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Analysis of a large fireball event imaged during the 2011 Draconid outburst

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Abstract
The SPanish Meteor Network (SPMN) joined the international initiative organized with the aim to study the 2011 Draconid outburst. To cover this event we employed high-sensitivity CCD video devices endowed with diffraction gratings. We analyze here of an extraordinarily bright Draconid event (mag. -10.5) imaged together with its spectrum during this outburst.

1. Introduction

The parent body of the Draconid meteoroid stream is the short period comet 21P/Giacobini-Zinner. This cometary debris gives rise to an annual display of meteors from about October 6 to October 10, with a maximum activity around October 8. Although the Draconids is a minor meteor shower, sometimes it has produced brief but spectacular meteor storms [1].

Several researchers predicted the encounter of Earth on October 8, 2011 with different dust trails ejected by comet 21P/Giacobini-Zinner during the last two centuries. According to this, an outburst with an activity of several hundred meteors per hour was expected [2, 3]. We joined the international initiative organized with the aim to study this event. The Draconid meteoroids are very fragile [2], and accurate data are fundamental to reach a better knowledge about their physico-chemical properties. The moon, with a phase of ~91%, interfered with the observation, but despite this, multi-station meteors as faint as mag. +1/+2 could be recorded together with some fireballs. One of these events, with an absolute magnitude of -10.5±0.5, is analyzed here.

2. Instrumentation

Four of the SPMN stations located in Andalusia (Sevilla, Cerro Negro, Sierra Nevada-OSN and El Arenosillo) were involved in the detection of the Draconid event considered here. They work in an autonomous way by means of proper software [4] and employ high-sensitivity Watec CCD video cameras [5, 6]. Most of the cameras operated with holographic diffraction gratings (1000 lines/mm) to obtain the emission spectra resulting from the ablation of meteoroids in the atmosphere. This provides chemical information about these particles [7, 8, 9, 10].

2. Observations and results

The mag. -10.5±0.5 fireball analyzed here (code SPMN081011) was recorded on Oct. 8, 2011 at 19h47m59.3±0.1s UT (Fig. 1). Its luminous phase started at a height of about 107.3 km above the ground level, with a terminal point located at a height of about 77.0 km. The calculated preatmospheric velocity was V_∞=23.3 ±0.3 km/s. Its radiant and orbital parameters are shown on table I. The fireball suffered a very bright flare at about 99.1 km over the ground level (Fig. 1), which corresponds to a velocity of about 22.5 km/s. With this data we can obtain the aerodynamic strength at which the particle suffered the break-up [11]. By using the average atmospheric density from the US standard atmosphere [12] the aerodynamic strength yields $1.9\pm0.1\times10^2$dyn/cm^2.

On the other hand, the light curve (Fig. 2) was obtained from the photometric analysis of the video frames. This information has been employed to infer the initial mass of the meteoroid by using the technique described in [13, 14]. In this way, the preatmospheric mass of the particle was estimated to be of about 13 kg. For a density of 2 g/cm^3 this yields a diameter for the meteoroid of about 23 cm.

The emission spectrum was imaged from Cerro Negro. It was calibrated by identifying typical metal lines (Ca, Fe, Mg and Na multiplets) and corrected according to the efficiency of the instrument. The raw and processed spectra are shown on Fig. 3. Main lines correspond to Mg I-3 (382.9 nm), Fe I-20 (383.4 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). A clear evolution of the spectrum with time can be noticed.

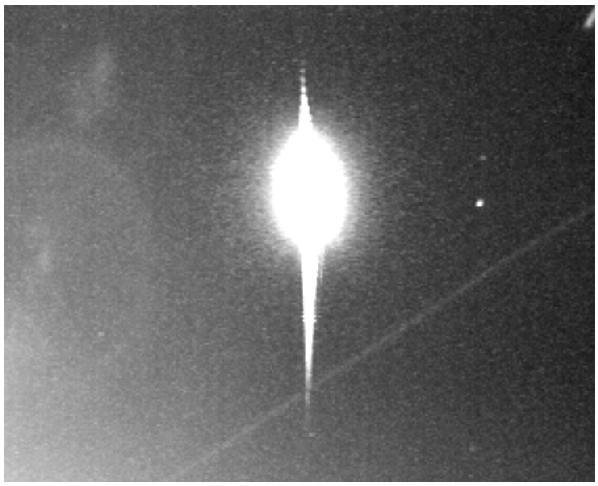

Figure 1: The SPMN081011 fireball as recorded from Sevilla.

Table 1: Radiant and orbital data (J2000) for the SPMN061211 sporadic fireball.

Radiant data			
	Observed	**Geocentric**	**Heliocentric**
R.A. (º)	269.7±0.1	264.1±0.2	-
Dec. (º)	55.1±0.1	54.6±0.1	-
Ecliptical lon.(º)	-	-	-77.99±0.04
Ecliptical lat. (º)	-	-	31.0±0.3
V_∞ (km/s)	23.3 ±0.3	20.6±0.3	39.2±0.3
Orbital data			
a (AU)	3.7±0.2	**ω (º)**	173.8±0.1
e	0.73 ±0.02	**Ω (º)**	195.1872±10^{-4}
q (AU)	0.9967 ±0.0001	**i (º)**	31.0 ±0.3

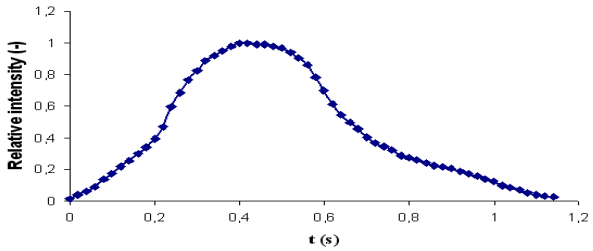

Figure 3: Light curve of the SPMN081011 fireball.

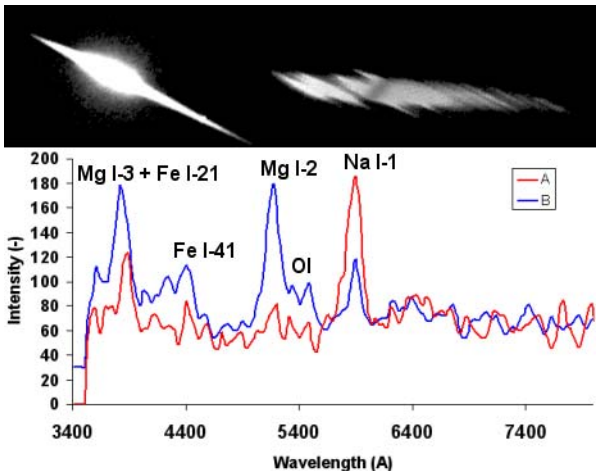

Figure 3: Raw and processed emission spectrum of the SPMN081011 Draconid fireball.

6. Summary and Conclusions

We have monitored the Draconid outburst on October 8, 2011. Fireball activity from this shower was observed during its maximum. We have analyzed here the brightest (abs. mag. -10.5) Draconid fireball recorded by the SPMN during this outburst. Radiant and orbital data were obtained, together with the mass of the meteoroid and information about its chemical composition.

References

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