A 2012 GEMINID FIREBALL: ATMOSPHERIC TRAJECTORY, ORBIT AND SPECTRUM. S. Prieto[1], J.M. Madiedo[1, 2], J.M. Trigo-Rodríguez[3], J. Zamorano[4], J. Izquierdo[4], F. Ocaña[4], A. Sánchez de Miguel[4], A.J. Castro-Tirado[5] and J.L. Ortiz[5]. [1]Facultad de Ciencias Experimentales, Universidad de Huelva, 21071 Huelva, Spain, madiedo@uhu.es. [2]Dpto. de Física Atómica, Molecular y Nuclear, Facultad de Física, Universidad de Sevilla, 41012 Sevilla, Spain. [3]Institute of Space Sciences (CSIC-IEEC). Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra, Spain. [4]Dpto. de Astrofísica y CC. de la Atmósfera, Facultad de Ciencias Físicas, Universidad Complutense de Madrid, 28040 Madrid, Spain. [5]Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada, Spain.

Introduction: Asteroid (3200) Phaeton is the parent body of the Geminid meteoroid stream. These particles give rise to one of the strongest annual meteor showers, with an activity period that extends from Nov. 27 to Dec. 28, peaking on Dec. 14 [1]. Ceplecha and McCrosky concluded that the bulk density of Geminid meteoroids is of about 3–4 g/cm^3 [2]. However, Babadzhanov obtained a value of 2.9 g/cm^3 [3]. It is possible that the high density of Geminid meteoroids in comparison with other meteoroids is due to the small perihelion distance of the Geminid orbit (q=0.141). This, in fact, would cause a depletion in the most volatile elements. One common technique to analyze the composition of Geminid meteoroids is meteor spectroscopy. Thus, the SPanish Meteor Network employs an array of CCD video spectrographs to determine the chemical nature of meteoroids ablating in the atmosphere. In this work we present the analysis of a bright Geminid bolide (absolute magnitude -10) observed over the south and center of Spain in 2012. Its spectrum was recorded from three of our meteor observing stations.

Instrumentation: Several SPMN meteor observing stations located in the south and center of Spain were involved in the detection of the fireball discussed here. These employ an array of high-sensitivity CCD video cameras (models Watec 902H and 902H Ultimate) endowed with fast aspherical lenses [4, 5]. Some of these cameras are configured as spectrographs by attaching holographic diffraction gratings (500 or 1000 lines/mm, depending on the device) to the objective lens.

Atmospheric trajectory and orbit: The fireball received the SPMN code 121212 and was simultaneously imaged from Sevilla, La Hita, El Arenosillo and Villaverde del Ducado on Dec. 12, 2012 at 3h47m19.7±0.1s UTC (Fig. 1). Its trajectory was calculated with our AMALTHEA software, which employs the planes intersection method [6]. This analysis shows that the meteoroid struck the atmosphere with an initial velocity V_∞=39.0±0.3 km/s and a zenith angle of 13.4º. The fireball began at 101.6±0.5 km above the ground level. It ended at 39.9±0.5 km and its maximum brightness corresponded to an absolute magnitude of -10±1. The analysis of the light curve (Figure 2) shows that the fireball suffered several flares along its trajectory, with two main fulgurations (highlighted in Figure 2) taking place at about 65.3 km and 57.1 km above the ground level. These took place under an aerodynamic pressure, calculated in the usual way [7], of 2.0±0.4×10^{5}dyn/cm^2 and 3.4±0.4×10^{5}dyn/cm^2 respectively. On the other hand, the orbit of the meteoroid was obtained by following the method described in [6]. Orbital and radiant parameters are summarized in Table 1.

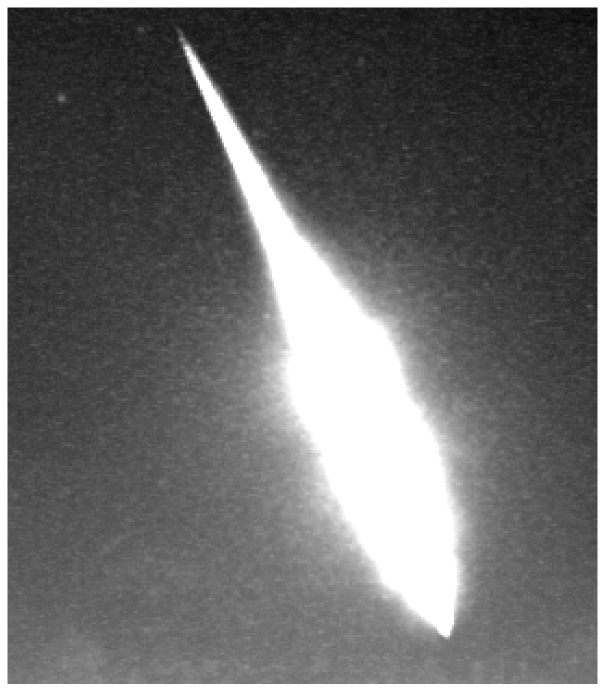

Figure 1. Composite image of the mag. -10 SPMN121212 Geminid fireball, recorded from Sevilla.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	116.2±0.3	114.8±0.3	
Dec. (º)	35.1±0.2	34.9±0.2	
V_∞ (km/s)	39.0±0.3	37.5±0.3	34.9±0.3

Orbital parameters			
a (AU)	1.5±0.04	**ω (º)**	326.0±0.5
e	0.920±0.003	**Ω (º)**	260.3488±10^{-4}
q (AU)	0.120±0.003	**i (º)**	36.2±0.8

Table 1. Radiant and orbital data (J2000).

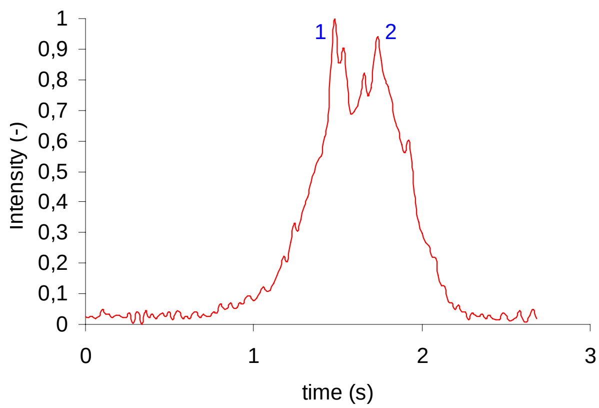

Figure 2. Light curve (relative brightness vs. time). Main fulgurations for which the aerodynamic pressure was calculated are highlighted.

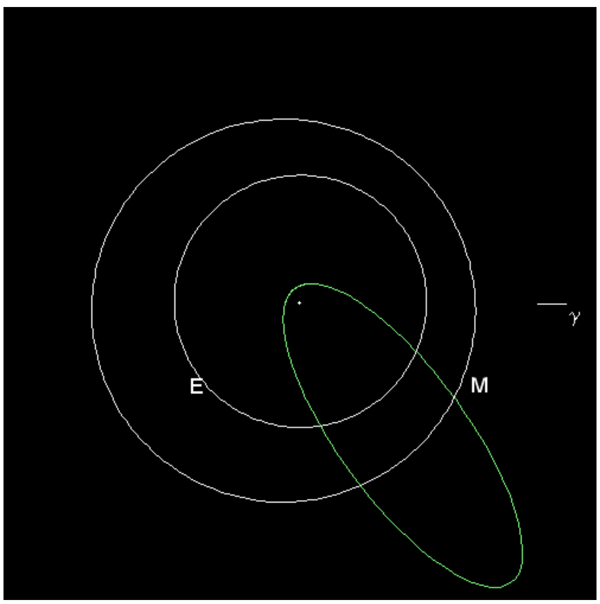

Figure 3. Projection on the ecliptic plane of the orbit of the parent meteoroid.

Spectrum: Two spectrographs operating from La Hita and El Arenosillo recorded the emission spectrum of the SPMN121212 fireball. The calibrated signal, corrected by taking into account the spectral response of the imaging device, is shown in Figure 4. As is usual in meteor spectra, most lines are associated to Fe I multiplets. However, the brightest lines correspond to the emission from Mg I-2 (516.7 nm) and to the contribution of H and K lines of Ca II in the ultraviolet. These two lines appear blended with the emission from Fe I-4 (387.8 nm). The Na I-1 line at 588.9 nm is also remarkable, and the contribution of atmospheric nitrogen in the red region can be easily identified.

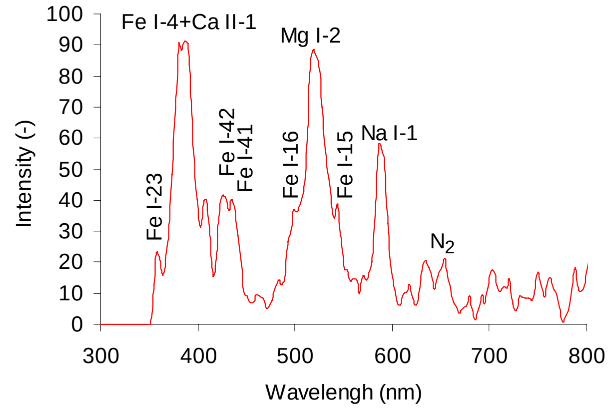

Figure 4. Main emission lines identified in the calibrated spectrum.

Conclusions: A three-station bright bolide was analyzed. Its atmospheric trajectory and radiant were calculated, and the orbit of the parent meteoroid was obtained. These data revealed that the event was associated to the Geminid shower. The analysis of the light curve shows that the bolide exhibited several fulgurations along its atmospheric path. The aerodynamic pressure under which these events took place was obtained. Besides, the emission spectrum has provided information about the chemical nature of the meteoroid. The signal is dominated by the emission from Mg I-2, but also by Ca II H and K lines. The Na I-1 line is also strong.

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