our recently developed CHIMET software is also included. Most prominent

lines correspond to Fe I-5 (374.5 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). The low signal obtained for the Na I-1 multiplet indicates a depletion in this relatively volatile element. Atmospheric oxygen lines can also be noticed. Additional improvements are currently being made on this software to calculate also the relative abundances of the corresponding chemical species.

Table 1: Radiant and orbital data (J2000) for the SPMN20101015 sporadic fireball.

Radiant data (SPMN20101015)			
	Observed	Geocentric	Heliocentric
R.A. (º)	35.9±0.2	35.2±0.2	
Dec. (º)	34.5±0.1	33.8±0.1	
V_∞ (km/s)	34.7±0.5	33.0±0.5	33.1±0.5

Orbital parameters (SPMN20101015)			
a (AU)	1.25±0.04	**ω (º)**	325.1±0.7
e	0.886±0.007	**Ω (º)**	263.1900 ± 10^{-4}
q (AU)	0.14±0.05	**i (º)**	17.3±0.6

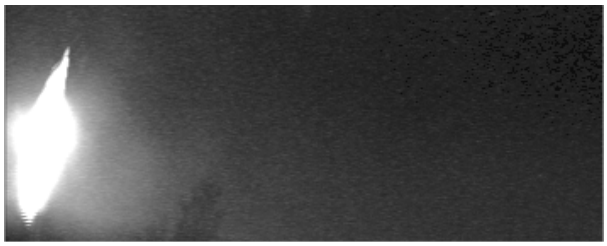

Figure 1: Figure 1: mag. -7 sporadic fireball imaged from La Cañada video station on Oct. 15, 2010, at 0h31m27.2±0.1s UT.

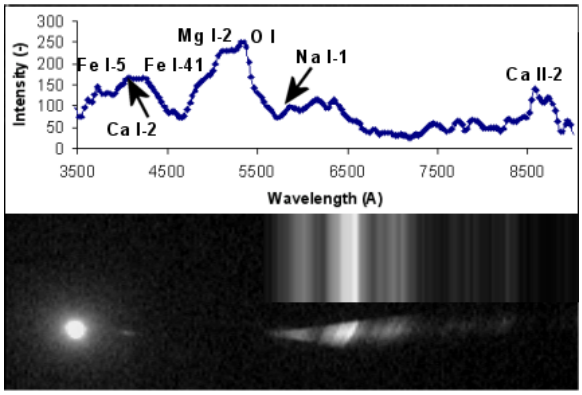

Figure 2: Emission spectrum of the SPMN151010 sporadic fireball.

6. Summary and Conclusions

We are employing high-sensitivity CCD video cameras endowed with holographic diffraction gratings to obtain radiant, orbital and chemical information about meteoroids ablating in the Earth's atmosphere. This continuous monitoring provides data that improve our knowledge about meteoroid streams and meteoroids of sporadic origin. The analysis of the mag. -7 fireball of sporadic origin studied here has provided information about the chemical composition of the corresponding meteoroid.

Acknowledgements

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