

**THE "VALENCIA DE LAS TORRES" SUPERBOLIDE OF AUGUST 23, 2012.** M.L. Rodríguez-Vallejo<sup>1</sup>, J.M. Madiedo<sup>1,2</sup>, J.M. Trigo-Rodríguez<sup>3</sup>, J. Zamorano<sup>4</sup>, J. Izquierdo<sup>4</sup>, A.J. Castro-Tirado<sup>5</sup>, J.L. Ortiz<sup>5</sup>, F. Ocaña<sup>4</sup>, A. Sánchez de Miguel<sup>4</sup>. <sup>1</sup>Facultad de Ciencias Experimentales, Universidad de Huelva, Avda. de las Fuerzas Armadas S/N. 21071 Huelva, Spain. <sup>2</sup>Depto. de Física Atómica, Molecular y Nuclear, Facultad de Física, Universidad de Sevilla, 41012 Sevilla, Spain, madiedo@uhu.es. <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>Depto. de Astrofísica y CC. de la Atmósfera, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, 28040 Madrid, Spain. <sup>5</sup>Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada, Spain.

**Introduction:** On August 23, 2012, a superbolide was recorded by our fireball monitoring systems operating in the south and center of Spain. Its emission spectrum was also obtained in the framework of the continuous spectroscopic campaign developed by the SPANISH Meteor Network (SPMN) since 2006. In this work we present the analysis of this event, which was produced by a meteoroid with a cometary origin.



Figure 1. Composite image of the fireball as imaged from Sevilla (top) and El Arenosillo (bottom).

#### Instrumentation and data reduction methods:

An array of low-lux CCD video cameras (models 902H and 902H Ultimate from Watec Corporation, Japan) has been used to image the fireball considered in this work. A more detailed description of these systems and

their operation has been given in [1, 2]. Some of these CCD devices are configured as spectral cameras, with transmission diffraction gratings attached to the objective lens. For trajectory, radiant and orbital parameters calculation we have employed our AMALTHEA software. The emission spectrum was analyzed with our CHIMET program.

**Atmospheric trajectory, radiant and orbit:** The bolide, with an absolute magnitude of  $-17 \pm 1$ , was recorded on August 23, 2012 at 22h45m55.1 $\pm$ 0.1s UTC (Figure 1) from our meteor stations located at La Hita, Sevilla, El Arenosillo, Madrid and Villaverde del Ducado. Its emission spectrum was also recorded by two spectroscopes operating from El Arenosillo and La Hita. It was named "Valencia de las Torres", as its maximum brightness, due to the sudden disruption of the parent meteoroid, took place north-east of this town in the region of Extremadura (Figure 2).



Figure 2. Projection on the ground of the atmospheric path of the bolide.

Radiant data			
	Observed	Geocentric	Heliocentric
<b>R.A. (°)</b>	313.2 $\pm$ 0.4	311.7 $\pm$ 0.5	
<b>Dec. (°)</b>	1.5 $\pm$ 0.3	-0.6 $\pm$ 0.4	
<b>V<sub>∞</sub> (km/s)</b>	24.8 $\pm$ 0.3	22.2 $\pm$ 0.3	41.7 $\pm$ 0.3
Orbital parameters			
<b>a (AU)</b>	83 $\pm$ 8	<b>ω (°)</b>	239.8 $\pm$ 0.4
<b>e</b>	0.99 $\pm$ 0.01	<b>Ω (°)</b>	151.0113 $\pm$ 10 <sup>-4</sup>
<b>q (AU)</b>	0.760 $\pm$ 0.003	<b>i (°)</b>	10.1 $\pm$ 0.2

Table 1. Radiant and orbital data (J2000).

According to our calculations, the meteoroid struck the atmosphere with an initial velocity  $V_{\infty}=24.8\pm 0.3$  km/s. The trajectory was almost vertical, with a zenith angle of about  $2.5^{\circ}$ . The fireball began at a height of about  $118.5\pm 0.5$  km and ended at  $87.4\pm 0.5$  km. The orbit obtained for this particle is shown in Figure 3. Radiant and orbital parameters are summarized in Table 1. The light curve (Figure 4) is rather smooth, and shows two flares, the main one corresponding to the destruction of the meteoroid at a height of 91.5 km. By calculating the aerodynamic pressure under which this flare took place [3], we have estimated that the tensile strength of the meteoroid [4] was of about  $1.1\pm 0.4\times 10^3$  dyn/cm<sup>2</sup>.

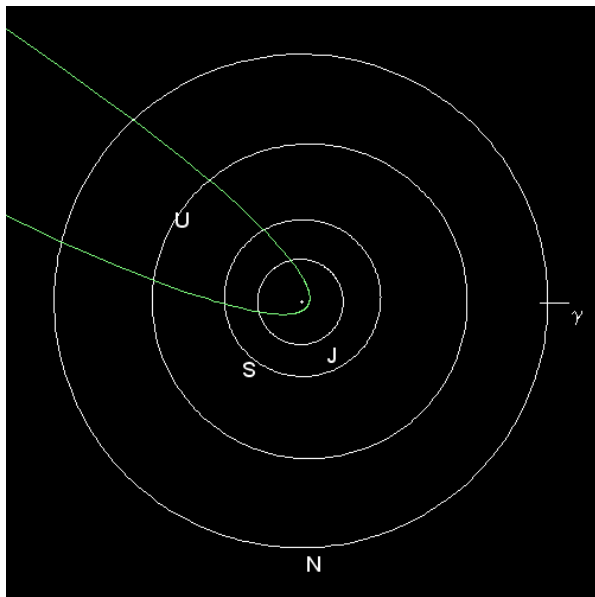


Figure 3. Orbit of the parent meteoroid projected on the ecliptic plane.

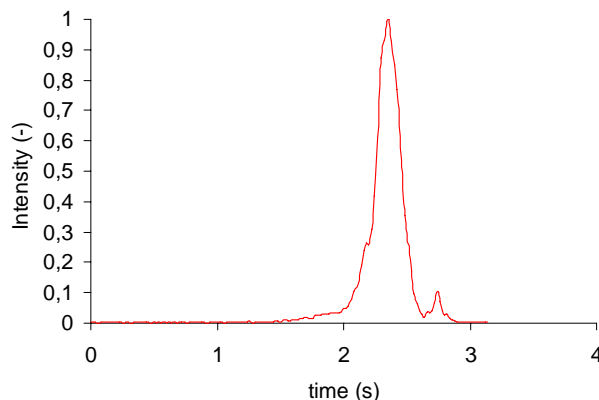


Figure 4. Light curve (relative pixel brightness vs. time).

**Emission spectrum:** The emission spectrum was reduced with our CHIMET software, which follows

the analysis technique described in [5, 6]. The calibrated signal, corrected by using the spectral response of the recording device, is shown in Figure 5. The spectrum is dominated by the emission from Na I-1 (588.9 nm). The contribution from Mg I-2 is also strong. On the other hand, the emission due to the H and K lines of Ca II was identified, but these appear blended with several Fe I lines. Atmospheric N<sub>2</sub> bands can also be noticed in the red region.

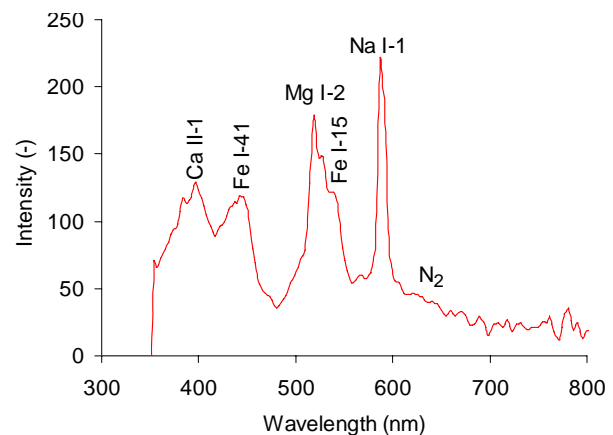


Figure 5. Calibrated emission spectrum.

**Conclusions:** We have analyzed a double-station superbolide recorded over the south of Spain in August 2012. The atmospheric trajectory was almost vertical, and the parent meteoroid penetrated till a height of about 87.4 km above the ground level. At that stage, the particle, with a relatively low tensile strength, experienced a sudden disruption. The orbital analysis confirmed the sporadic origin of this event and the cometary nature of the parent meteoroid. On the other hand, the emission spectrum indicates that the abundance of Na is high.

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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] Bronshten V. A., 1981, *Geophysics and Astrophysics Monographs*. Reidel, Dordrecht. [4] Trigo-Rodríguez J. M. et al. (2003) *MAPS* 38, 1283-1294. [5] Trigo-Rodríguez J.M. et al. (2003) *MAPS* 38, 1283-1294. [6] Trigo-Rodríguez J.M. et al. (2004) *MNRAS* 348, 802-810.