ANALYSIS OF A SUPERBOLIDE OBSERVED OVER THE IBERIAN PENINSULA ON JULY 21, 2012. J. Alonso-Azcárate[1], J.M. Madiedo[2, 3], J.M. Trigo-Rodríguez[4], J. Zamorano[5], J. Izquierdo[5], A.J. Castro-Tirado[6], J.L. Ortiz[6], F. Ocaña[5], A. Sánchez de Miguel[5], J. Lacruz[7] and J.Cabrera[3]. [1]Universidad de Castilla-La Mancha, Campus Fábrica de Armas, 45071 Toledo. [2]Facultad de Ciencias Experimentales, Universidad de Huelva, Avda. de las Fuerzas Armadas S/N. 21071 Huelva, Spain. [3]Depto. de Física Atómica, Molecular y Nuclear, Facultad de Física, Universidad de Sevilla, 41012 Sevilla, Spain, madiedo@uhu.es. [4]Institute of Space Sciences (CSIC-IEEC). Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra, Spain, trigo@ice.csic.es. [5]Depto. de Astrofísica y CC. de la Atmósfera, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, 28040 Madrid, Spain. [6]Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada, Spain. [7]La Cañada Observatory (MPC J87), Ávila, Spain.

Introduction: A superbolide was observed on July 21, 2012 over the center and south of Spain. The event was recorded in the framework of our continuous fireball monitoring and spectroscopic campaigns. Besides, because of optimal weather conditions, the bolide was imaged from ten meteor observing stations operated by the SPanish Meteor Network (SPMN). These employ high-sensitivity CCD video cameras and spectrographs to monitor the night sky. In this way, different physico-chemical parameters of meteoroids ablating in the atmosphere can be calculated [1, 2, 3]. We present here a preliminary analysis of this multi-station fireball, which was imaged together with its emission spectrum.

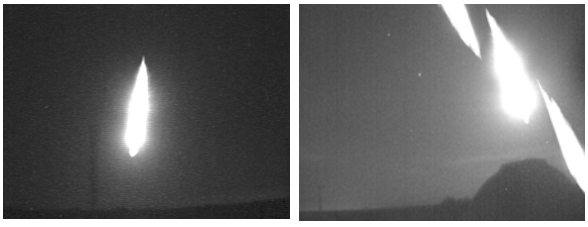

Figure 1. Composite image of the fireball as imaged from El Arenosillo (left) and La Hita (right).

Figure 2. Composite image taken by a low-sensitivity colour CCD camera operating from Sevilla.

Observational techniques 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.

The July 21, 2012 event: Because of the very high brightness of this bolide (absolute magnitude -16±1) and excellent weather conditions in the Iberian Peninsula on July 21, 2012, the fireball was imaged from most SPMN stations located in the south and center of Spain (Figures 1 and 2). The best images were obtained from our fireball recording systems operating from La Hita Astronomical Observatory, Madrid, Toledo, El Arenosillo, Sevilla, Ávila, Villaverde del Ducado and Huelva. The event was observed at 22h21m56.7±0.1s UTC and received the SPMN code 210712. Its emission spectrum was also recorded by two spectroscopes operating from El Arenosillo and La Hita.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	290.4±0.5	270.8±0.5	
Dec. (º)	38.1±0.4	34.7 ±0.4	
V_∞ (km/s)	25.1±0.3	22.5±0.3	36.7±0.3

Orbital parameters			
a (AU)	2.2±0.1	**ω (º)**	229.8±1.0
e	0.60±0.01	**Ω (º)**	119.3612 ± 10^{-4}
q (AU)	0.879±0.004	**i (º)**	33.9±0.4

Table 1. Radiant and orbital data (J2000).

Atmospheric trajectory, radiant and orbit: Our calculations reveal that the meteoroid struck the atmosphere with an initial velocity V_∞=25.1.±0.3 km/s. The fireball began at a height of about 81.8±0.5 km and ended at 30.2±0.5 km. With this information, the orbit of the parent meteoroid in the Solar System was obtained (Figure 3) by following the procedure de-

scribed in [4]. Radiant and orbital parameters are summarized in Table 1. The analysis of the light curve (Figure 4) shows that the fireball suffered several flares along its trajectory, with two main fulgurations taking place at about 55.8 km and 43.5 km above the ground level. These took place under an aerodynamic pressure, calculated in the usual way [5], of $1.9\pm0.3\times10^5$dyn/cm^2 and $7.5\pm0.3\times10^5$dyn/cm^2 respectively.

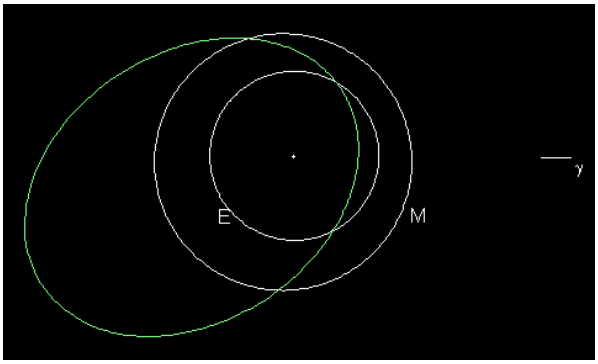

Figure 3. Projection on the ecliptic plane of the orbit of the parent meteoroid.

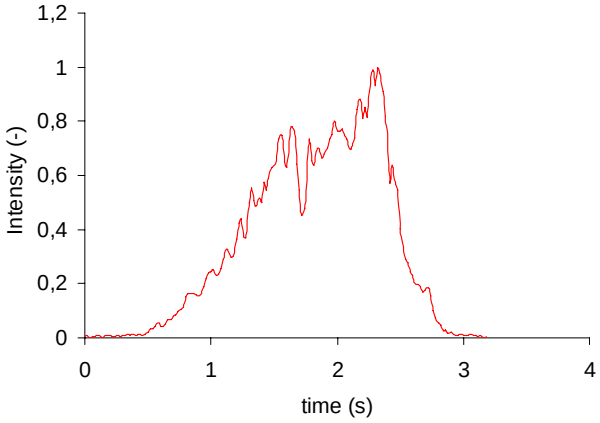

Figure 4. Light curve (relative pixel intensity vs. time) of the SPMN210712 fireball.

Emission spectrum: Figure 1 (right) shows a composite image of the fireball, together with its emission spectrum. This was reduced with our CHIMET software, which follows the analysis technique described in [6, 7]. Thus, the software initially provided an intensity profile (pixel brightness, in arbitrary units, vs. pixel number). The signal was then converted to intensity versus wavelength by identifying typical lines appearing in meteor spectra (mainly Fe I, Na I, Ca I, Ca II and Mg I multiplets). Then, the spectrum was corrected by taking into account the spectral response of the device. The result is shown in Figure 5. The main emission comes from the H and K lines of ionized calcium in the ultraviolet and also from the Mg I-3 (382.9 nm) multiplet. Several lines corresponding to Fe I can also be seen, together with the emission from atmospheric N_2. However, the contribution from Na I-1 (588.9 nm) is not clear. This means that either the parent meteoroid was depleted in this element or the fireball was produced by a metallic meteoroid. Further analyses are currently in progress in order to clarify this situation.

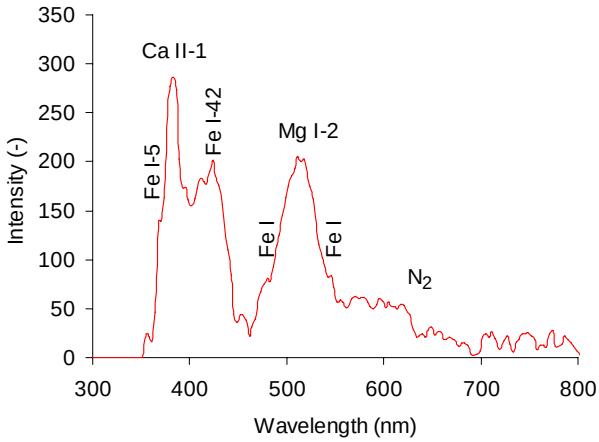

Figure 5. Emission spectrum of the SPMN210712 bolide.

Conclusions: A multistation -16±1 bolide was recorded in the framework of the continuous fireball monitoring and spectroscopic campaigns developed by the SPMN. Its atmospheric trajectory and radiant were obtained. Besides, the orbit of the parent meteoroid was also calculated. On the other hand, the analysis of the emission spectrum has provided an insight into the chemical nature of this particle.

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] Trigo-Rodriguez, et al. (2009) *MNRAS*. 392, 367–375. [4] Ceplecha, Z. (1987) *Bull. Astron. Inst. Cz.* 38, 222-234. [5] Bronshten V. A., 1981, *Geophysics and Astrophysics Monographs*. Reidel, Dordrecht. [6] J.M. Trigo-Rodríguez et al. (2003) *MAPS* 38, 1283-1294. [7] Trigo-Rodríguez et al. (2004) *MNRAS* 348, 802-810.