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Spectroscopy of a sporadic fireball afterglow

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Abstract

We analyze a mag. -11 fireball imaged over the south of Spain on April 14, 2013. This event was recorded in the framework of our systematic meteor spectroscopy campaign. The atmospheric trajectory of the bolide is calculated and the orbit of the parent meteoroid is inferred. The evolution with time of the emission spectrum of the afterglow of this fireball is discussed.

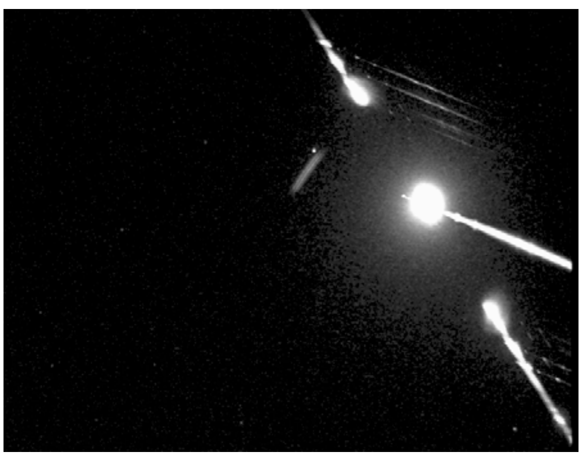

Figure 1. Composite image of the SPMN140413 fireball as imaged from El Arenosillo.

1. Introduction

A mag. -11±1 fireball was imaged over the south of Spain on April 14, 2013 at 22h35m49.8 ± 0.1s UTC. Its emission spectrum was also obtained. This event was assigned the SPMN code 140413 after the recording date. By the end of its atmospheric path it exhibited a very bright flare which resulted in a persistent train whose spectrum was recorded. Here we present a preliminary analysis of this event and focus special attention on the evolution of the main emission lines in the spectrum of the afterglow.

2. Instrumentation and methods

An array of low-lux CCD video devices (models 902H and 902H Ultimate from Watec Co.) operating from our stations at Sevilla and El Arenosillo was employed to record the SPMN140413 fireball (Fig. 1). The operation of these systems is explained in [1, 2]. Some of these are configured as spectrographs by attaching holographic diffraction gratings (1000 lines/mm) to the objective lens [3]. To calculate the atmospheric trajectory, radiant and orbit we have employed our AMALTHEA software, which follows the planes intersection method [4]. The spectrum was analyzed with our CHIMET application [5].

Table 1. Radiant and orbital data (J2000).

Radiant data			
	Observed	**Geocentric**	**Heliocentric**
R.A. (º)	186.79±0.03	186.30±0.03	-
Dec. (º)	-38.1±0.1	-41.6±0.1	-
V_∞ (km/s)	28.9±0.3	26.6±0.3	39.7±0.3

Orbital parameters			
a (AU)	4.6±0.4	**ω (º)**	71.1±0.1
e	0.85±0.01	**Ω (º)**	204.9556±10^{-4}
q (AU)	0.690±0.001	**i (º)**	27.2±0.2

3. Data reduction and results

The parent meteoroid impacted the atmosphere with an initial velocity V_∞=28.9±0.3 km/s and the fireball began at a height of 104.4±0.5 km. The event ended at 80.7±0.5 km above the ground level, with the main fulguration taking place at 83±0.5 km under an aerodynamic pressure, calculated in the usual way, of (7.4±0.6)·10^4 dyn/cm^2 [6, 7]. The apparent path in the night sky as seen from both stations is shown in Figure 2. The radiant and orbital parameters are shown in Table I. These data confirm the sporadic nature of the bolide.

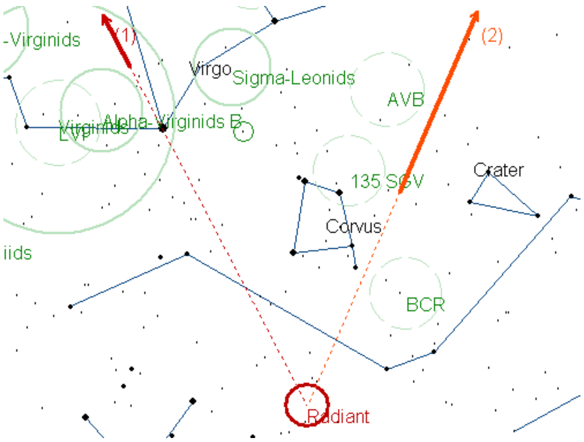

Figure 2. Apparent trajectory as observed from (1) Sevilla and (2) El Arenosillo.

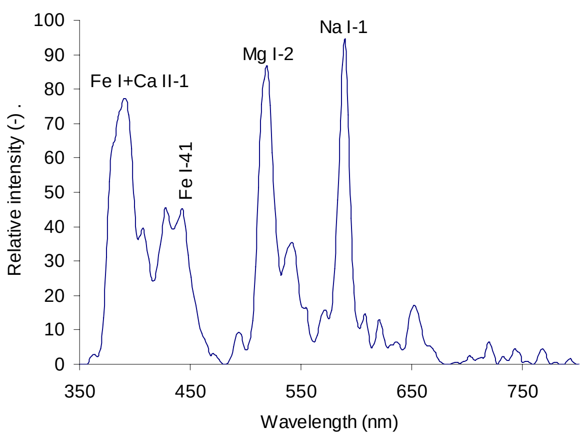

Figure 3. Calibrated emission spectrum of the SPMN140413 fireball.

The calibrated emission spectrum (Fig. 3) shows that the most important contributions correspond to the Na I-1 (588.9 nm) and Mg I-2 (517.2 nm) multiplets. In the ultraviolet, the contribution from the H and K lines from Ca was also identified. As usual in meteor spectra, most of the lines correspond to Fe I. The train spectrum was recorded during about 0.12 seconds. This provided the evolution with time of the intensity of the emission lines in this signal. The contributions from Mg I, Na I, Ca I, Fe I, Ca II and O I were identified in the afterglow, with the Na I-1 (588.9 nm) and Mg I-2 (517.2 nm) lines being the most important ones. The brightness of these lines decreased exponentially with time (Fig. 4). Additional analyses are currently being performed to establish the conditions in the meteor train.

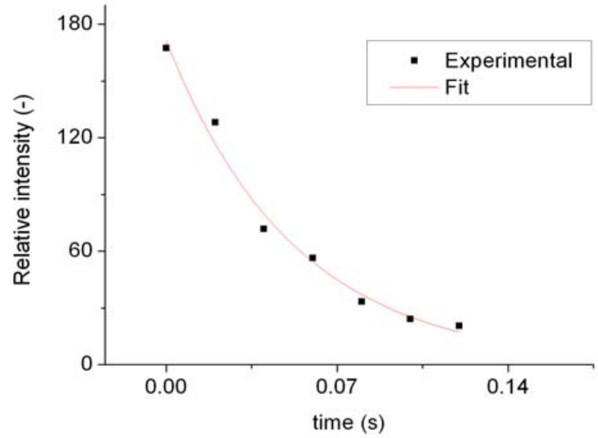

Figure 4. Variation with time of the intensity of the Na I-1 line in the afterglow spectrum.

6. Summary and Conclusions

The preliminary atmospheric trajectory, orbit and radiant data derived from the analysis of a sporadic fireball recorded over Spain on April 14, 2013 have been presented. The contributions from Mg I, Na I, Ca I, Fe I, Ca II and O I were identified in the afterglow spectrum, with the Na I-1 (588.9 nm) and Mg I-2 (517.2 nm) lines being the most important ones. The brightness of these lines decreased exponentially with time.

Acknowledgements

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References

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