**SPECTRUM, ATMOSPHERIC TRAJECTORY AND ORBIT OF A 2011 JANUARY ZETA AURIGID FIREBALL.** N. Gómez[1], J.M. Madiedo[1, 2] and J.M. Trigo-Rodríguez[3]. [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.

**Introduction:** The January ζ-Aurigids (IAU code JZA) can be observed from Jan. 1 to Jan. 21, with a maximum activity on Jan. 13 [1]. This shower produces slow meteors and was first detected by Denning in 1885 [2]. As the parent body of the JAZ stream is unknown, precise orbital data can be very helpful in order to determine the origin of these meteoroids. The calculation of high-precision orbits is one of the aims of the SPanish Meteor Network (SPMN). For this purpose we operate 25 meteor observing stations that monitor the night sky over Spain and neighbouring areas. We also focus on meteor spectroscopy, as this technique provides an insight into the chemical nature of meteoroids ablating in the atmosphere [3 ,4]. In this context, we analyze here a JZA fireball recorded together with its emission spectrum in January 2011.

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

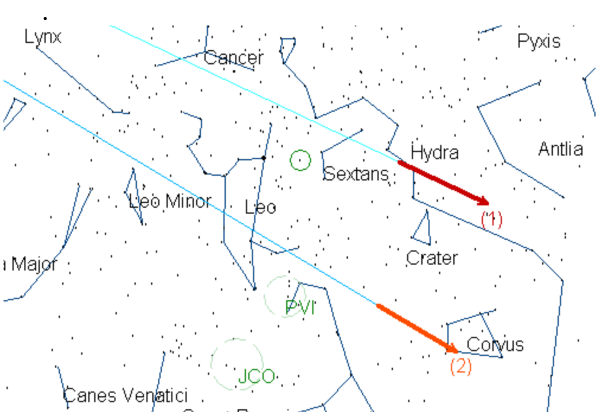


Figure 2. Apparent trajectory of the bolide as imaged from Sevilla (1) and Huelva (2).

**Instrumentation and data reduction methods:** Two SPMN meteor observing stations recorded the JZA bolide analyzed here: Sevilla and Huelva. These employ an array of high-sensitivity CCD video cameras (models 902H and 902H Ultimate, from Watec Co.) to monitor the night sky. They work in a fully autonomous way by means of software developed by us [5, 6]. In addition, these automatic stations perform a continuous spectroscopic campaign by recording the emission spectrum produced by meteoroids ablating in the atmosphere. For this purpose, holographic diffraction gratings are attached to the optics of the above mentioned cameras. The analysis of the atmospheric trajectory and orbit of multi-station events is performed with our AMALTHEA software, which follows the methods described in [7]. On the other hand, meteor spectra are reduced with our CHIMET application.

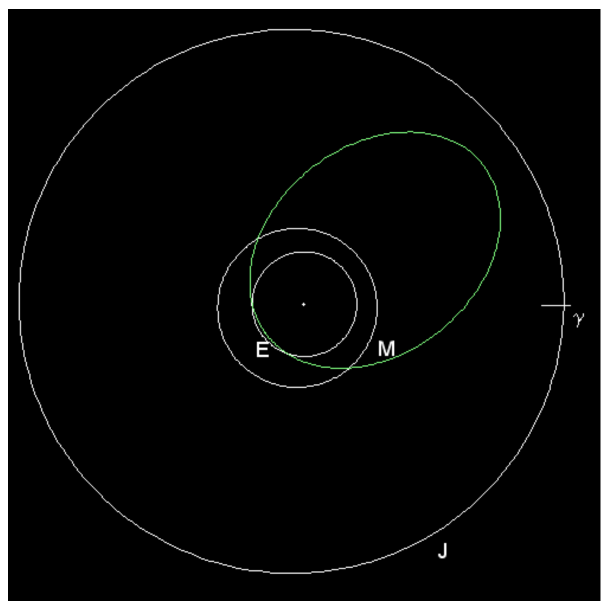


Figure 3. Orbit of the parent meteoroid.

**Atmospheric trajectory and orbit:** The JZA discussed here was recorded on January 10, 2011, at 2h53m38.4±0.1s UTC (Figure 1). Figure 2 shows its apparent trajectory in the night sky as seen from both meteor observing stations. Its absolute magnitude, obtained from the photometric analysis of the AVI files recorded by our CCD video cameras, was of about -7±1. The fireball began at 97.4±0.5 km above the ground level, with the meteoroid striking the atmosphere with an initial velocity $V_\infty$=16.6±0.3 km/s. The parent meteoroid penetrated the atmosphere till a height of 67.4±0.5 km. The projection on the ecliptic plane of the orbit in the Solar System of the particle is shown in Figure 3. Orbital and radiant parameters are summarized on Table 1.

| Radiant data | | | |
|---|---|---|---|
| | Observed | Geocentric | Heliocentric |
| **R.A. (º)** | 79.2±0.3 | 64.7±0.3 | |
| **Dec. (º)** | 57.4±0.2 | 53.4±0.2 | |
| **$V_\infty$ (km/s)** | 16.6±0.3 | 12.6±0.3 | 38.3±0.3 |
| **Orbital parameters** | | | |
| **a (AU)** | 2.6±0.1 | **ω (º)** | 213.1±0.5 |
| **e** | 0.65±0.01 | **Ω (º)** | 289.3579±10$^{-4}$ |
| **q (AU)** | 0.920±0.002 | **i (º)** | 10.2 ±0.3 |

Table 1. Radiant and orbital data (J2000).

**Emission spectrum:** One of our video spectrographs operating from Huelva recorded the emission spectrum of the fireball. The signal, once calibrated in wavelengths and corrected by taking into account the instrumental efficiency, is shown in Figure 4. This spectrum is dominated by a strong emission from the Na I-1 (588.9 nm) multiplet. This line is, in fact, much more intense than the Mg I-2 (516.7 nm) line. The contribution of several Fe I multiples was also identified, together with the emission of atmospheric $N_2$.

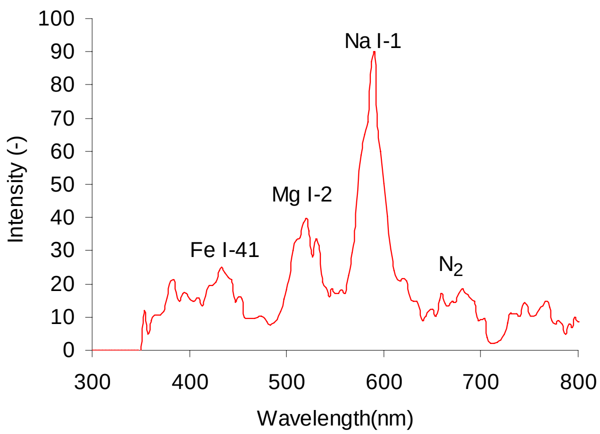


Figure 4. Calibrated emission spectrum..

**Conclusions:** A slow-moving mag. -7 double-station fireball has been analyzed. Its atmospheric path and radiant were obtained and the orbit of the parent meteoroid was calculated. The results show that the particle belonged to the JZA meteoroid stream and penetrated the Earth's atmosphere till a height of about 67.4 km above the ground level. The emission spectrum was also recorded. This is dominated by the emission from Na.

**Acknowledgements:** We acknowledge support from the Spanish Ministry of Science and Innovation (projects AYA2009-13227 and AYA2011-26522).

**References:** [1] Jenniskens P., AJ, Vol. 127, pp. 3018, 2004. [2] Denning W.F. (1899) Memoirs of the Royal Astronomical Society, 53, p. 203. [3] Trigo-Rodríguez J.M. et al. (2004) *MNRAS* 348, 802-810. [4] Madiedo J.M. et al. (2012) *MNRAS*, submitted. [5] Madiedo J.M. and Trigo-Rodríguez J.M. (2007) *EMP* 102, 133-139. [6] Madiedo J.M. et al. (2010) *Adv.in Astron*, 2010, 1-5. [7] Ceplecha Z. (1987) *Bull. Astron. Inst. Cz.* 38, 222-234.