ORBIT AND LINES IDENTIFICATION IN THE EMISSION SPECTRUM OF A SPORADIC FIREBALL.

J. Zamorano[1], J.M. Madiedo[2,3], J.M. Trigo-Rodríguez[4], J. Izquierdo[1], F. Ocaña[1] and A. Sánchez de Miguel[1]. [1]Dpto. de Astrofísica y CC. de la Atmósfera, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, 28040 Madrid, Spain, jzamorano@fis.ucm.es. [2]Facultad de Ciencias Experimentales, Universidad de Huelva, 21071 Huelva, Spain, madiedo@uhu.es. [3]Dpto. de Física Atómica, Molecular y Nuclear, Facultad de Física, Universidad de Sevilla, 41012 Sevilla, Spain, [4]Institute of Space Sciences (CSIC-IEEC). Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra, Spain, trigo@ieec.uab.es.

Introduction: High-sensitivity CCD video cameras have been commonly used for the study of the activity of meteoroid streams. These provide useful data for the determination, for instance, of radiant, orbital and photometric parameters [1, 2, 3]. These devices can also be used to record emission spectra of meteoroids ablating in the Earth's atmosphere when holographic diffraction gratings are employed [3].

The SPMN is currently performing a continuous monitoring of meteor activity by means of 25 meteor observing stations in Spain. One important goal of our network is the study 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 atmosphere. This continuous monitoring can provide useful data to improve our knowledge about meteoroid streams and meteoroids of sporadic origin, and the mechanisms that deliver these materials to the Earth. With this aim, we analyze here a sporadic fireball recorded on December 28, 2011.

Instrumentation and methods: The meteor observing stations involved in this research are based on an array of high-sensitivity CCD video cameras (902H and 902H Ultimate from Watec Co., Japan) to monitor the night sky. Some of these devices employ holographic diffraction gratings (600 lines/mm) for meteor spectroscopy. For data reduction we have used our AMALTHEA software, which follows the planes intersection method [4] to determine the atmospheric trajectory and radiant of meteor events. The orbital parameters of the meteoroid are calculated by means of the procedure described in [4].

Atmospheric trajectory, radiant and orbit: A mag. -7 fireball was simultaneously imaged from four SPMN stations on December 28, 2011: Villaverde del Ducado, Sevilla, El Arenosillo and La Hita. Its apparent trajectory, as observed from Sevilla and El Arenosillo, can be seen in Figure 3. The event was imaged at 3h59m32.5±0.1s UTC and exhibited several fulgurations along its trajectory (Figure 1). It began at a height of 110.1±0.5 km and ended at 62.5±0.5 km above the ground level. The projection of this trajectory on the ground is shown in Figure 3. The meteoroid stroke the atmosphere with an initial velocity V_∞=32.1±0.3 km/s. The main flare took place at a height of about 70.4 km, with a velocity of 27.1 km/s. With these data we have estimated that the meteoroid suffered this break-up under an aerodynamic pressure of $5.1\pm0.3\times10^4$ dyn/cm^2. This calculation was performed by following the procedure described in [5]. Once the trajectory was determined and the radiant position was inferred, we calculated the orbit of the meteoroid (Figure 4). The radiant and orbital parameters are summarized on Table 1. These values imply that the fireball was associated to the antihelion source.

Figure 1. Composite image of the fireball, as imaged from Sevilla.

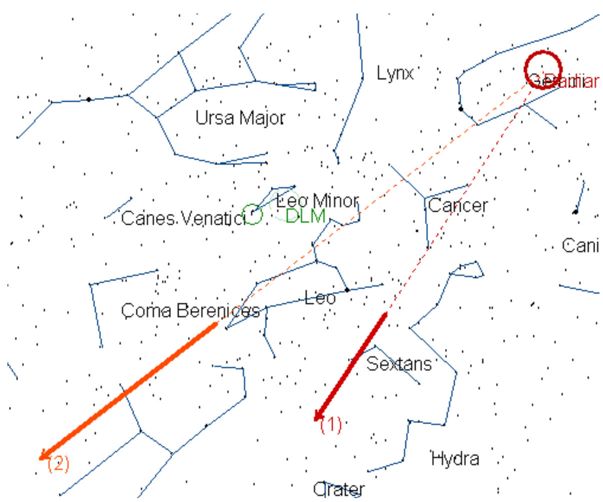

Figure 2. Apparent trajectory of the bolide as seen from Sevilla (1) and El Arenosillo (2).

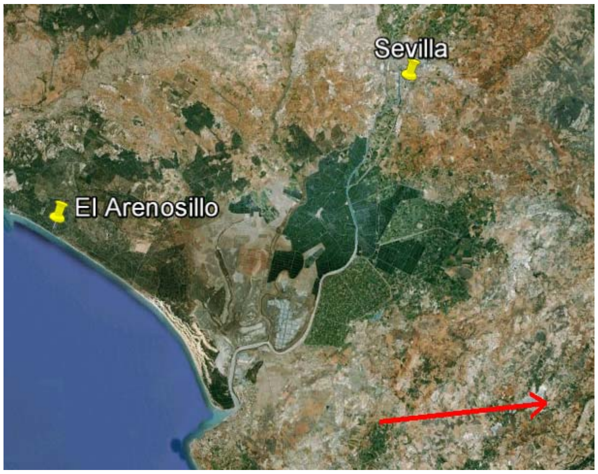

Figure 3. Projection on the ground of the atmospheric path of the fireball.

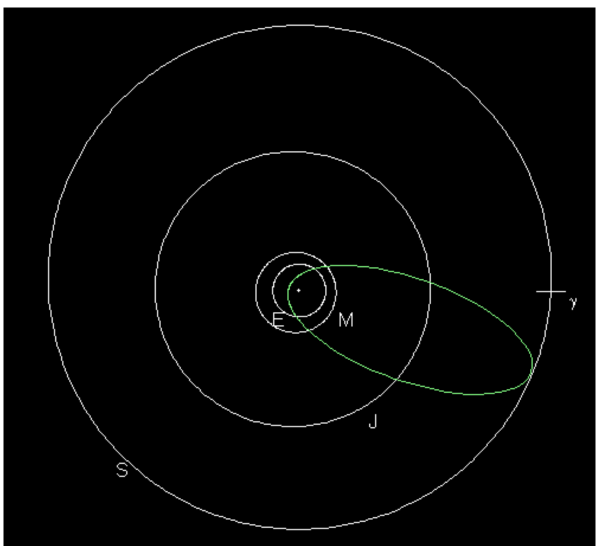

Figure 4. Projection on the ecliptic plane of the orbit of the meteoroid that produced the SPMN281211 fireball.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	106.0±0.3	103.8±0.3	
Dec. (º)	23.8±0.2	22.8 ±0.2	
V_∞ (km/s)	32.1±0.3	30.4±0.3	40.3±0.3
Orbital parameters			
a (AU)	5.0±0.5	**ω (º)**	106.0±0.4
e	0.919±0.008	**Ω (º)**	93.19460±10^{-4}
q (AU)	0.403±0.004	**i (º)**	0.03±0.04

Table 1. Radiant and orbital data (J2000).

Emission spectrum: The spectrum, after calibration in wavelengths and correction for instrument sensitivity, is shown in Figure 5. It was obtained by one spectral camera at Villaverde del Ducado. The signal is dominated by strong Mg and Na emission lines. The Mg I-2 (516.7 nm) line, however, has a latter onset than the Na I-1 (588.9 nm) line. In any event, most lines identified correspond to Fe I multiplets. The Ca II H and K lines (393.4 and 396.8 nm) are also present, but they are blended with the Mg I-3 (382.9 nm) and Fe I-4 (389.9 nm) lines. In the infrared, the O I triplet at 777.4 nm was recorded. The contribution from the first positive system of N_2 is also seen.

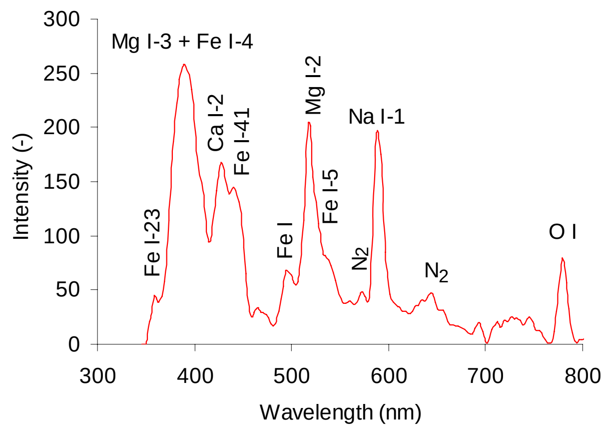

Figure 5. Spectrum of the SPMN281211 bolide, with main emission lines.

Conclusions: We have performed spectroscopic and imaging observations of a mag. -7 sporadic fireball. For this purpose we have employed an array of high-sensitivity CCD video devices. The analysis of this event has provided its atmospheric trajectory and radiant, but also the orbit of the meteoroid. The emission spectrum gave us an insight into the chemical composition of this particle.

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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. Bull. Astron. Inst. Cz. 38, 222-234, 1987 [5] Bronshten V. A., 1981, *Geophysics and Astrophysics Monographs*. Reidel, Dordrecht.