EPSC Abstracts
Vol. 8, EPSC2013-282, 2013
European Planetary Science Congress 2013

Trajectory, orbit and spectroscopic analysis of a bright fireball observed over Spain in April 2013

J.M. Madiedo (1,2), J.M. Trigo-Rodríguez (3), J. Zamorano (4), J. Izquierdo (4), J.L. Ortiz (5), L.A. Hernandez (6), A.J. Castro-Tirado (5), F. Ocaña (4), A. Sánchez de Miguel (4), S. Pastor (7), J.A. de los Reyes (7), F. Organero (6), F. Fonseca (6) and J. Cabrera-Caño (2)

(1) Facultad de Ciencias Experimentales. Universidad de Huelva, 21071 Huelva, Spain. (2) Facultad de Física, Universidad de Sevilla, Depto. de Física Atómica, Molecular y Nuclear, 41012 Sevilla, Spain. (3) Institute of Space Sciences (CSIC-IEEC), Campus UAB, Fac. Ciencias C5, 08193 Bellaterra, Barcelona, Spain. (4) Depto. de Astrofísica y CC. de la Atmósfera, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, 28040 Madrid, Spain. (5) Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, Camino Bajo de Huetor 50, 18080 Granada, Spain. (6) Observatorio Astronómico de La Hita, La Puebla de Almoradiel, Toledo, Spain. (7) Observatorio Astronómico de La Murta. Molina de Segura, 30500 Murcia, Spain. (madiedo@uhu.es)

Abstract

The preliminary results of the analysis of a bright fireball observed over Spain on April 13, 2013 are discussed here. This extraordinary event, with an absolute magnitude of -13.0±0.5, was simultaneously observed from 7 meteor observing stations operated by the SPanish Meteor Network (SPMN) together with its emission spectrum.

Figure 1. Selected video frames showing the maximum (left) and final (right) phases of the SPMN130413 fireball as imaged from La Hita.

1. Introduction

Numerous casual witnesses in Spain reported a very bright fireball event in the evening of April 13th 2013. This was confirmed by our meteor observing stations, which recorded the bolide at 21h43m55.4 ± 0.1s UTC. The event was included in our fireball database with the SPMN code 130413. It lasted about 3.1 seconds and flew over the center of the country. The bolide exhibited a very bright flare during the second half of its apparent path and some witnesses located near the epicenter of the event reported that at that instant the night turned into day for a fraction of a second. We named this fireball "Serranillos del Valle", as its maximum brightness was reached when the bolide was located next to the zenith of this town, at about 26 km southwest of Madrid. Here we present a preliminary analysis of this event.

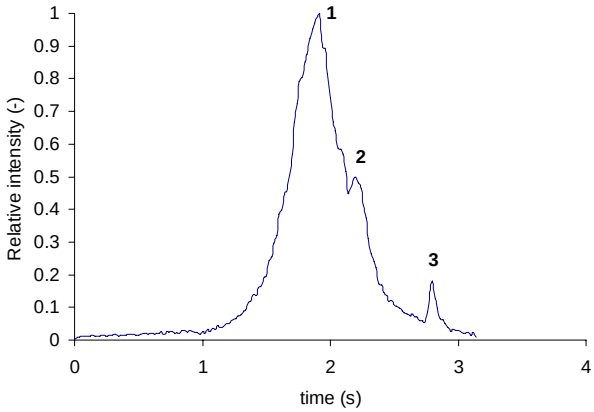

Figure 2. Light curve.

2. Instrumentation

The bolide discussed here (Fig. 1) was recorded from 7 SPMN meteor observing stations: Sevilla, La Hita, Huelva, El Arenosillo, Madrid, Villaverde del Ducado and Molina de Segura. It was also registered by a low-resolution camera from the Calar Alto Astronomical Observatory. SPMN systems employ high-sensitivity CCD video devices (models 902H and 902H Ultimate, from Watec Co.) that provide 25 fps interlaced video sequences [1, 2]. Some of these are configured as spectrographs by attaching

holographic diffraction gratings (1000 lines/mm) to the objective lens [3]. In addition, a digital photographic camera operating from La Hita with a fisheye lens also imaged the event. To calculate the atmospheric trajectory, radiant and orbit we have employed our AMALTHEA software, which follows the planes intersection method [4]. The analysis of the emission spectrum was performed with our CHIMET application [5].

3. Data reduction and results

The analysis of the atmospheric path reveals that the fireball began at 102.9±0.5 km above the ground level. The meteoroid struck the atmosphere with an initial velocity V_∞=22.4±0.3 km/s and penetrated till a height of 68.9±0.3 km. This discards the survival of fragments as meteorites on the ground. The calculated radiant and orbital parameters are summarized in Table 1. The maximum brightness corresponded to an absolute magnitude of -13.0±0.5. The light curve (Fig. 2) shows the three main flares exhibited by this event. The tensile strength estimated from the aerodynamic pressure corresponding to the first of these flares [6, 7] was $(4.5\pm0.6)\cdot10^4$ dyn/cm^2. On the other hand, the initial mass of the meteoroid, calculated from this light curve, was 40±5 kg.

Table 1. Radiant and orbital data (J2000).

Radiant data			
	Observed	**Geocentric**	**Heliocentric**
R.A. (º)	165.0±0.1	163.7±0.1	-
Dec. (º)	-12.2±0.1	-17.1±0.1	-
V_∞ (km/s)	20.3±0.3	16.9±0.3	40.6±0.3
Orbital parameters			
a (AU)	7.5±1.5	**ω (º)**	39.55±0.03
e	0.88±0.02	**Ω (º)**	203.9436±10^{-4}
q (AU)	0.895±0.001	**i (º)**	9.5±0.1

The emission spectrum of the fireball, corrected by taking into account the spectral response of the recording device, is shown in Fig. 3. The most prominent lines correspond to the emission from the Na I-1 (588.9 nm) and Mg I-2 (517.2 nm) multiplets. Several Fe I multiplets were also identified in the signal.

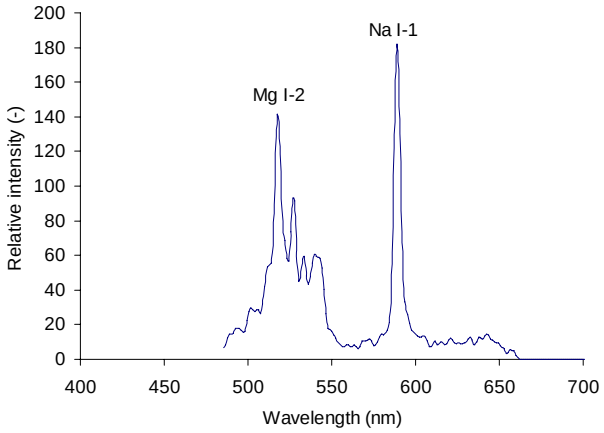

Figure 3. Calibrated emission spectrum.

6. Summary and Conclusions

A preliminary analysis of the mag. -13 fireball witnessed over Spain on April 13, 2013 has been presented. The mass of the parent meteoroid was of about 40 kg. No fragments survived as meteorites because of the low penetration of the bolide (about 69 km above the ground level). The emission spectrum is dominated by the emission from Na I-1 and Mg I-2 multiplets. Additional analysis will be performed in order to obtain the relative abundances of the main rock-forming elements in the meteoroid.

Acknowledgements

We acknowledge support from the Spanish Ministry of Science and Innovation (project AYA2011-26522) and Junta de Andalucía (project P09-FQM-4555).

References

[1] Madiedo J.M. and Trigo-Rodríguez J.M. (2007) *EMP* 102, 133-139. [2] Madiedo J.M. et al. (2010) *Adv.in Astron* 2010 1-5. [3] Trigo-Rodriguez, et al. (2009) *MNRAS* 392, 367–375. [4] Ceplecha, Z. (1987) Bull. Astron. Inst. Cz. 38, 222-234. [5] Madiedo J.M. et al. (2012) *MNRAS*, submitted. [6] Bronshten V.A. (1981) *Geophysics and Astrophysics Monographs*. Reidel, Dordrecht. [7] Trigo-Rodríguez J.M. and Llorca J. (2006) *MNRAS*, 372, 655.