ANALYSIS OF A KAPPA-CYGNID FIREBALL. L. Martínez[1], J.M. Madiedo[1,2], J.M. Trigo-Rodríguez[3]. [1]Facultad de Ciencias Experimentales, Universidad de Huelva, Huelva, Spain. [2]Departamento de Física Atómica, 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@ieec.uab.es.

Introduction: The κ-Cygnids (KCG) were first observed about 150 years ago [1]. The activity period of this annual minor shower extends from August 3 to August 31, peaking on August 18 with a Zenithal Hourly Rate (ZHR) of about 2.3±0.4 [2, 3]. Because of the duration of activity and the associated spread in the longitude of the nodes, Jenniskens suggested that the KCG stream might be old [2]. However, the analysis of the outbursts experienced in 1997 and 2007 [4, 5] suggested an opposite scenario. Besides, observations support the hypothesis that the formation of this meteoroid stream is a consequence of the fragmentation of a comet nucleus [5]. This disruptive process could have proceeded as a cascade, where the break up of the progenitor body leaded to produce small remnants, some fully disintegrated into different clumps of particles and other remained as dormant objects such as 2008ED69, 2001MG1 and 2004LA12 which are now observed as near-Earth asteroids. In this work we analyze a fireball produced by a meteoroid belonging to the KCG stream on August 2012. Its emission spectrum was also recorded.

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

Instrumentation and methods: To image the fireball analyzed here we have employed an array of low-lux CCD video devices (models 902H and 902H Ultimate, from Watec Co.) operating from two of our meteor observing stations: Sevilla and El Arenosillo. These systems work in a fully autonomous way by means of software developed by us [6, 7]. On the other hand, for meteor spectroscopy we have attached holographic diffraction gratings (1000 lines/mm) to the objective lens of these cameras. Data reduction is performed with our Amalthea software, which follows the planes intersection method to determine the atmospheric trajectory and radiant of multi-station meteor events [8]. The emission spectrum was analyzed with our CHIMET software.

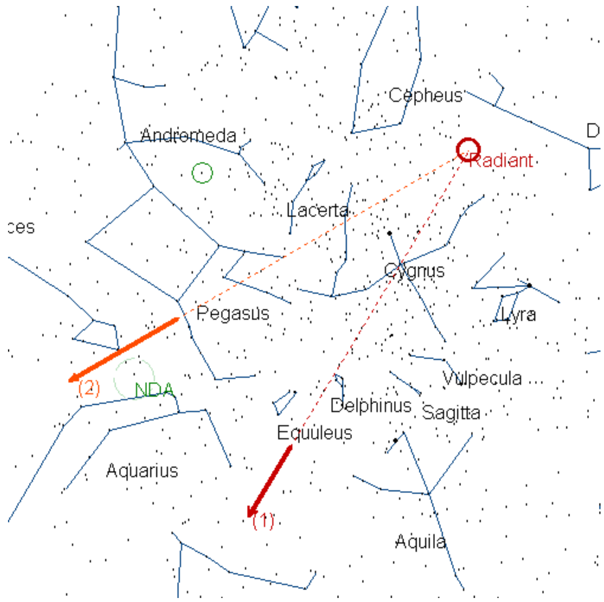

Figure 2. Apparent trajectory of the fireball as observed from (1) Sevilla and (2) El Arenosillo.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	295.4±0.3	291.3±0.3	
Dec. (º)	60.2±0.2	60.6±0.2	
V_∞ (km/s)	27.1±0.3	24.8±0.3	37.6±0.3
Orbital parameters			
a (AU)	2.6±0.1	**ω (º)**	199.8±0.3
e	0.62±0.01	**Ω (º)**	143.3539±10^{-4}
q (AU)	0.9895±0.0007	**i (º)**	40.8±0.4

Table 1. Radiant and orbital data (J2000).

Atmospheric trajectory, radiant and orbit: The bolide considered here was recorded on August 15, 2012, at 23h44m39.2±0.1s UTC (Figure 1). It was included in our fireball database under the code SPMN150812. Its apparent path, as seen from both meteor observing stations, is shown in Figure 2. According to the photometric analysis of the images, the event reached an absolute magnitude of about -10±1. As can be seen in Figure 1, the fireball experienced a very bright fulguration at the end of its luminous path, as a consequence of a violent disruption of the parent meteoroid. According to our analysis, the fireball began at a height of 104.5±0.5 km and ended at 80.0±0.5 km above the ground level. The meteoroid struck the atmosphere with an initial velocity V_∞=27.1±0.3 km/s. Once the trajectory and radiant were characterized, the orbit of the meteoroid was calculated. Radiant and orbital parameters (J2000) are summarized on table 1. The projection on the ecliptic plane of the orbit of the meteoroid in the Solar System is shown in Figure 3. The tensile strength of this particle was also calculated by following the method described in [9]. Thus, this value was estimated by calculating the aerodynamic strength S at which the meteoroid suffered the above-mentioned break-up [10]. In this way, a value $S=1.1\pm0.3\times10^4$ dyn/cm^2 was obtained.

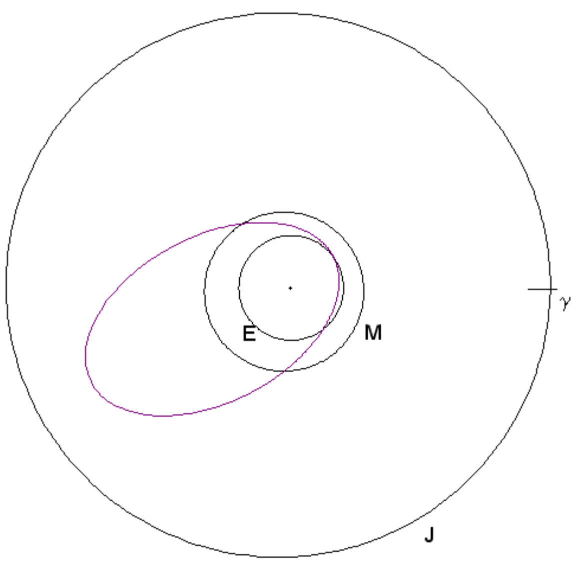

Figure 3. Projection on the ecliptic plane of the orbit of the parent meteoroid.

Analysis of the emission spectrum: The spectrum was reduced by following the technique described in [11, 12]. Thus, the raw signal imaged by the spectral camera was calibrated in wavelengths by using typical metal lines appearing in meteor spectra (Ca, Fe, Mg, and Na multiplets), and then corrected by taking into account the instrumental efficiency. The result is shown in Figure 4. Most lines identified in the spectrum correspond to Fe I multiplets. The most important contributions are those produced by multiplets Mg I-3 (382.9 nm), Ca I-2 (422.6 nm), Fe I-41 (440.4 nm), Mg I-2 (516.7 nm) and Na I-1 (588.9 nm). In the red region, prominent atmospheric N_2 bands can also be seen.

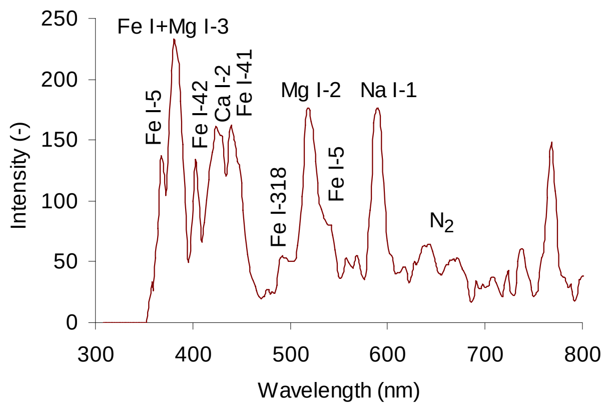

Figure 4. Calibrated emission spectrum.

Conclusions: A mag -10±1 KCG fireball was imaged from two of our meteor observing stations operating in the south of Spain. Its atmospheric trajectory and radiant were calculated. The orbit of the parent meteoroid and the tensile strength of the particle were also inferred. The analysis of the emission spectrum recorded by one of our spectral cameras also provided helpful information about the chemical nature of this particle.

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References: [1] Denning W. F., 1877, The Observatory, 16, 317. [2] Jenniskens, P. (2006) Meteor Showers and their Parent Comets. Cambridge University Press. [3] Jenniskens P., 1994, A&A, 287, 990. [4] Trigo-Rodríguez et al., 2008. Earth Moon Planets,102, 231. [5] Trigo-Rodríguez et al., 2009, MNRAS, 392, 367–375. [6] Madiedo J.M. and Trigo-Rodríguez J.M. (2007) EMP 102, 133-139. [7] Madiedo J.M. et al. (2010) Adv.in Astron, 2010, 1-5. [8] Ceplecha, Z. Bull. Astron. Inst. Cz. 38, 222-234, 1987. [9] Trigo-Rodríguez J. M., Llorca J., 2006, MNRAS, 372, 655. [10] Bronshten V. A., 1981, Geophysics and Astrophysics Monographs. Reidel, Dordrecht. [11] J.M. Trigo-Rodríguez et al. (2003) MAPS 38, 1283-1294. [12] Trigo-Rodríguez et al. (2004) MNRAS 348, 802-810.