A FIREBALL PRODUCED BY A METEOROID FOLLOWING A RETROGRADE ORBIT. G. Alvarez[1], J.M. Madiedo[1,2], J.M. Trigo-Rodríguez[3], J.L. Ortiz[4], A.J. Castro-Tirado[4] and J. Cabrera[2]. [1]Facultad de Ciencias Experimentales, Universidad de Huelva, Huelva, Spain, madiedo@uhu.es. [2]Departamento de Fisica Atomica, Molecular y Nuclear. Universidad de Sevilla. 41012 Sevilla, Spain. [3]Institute of Space Sciences (CSIC-IEEC). Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra, Spain, trigo@ice.csic.es. [4]Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada, Spain.

Introduction: One of the systems employed by the SPanish Meteor Network (SPMN) to perform a continuous monitoring of meteor and fireball activity is based on high-sensitivity CCD video cameras. These devices have been commonly used for the determination, for instance, of radiant, orbital and photometric parameters [1, 2, 3]. Besides, they are also suitable for meteor spectroscopy [3]. When properly configured, these cameras are also able to work under twilight conditions. This is one advantage with respect to slow-scan CCD systems, as this allows extending the operation period to some minutes before sunset and after sunrise. Here we analyze a double-station sporadic fireball recorded in the morning twilight of July 7, 2011.

Figure 1. Composite image of the SPMN070711 fireball imaged from La Hita Astronomical Observatory.

Instrumentation and data reduction methods: High-sensitivity CCD video cameras (models 902H and 902H Ultimate from Watec Corporation, Japan) have been employed to image the fireball analyzed here. These devices operated from two SPMN meteor stations that work in an autonomous way by means of software developed by us [1, 2]. These devices are configured as spectral cameras, with transmission diffraction gratings attached to the objective lenses. For trajectory, radiant and orbital parameters calculation we have employed our AMALTHEA software. Emission spectra are processed with our CHIMET program.

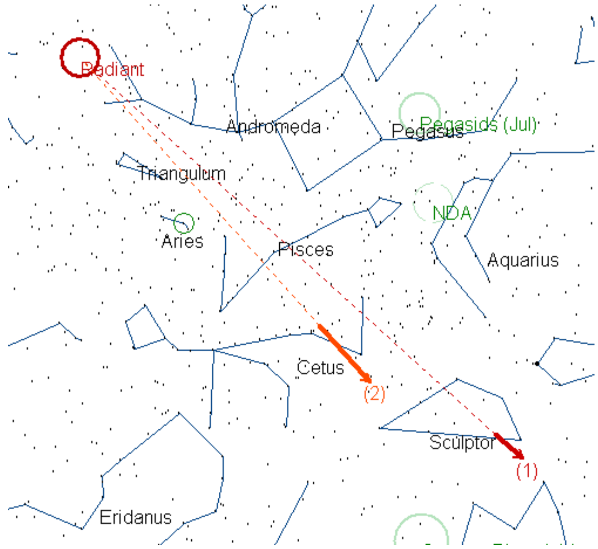

Figure 2. Apparent trajectory of the SPMN070711 fireball as recorded from Sierra Nevada (1) and La Hita (2) meteor observing stations.

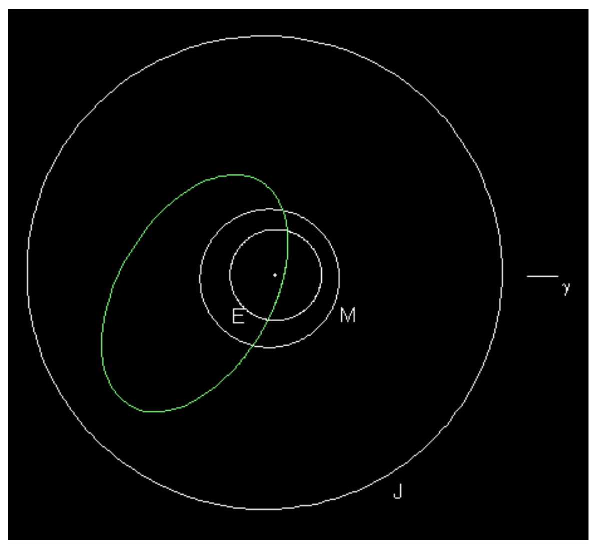

Figure 3. Projection on the ecliptic plane of the orbit of the SPMN070711 fireball.

Atmospheric trajectory, radiant and orbit: The bolide discussed here was imaged in the morning twilight on July 7, 2011, at 4h03m20.7±0.1s UTC (Figure 1). It was simultaneously recorded by our meteor cameras at Sierra Nevada and La Hita astronomical observatories, in Spain. Its apparent trajectory in the sky is shown in Figure 2. The estimated magnitude of this event, which received the SPMN code 070711, was of about -7±1 fireball. Its atmospheric trajectory and radiant were obtained by using the planes intersection method [4]. According to this, the fireball begun at a height of 112.7±0.5 km and ended at about 81.8±0.5 km above the ground level. The preatmospheric velocity, obtained by extrapolating the velocities measured at the beginning of the meteor trail was V_∞=56.1.±0.3 km/s. With this information we calculated the orbit of the meteoroid that produced this bolide. Radiant and orbital parameters are shown on Table 1. The projection of this orbit on the ecliptic plane can be seen in Figure 3.

By analyzing the flare exhibited by the fireball (Figure 1), which took place at a height of 85.6 km, we could infer the tensile strength of the meteoroid by following the procedure described in [5]. A value of $1.8\pm0.1\times10^3$dyn/cm^2 was obtained for this parameter.

Emission spectrum: One our video spectrographs operating from Sierra Nevada imaged the emission spectrum of the bolide despite working under twilight conditions. The raw signal is shown in Figure 4a. This was processed by following the procedure described in [6, 7] with our CHIMET software. The calibrated spectrum, obtained by taking into account the spectral response of the instrument, is shown in Figure 4b. Different Fe I multiplets were identified. Some of these are shown in Figure 5, together with the contribution of Mg I-3 (382.9 nm), Mg I-2 (516.7 nm) and Na I-1 (588.9 nm) multiplets. Atmospheric nitrogen lines can also be seen.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	31.2±0.4	31.2±0.4	
Dec. (º)	48.1±0.3	48.3±0.3	
V_∞ (km/s)	56.1±0.3	54.7±0.3	40.0±0.3

Orbital parameters			
a (AU)	6.1±1.0	**ω (º)**	98.6±1.2
e	0.90±0.01	**Ω (º)**	104.5729 ± 10^{-4}
q (AU)	0.607±0.008	**i (º)**	107.1±0.5

Table 1. Radiant and orbital data (J2000) for the SPMN070711 fireball.

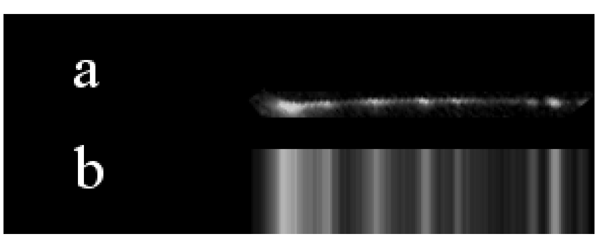

Figure 4. Raw (a) and processed (b) emission spectrum of the SPMN070711 fireball.

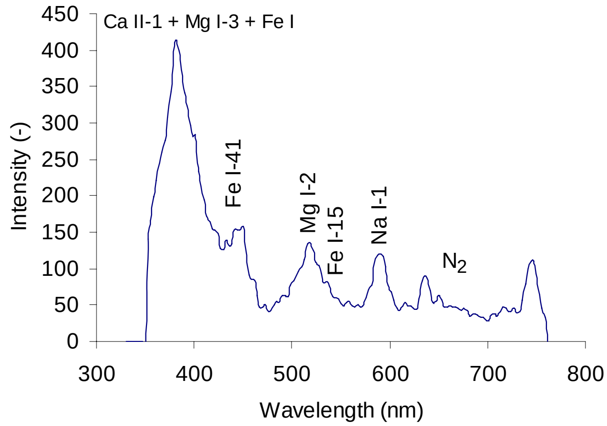

Figure 5. Main emission lines identified in the spectrum of the SPMN070711 fireball.

Conclusions: Thanks to the ability of our video systems to work under twilight conditions, we have recorded the mag. -7 double-station fireball discussed here. The analysis of this event has provided its trajectory and radiant, but also the orbit in the Solar System and the tensile strength of the meteoroid that produced this bolide. By means of the emission spectrum produced during the ablation of this particle, we could also infer helpful information about its chemical composition.

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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] Trigo-Rodríguez J.M., and Llorca J., 2006, MNRAS, 372, 655. [6] J.M. Trigo-Rodríguez et al. (2003) *MAPS* 38, 1283-1294. [7] Trigo-Rodríguez et al. (2004) *MNRAS* 348, 802-810.