DETERMINATION OF PHYSICO-CHEMICAL PARAMETERS OF A POSSIBLE SIGMA HYDRID FIREBALL OBSERVED IN 2012. V. Robles[1], J.M. Madiedo[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: High sensitivity CCD video cameras are employed in most of the stations operated by the SPanish Meteor Network (SPMN) to monitor meteor and fireball activity over the Iberian Peninsula and neighbouring areas. Thus, these devices provide helpful information about the atmospheric trajectory, radiant and orbital data of events simultaneously recorded from, at least, two different observing stations. Other physical parameters such as mass and tensile strength can also be obtained [1, 2, 3]. Besides, these cameras can be also employed for meteor spectroscopy by attaching holographic diffraction gratings to the objective lenses. These video spectrographs provide information about the chemical nature of meteoroids ablating in the atmosphere [3]. In this context we analyze here a double-station fireball imaged from two of our video stations in 2012. The fireball appeared on December 28, at 6h29m39.7±0.1s UTC (Figure 1). It received the SPMN code 281212. Its emission spectrum was also recorded and different physico-chemical parameters characterizing the bolide and its parent meteoroid could be determined.

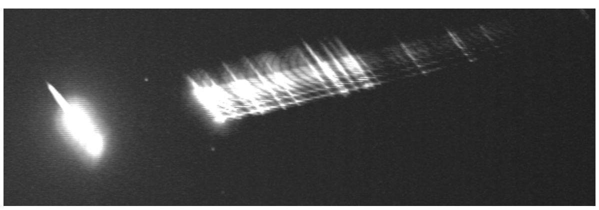

Figure 1. Composite image of the fireball and its emission spectrum, as imaged from Sevilla.

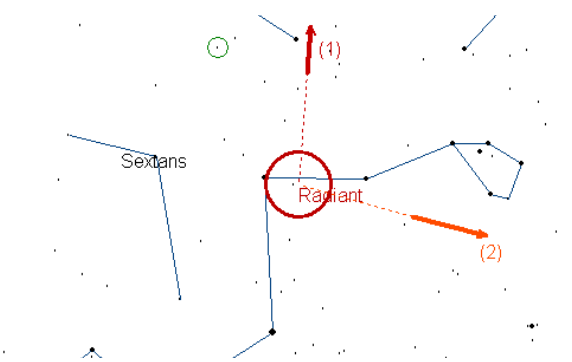

Figure 2. Apparent trajectory of the fireball as recorded from Sevilla (1) and Huelva (2).

Methods: The two meteor observing stations involved in this work (Sevilla and Huelva) employ an array of high-sensitivity CCD video cameras (models 902H and 902H Ultimate, from Watec Co.) to monitor the night sky. The operation of these systems, which operate in a fully autonomous way, is explained in [1, 2]. Besides, these automatic stations develop since 2006 a continuous spectroscopic campaign by attaching holographic diffraction gratings (1000 or 500 lines/mm) to the objective lens of these CCD cameras. For data reduction we employ our AMALTHEA software, which calculates atmospheric trajectories, radiants and orbits by following the procedures described in [4]. Emission spectra are analyzed with our CHIMET software.

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

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	142.8±0.2	141.8±0.2	
Dec. (º)	0.7±0.1	0.3±0.1	
V_∞ (km/s)	54.8±0.3	54.0±0.3	38.7±0.3
Orbital parameters			
a (AU)	2.9±0.2	**ω (º)**	140.4±0.7
e	0.955±0.001	**Ω (º)**	96.75155 ± 10^{-4}
q (AU)	0.132±0.003	**i (º)**	122.5±0.9

Table 1. Radiant and orbital data (J2000).

Results and discussion: The apparent trajectory as seen from both meteor observing stations is shown in Figure 2 that is indicative that this event was recorded under a very favourable convergence angle of 73.9º. The absolute magnitude of this event, estimated from the photometric analysis of the images, was -8±1. According to our calculations, the meteoroid struck the atmosphere with an initial velocity V_∞=54.8±0.3 km/s and the fireball began at a height of 119.5±0.5 km above the ground level. The terminal point of its atmospheric trajectory was located at a height of about

65.2±0.5 km. The projection on the ground of this atmospheric path is shown in Figure 3. With this information, the orbit in the Solar System of the progenitor meteoroid was calculated (Figure 4). From the computed radiant and orbital elements (Table 1) we suggest two possibilities: 1) A large meteoroid being a Sigma Hydrid outsider, or 2) A sporadic fireball On the other hand, the bolide exhibited several flares along its trajectory. The main one took place at a height of about 85 km above the ground level, under an aerodynamic pressure, calculated in the usual way [5], of about $1.9 \pm 0.4 \times 10^4$dyn/cm^2. This provides an estimation of the tensile strength of the particle [6].

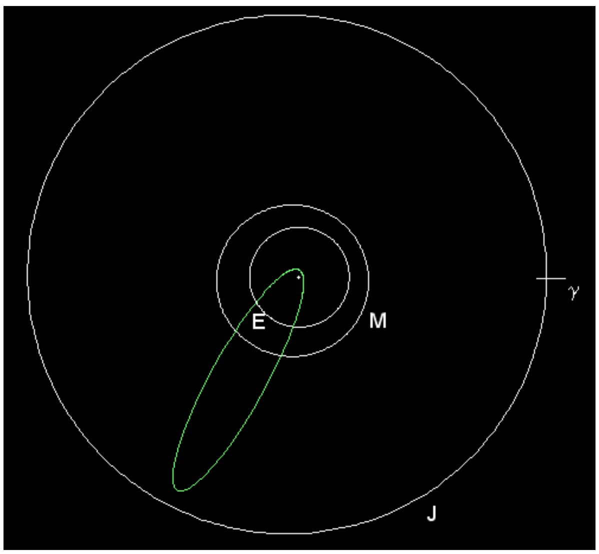

Figure 4. Projection on the ecliptic plane of the orbit of the SPMN281212 fireball.

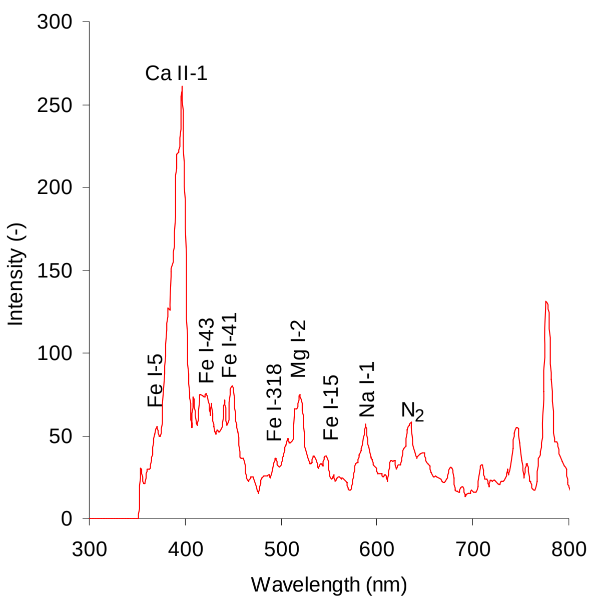

Figure 5. Calibrated emission spectrum.

The calibrated emission spectrum obtained by one of our video spectrographs is shown in Figure 5. This signal was corrected by taking into account the spectral response of the instrument. Several Fe I multiplets have been identified. However, the spectrum is clearly dominated by a strong emission from the H and K lines of ionized calcium in the ultraviolet. The contributions from Mg I-2 (516.7 nm) and Na I-1 (589.5 nm) are also easily seen, although they are not so prominent. In the red region, emission bands from atmospheric N_2 are present.

Conclusions: Different physico-chemical parameters have been calculated for the mag. -8 double station fireball analyzed here. Thus, its atmospheric trajectory and radiant have been determined, and the orbit in the Solar System of the parent meteoroid was obtained. Besides, the particle followed a retrograde orbit. The tensile strength of the particle was also obtained. The emission spectrum, which is dominated by a strong emission from Ca II H and K lines, reveals depletion in volatile elements. This depletion can be explained on the basis of the small value obtained for the perihelion distance of the orbit of the parent meteoroid (q=0.132 AU).

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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 J.M. 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] Trigo-Rodríguez J.M. and Llorca J. (2006) *MNRAS*, 372, 655.