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Emission spectrum and orbital elements of a sporadic video meteor with a cometary origin

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Abstract

The SPanish Meteor Network (SPMN) monitors meteor and fireball activity over the Iberian Peninsula and neighboring areas by using, among other systems, high-sensitivity CCD video cameras. In this way, we can obtain the atmospheric trajectory and orbit in the Solar System for multi-station events. Besides, holographic diffraction gratings attached to some of our cameras also provide information about the chemical composition of the corresponding meteoroids. In this context, we analyze here the emission spectrum, trajectory and orbital parameters of a sporadic bolide imaged in 2011.

1. Introduction

Meteoroids give rise to significant ionization and light emission when they collide with the Earth's atmosphere. Thus, meteor networks use the atmosphere as a large detector that provides the opportunity to analyze these particles of interplanetary matter by monitoring meteor and fireball activity.

Sporadic meteors, i. e., those that do not belong to any recognized shower, comprise a very heterogeneous group of meteoric objects from the point of view of their origin, orbital parameters and physico-chemical properties. Besides, sporadic events represent a significant fraction of the total meteoric activity and, so, their analysis can improve our knowledge about the nature and sources of these particles and the mechanisms that deliver them to the Earth. Of special interest for our network is the determination of accurate orbital parameters from multi-station data and the analysis of the chemical composition of meteoroids by studying the corresponding emission spectra. With this aim, we analyze here a sporadic fireball recorded from two of our meteor observing stations on December 21, 2011.

2. Instrumentation

The three-station sporadic fireball analyzed here was imaged from our meteor observing stations in Sevilla, El Arenosillo and La Hita. All 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 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 [3, 4, 5, 6].

2. Observations and results

The mag. -7 fireball analyzed here (SPMN code 211211) was imaged on December 21, 2011, at 6h30m06.1±0.1s UT (Fig. 1). By using the method of planes intersection [7] its radiant and trajectory in the atmosphere was derived. Its luminous path started at a height of 104.3±0.5 km above the ground level, while the terminal point of the trajectory was reached at a height of 83.8±0.5 km. The preatmospheric velocity, obtained by extrapolating the velocities measured at the beginning of the meteor trail was V_∞=66.0.±0.3 km/s. The radiant and orbital parameters (J2000) are summarized on table 1. The apparent trajectory is shown on Fig. 2.

The emission spectrum of the bolide was imaged from El Arenosillo and La Hita astronomical observatories. It was calibrated by using typical lines appearing in meteor spectra and corrected by considering the instrumental efficiency. The raw

spectrum is shown on Fig. 1, together with the processed spectrum. The main lines correspond to Fe I-4 (388.8 nm), Fe I-41 (440.4 nm), Mg I-2 (516.7 nm) and Na I-1 (588.9 nm) multiplets. Atmospheric oxygen and nitrogen lines can also be noticed.

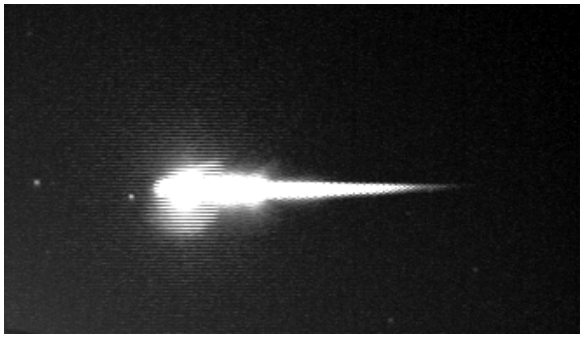


Figure 1: The SPMN211211 sporadic fireball imaged from Sevilla.

Table 1: Radiant and orbital data (J2000) for the SPMN211211 fireball.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	160.1±0.2	159.3±0.3	
Dec. (º)	-23.4±0.1	-23.7 ±0.2	
V_∞ (km/s)	66.0±0.3	65.2±0.3	42.2±0.3
Orbital parameters			
a (AU)	43 ±10	**ω (º)**	21.5±0.5
e	0.97 ±0.02	**Ω (º)**	88.8638 $\pm 10^{-4}$
q (AU)	0.949 ±0.001	**i (º)**	128.4 ±0.2

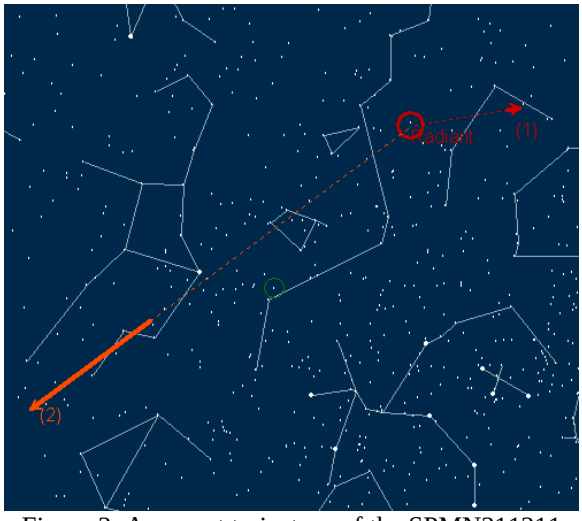
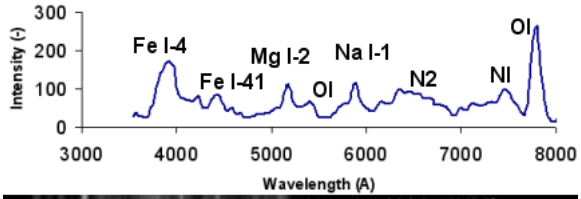


Figure 2: Apparent trajectory of the SPMN211211 fireball as recorded from La Hita (1) and El Arenosillo (2) meteor observing stations.



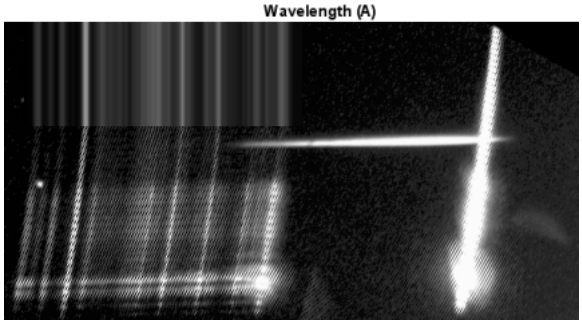


Figure 3: Raw and processed emission spectrum of the SPMN211211 fireball.

6. Summary and Conclusions

We are using high-sensitivity CCD video cameras endowed with holographic diffraction gratings to obtain radiant, orbital and chemical information about meteoroids ablating in the 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 orbit and the chemical composition of the corresponding meteoroid.

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