

A 2010 FIREBALL PRODUCED BY A METEOROID FROM COMET 1P/HALLEY. F.J. Montero¹, J.M. Madieto² and J.M. Trigo-Rodríguez³. ¹Facultad de Ciencias Experimentales, Universidad de Huelva, Huelva, Spain, madieto@uhu.es. ²Departamento de Física Atomica, Molecular y Nuclear. Universidad de Sevilla. 41012 Sevilla, Spain. ³Institute of Space Sciences (CSIC-IEEC). Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra, Spain, trigo@ice.csic.es.

Introduction: Comet 1P/Halley is the source of the Orionid and η Aquariid meteor showers [1]. The latter one takes place during the second encounter of the Earth with 1P/Halley debris in October, when our planet is as close as 0.16 AU from the comet's orbit [2]. A striking feature of 1P meteoroid streams is their filamentary structure, which has been explained on the basis of an orbital evolution affected by major planets, particularly Jupiter [3]. Besides, several authors have noted that the activity of the Orionid meteor shower varies significantly from year to year [4, 5]. In fact, it has been a source of important meteor outbursts [6]. The last of these took place in 2006 [7]. In order to increase our knowledge about this stream, the Spanish Meteor Network (SPMN) has performed in the recent years a continuous monitoring of the Orionid shower during its activity period by means of high-sensitivity CCD video devices. Thus, for instance, although no remarkable activity was observed during 2010, we could image several fireballs from this shower. In this work we analyze one of these events, which was recorded together with its emission spectrum on Oct. 23, 2010 at 23h53m09.3 $\pm$ 0.1s UTC and was named SPMN 231010.



Figure 1. The SPMN231010 Orionid fireball imaged from La Hita Astronomical Observatory.

Instrumentation: We have employed an array of high-sensitivity CCD video devices (models 902H and 902H Ultimate, from Wattec Co.) to image the fireball analyzed here. These operate from La Hita and Sierra Nevada astronomical observatories, in Spain. The

cameras work according to the PAL video standard (25 fps and a resolution of 720x576 pixels). A detailed description of these systems is given in [8, 9]. For meteor spectroscopy we have employed holographic diffraction gratings attached to the objective lens of the CCD video devices.

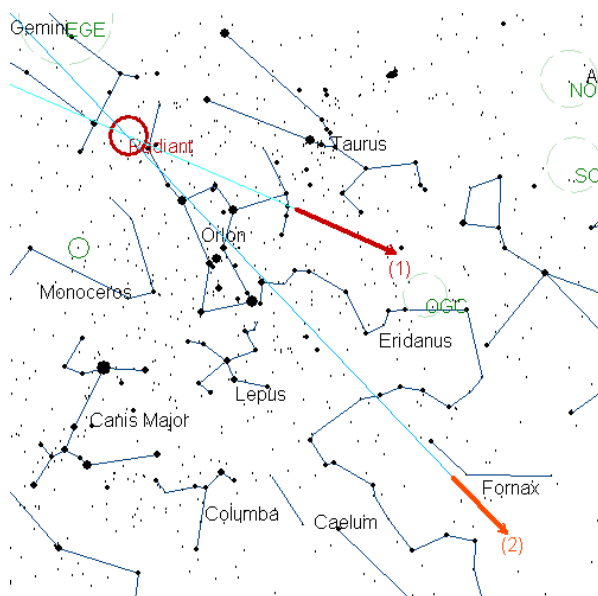


Figure 2. Apparent trajectory of the bolide as recorded from (1) Sierra Nevada and (2) La Hita.



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

Results and discussion: Figure 1 shows a composite of the fireball discussed here. Its apparent trajectory as seen from La Hita and Sierra Nevada is highlighted in Figure 2. Its absolute magnitude, obtained from the

photometric analysis of our images, was of about -7 ± 1 . By using the method of planes intersection [10] we could obtain its atmospheric trajectory and radiant. The projection on the ground of this trajectory is shown in Figure 3. The fireball began at 113.9 ± 0.5 km above the ground level. The meteoroid struck the atmosphere with an initial velocity $V_{\infty} = 66.8 \pm 0.3$ km/s. The terminal point of the trajectory occurred at a height of 80.5 ± 0.5 km. The apparent radiant was located at $\alpha = 95.5 \pm 0.1^\circ$, $\delta = 15.5 \pm 0.1^\circ$. With this information, we calculated the orbit (Figure 4) followed by the meteoroid that produced this fireball by following the procedure described in [4]. Radiant and orbital parameters are summarized in Table 1.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. ($^\circ$)	95.5 ± 0.1	95.6 ± 0.1	
Dec. ($^\circ$)	15.5 ± 0.1	15.3 ± 0.1	
V_{∞} (km/s)	66.8 ± 0.3	66.5 ± 0.3	41.1 ± 0.3
Orbital parameters			
a (AU)	9.6 ± 0.6	ω ($^\circ$)	88 ± 1
e	0.94 ± 0.01	Ω ($^\circ$)	30.32141 ± 10^{-4}
q (AU)	0.527 ± 0.006	i ($^\circ$)	162.61 ± 0.09

Table 1. Radiant and orbital data (J2000).

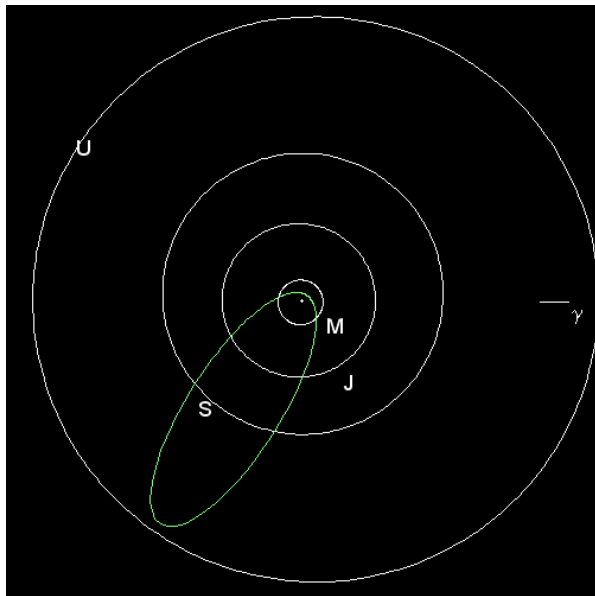


Figure 4. Projection on the ecliptic plane of the orbit of the parent meteoroid.

The emission spectrum produced during the ablation of the meteoroid in the atmosphere was recorded by two spectrographs operating from Sierra Nevada (Figure 5). The signal was calibrated in wavelengths and then corrected by taking into account the spectral sensitivity of the instrument. The most prominent line

in the signal corresponds to the emission from the O I triplet at 777.4 nm. The intensity of the atmospheric nitrogen bands in the red region is also very remarkable and similar to that of Mg I-1 and Na I-1 multiplets.

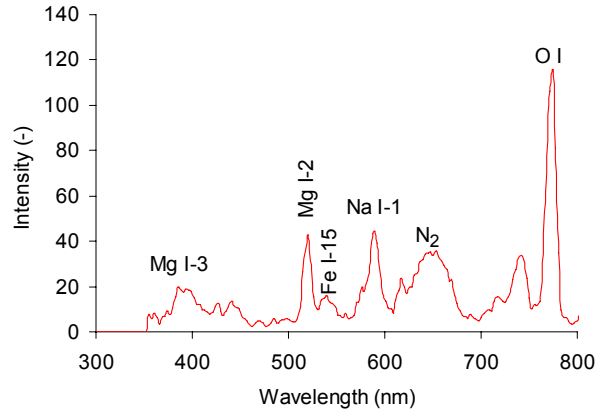


Figure 5. Calibrated spectrum of the SPMN231010 bolide. Main emission lines have been highlighted.

Conclusions: The atmospheric trajectory and radiant of the mag. -7 double-station fireball discussed have been calculated. The orbit in the Solar System of the parent meteoroid was also determined. These results reveal the association of this event with the Orionid meteoroid stream. On the other hand, the emission spectrum shows a strong contribution from O I (777.4 nm) and atmospheric nitrogen bands. Fe I lines are also present, although their intensity is weak.

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