

**SPECTRUM AND ORBIT OF A NOVEMBER LEONIS MINORIDS BOLIDE OBSERVED IN 2011.** J. Ares<sup>1</sup>, J.M. Madiedo<sup>1,2</sup>, J.M. Trigo-Rodríguez<sup>3</sup> and F.M. Toscano<sup>4</sup>. <sup>1</sup>Facultad de Ciencias Experimentales, Universidad de Huelva, Huelva, Spain, madiedo@uhu.es. <sup>2</sup>Departamento de Física Atomica, Molecular y Nuclear. Universidad de Sevilla. 41012 Sevilla, Spain. <sup>3</sup>Institute of Space Sciences (CSIC-IEEC). Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra, Spain, trigo@ice.csic.es. <sup>4</sup>Facultad de Química. Universidad de Sevilla. 41012 Sevilla, Spain.

**Introduction:** The Spanish Meteor Network (SPMN) is performing a continuous monitoring of meteor and fireball activity over Spain and neighbouring areas. Nowadays, we operate 25 meteor observing stations which employ different detection and recording techniques. Optimal weather conditions in our country in comparison to other areas in Europe favour our fireball monitoring and meteor spectroscopy campaigns and, as a result of this, we are obtaining helpful data about poorly known meteoroid streams. In this context, we analyze here a bolide belonging to the November Leonis Minorids shower (NLM) recorded in 2011. Its emission spectrum is also presented.



Figure 1. The SPMN291111 NLM bolide imaged, together with its emission spectrum, from La Hita Astronomical Observatory.

**Instrumentation and data reduction methods:** Two SPMN meteor observing stations were involved in the detection of the fireball discussed here. These operate from La Hita and Sierra Nevada astronomical observatories and employ an array of high-sensitivity CCD video cameras (models 902H and 902H Ultimate from Watec Corporation, Japan). Both stations work in a fully 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.

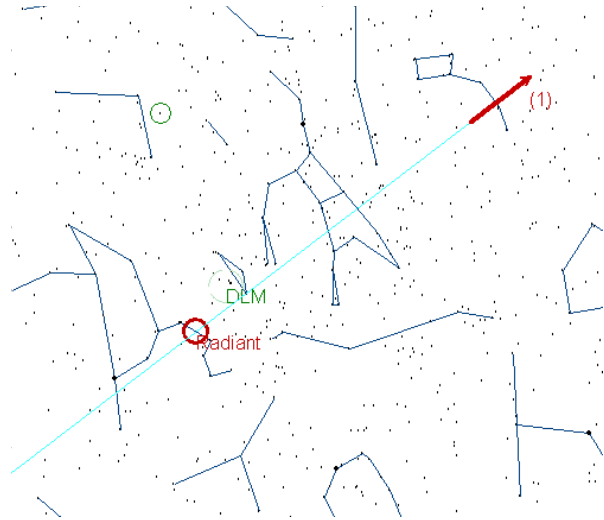


Figure 2. Apparent trajectory of the fireball as recorded from Sierra Nevada.



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

**Atmospheric trajectory, radiant and orbit:** The mag.  $-7 \pm 1$  NLM bolide shown in Figure 1 was recorded by two of our meteor cameras on November 29, 2011, at  $4\text{h}49\text{m}29.4 \pm 0.1\text{s}$  UTC (Figure 1). It was listed in our fireball database with code SPMN291111. Figure 2 shows its apparent trajectory in the sky as observed from Sierra Nevada. According to our calculations, the fireball begun at a height of  $110.0 \pm 0.5$  km and ended at about  $56.4 \pm 0.5$  km above the ground level. The parent meteoroid struck the atmosphere with an initial velocity  $V_{\infty} = 66.8 \pm 0.3$  km/s. The projection on the ground of this atmospheric path is indicated in

Figure 3. 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 4.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (°)	151.5±0.4	151.0±0.4	
Dec. (°)	27.5±0.3	27.5±0.3	
V <sub>∞</sub> (km/s)	66.8±0.3	66.8±0.3	38.8±0.3
Orbital parameters			
a (AU)	3.0±0.2	ω (°)	233.4±1.6
e	0.73±0.02	Ω (°)	246.4406±10 <sup>-4</sup>
q (AU)	0.817±0.008	i (°)	152.3±0.5

Table 1. Radiant and orbital data (J2000) for the NLM bolide analyzed in this work.

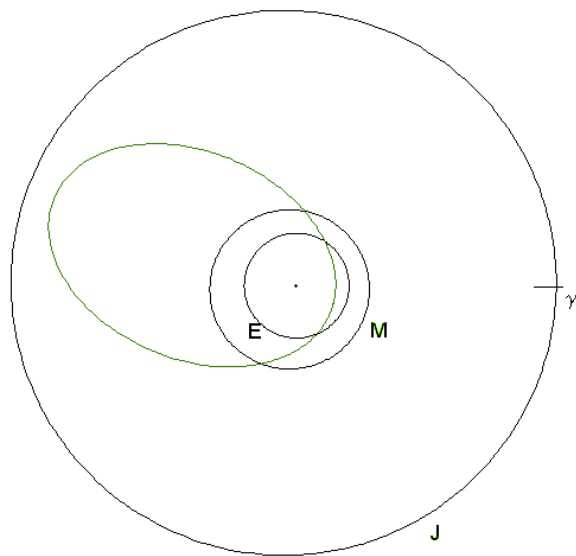


Figure 4. Projection on the ecliptic plane of the orbit of the parent meteoroid.

**Spectrum:** The emission spectrum of the bolide was recorded by one spectrograph operating from La Hita Astronomical Observatory (Figure 1). The calibrated spectrum and the main lines identified in it are shown in Figure 5. This result was obtained from the raw signal by following the procedure described in [3, 4]. As can be noticed, the spectrum is dominated by the emission from Fe I-23 at 360.9 nm and the H and K lines of ionized calcium in the ultraviolet. The line corresponding to the Mg I-2 multiplet at 516.7 nm is weak and the emission from Na I-1 (588.9 nm) was not found. Atmospheric nitrogen bands in the red region of the spectrum can be seen.

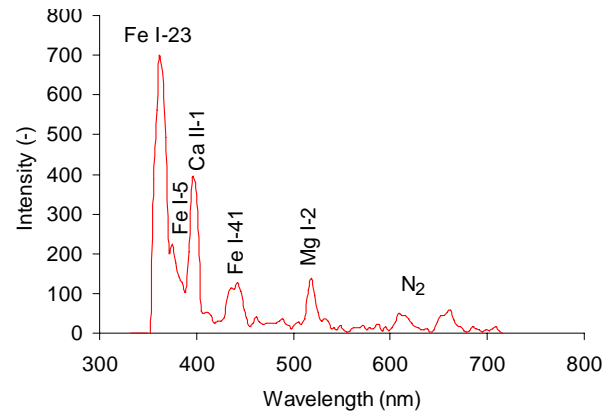


Figure 5. Calibrated emission spectrum.

**Conclusions:** A mag. -7 double-station fireball was imaged in the framework of our continuous fireball monitoring and meteor spectroscopy campaigns. Its atmospheric trajectory was obtained, and the analysis of radiant and orbital parameters revealed that this event was produced by a meteoroid belonging to the November Leonis Minorids (NLM) stream. The emission spectrum obtained during the ablation of this particle provides an insight into its chemical nature. Thus, the meteoroid was depleted in sodium, and a strong emission from Fe I-23 (360.9 nm) and Ca II H and K lines was found.

**Acknowledgements:** We thank *Fundación Astro-Hita* for its support in the establishment and operation of the automated meteor observing station located at La Hita Astronomical Observatory (La Puebla de Almoradiel, Toledo, Spain). We also acknowledge support from the Spanish Ministry of Science and Innovation (projects AYA2009-13227, AYA2011-26522 and AYA2009-06330-E).

**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] J.M. Trigo-Rodríguez et al. (2003) *MAPS* 38, 1283-1294. [4] Trigo-Rodríguez et al. (2004) *MNRAS* 348, 802-810.