ANALYSIS OF LARGE METEOROIDS PRODUCED BY COMET 7P/PONS-WINNECKE.

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Introduction: Dust ejecta of comet 7P/Pons-Winnecke produces the June Bootid meteoroid stream [1]. This gives rise to an annual display of meteors from about June 22 to July 2, with a maximum activity around June 28. A continuous monitoring of meteor and fireball events during the activity period of this meteor shower gives an interesting opportunity to analyze the dust from this comet. Besides, a recent study reveals that it is possible that this comet may produce large meteoroids that under some conditions could survive the atmospheric entry and reach the ground as meteorites [2]. So, the analysis of the debris produced by this comet can give valuable information about the physico-chemical properties of these particles and can also improve our understanding of the mechanisms that deliver these cometary materials to the Earth. These properties include not only radiant and orbital parameters, but also chemical information provided by the emission spectra produced during the ablation of these meteoroids in the atmosphere.

Although the activity of this meteor shower was not extraordinary on 2009, two of the meteor observing stations operated by the SPanish Meteor Network (SPMN) simultaneously imaged a June Bootid fireball with an absolute magnitude of about -9±1 on July 5. The analysis of this event is made here.

Methods: Both SPMN stations involved in the detection of the sporadic fireball considered here (Sevilla and Doñana) employ high-sensitivity 1/2" monochrome CCD video cameras manufactured by Watec Co. (Japan). These stations work in an autonomous way by means of proper software [3]. A more detailed description of our systems, which can record meteor trails as faint as mag. +3/+4, has been done elsewhere [4, 5]. The cameras operating from Doñana have attached holographic diffraction gratings (1000 lines/mm) to obtain the emission spectra resulting from the ablation of meteoroids in the atmosphere. Spectra of meteors brighter than mag. -4 can be recorded by these devices. This provides chemical information about the corresponding meteoroids [6, 7, 8, 9].

Results and discussion: The mag. -9±1 fireball analyzed here (code SPMN050709) was recorded on July 5, 2009 at 4h15m28.7±0.1s UT (Fig. 1). It started its luminous phase at a height of about 80.6±0.5 km, and disappeared from the cameras field of view at about 43.3±0.5 km, which means that the fireball continued its trajectory beyond this point. The radiant (Fig. 2) and orbital parameters of this bolide are shown on table I. The preatmospheric velocity calculated from the velocities measured at the beginning of the meteor trail was V_∞=18.4 ±0.4 km/s. Although the fireball was imaged a few days after the usual activity period of the June Bootids, these data clearly confirm that the bolide belongs to this shower. The projection on the ground of this event is shown on Fig. 3. As can be seen, the whole fireball trajectory was located over the Atlantic Ocean.

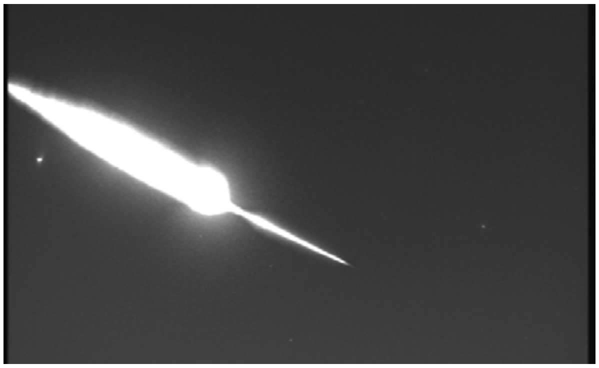

Figure 1. The SPMN050709 June Bootid fireball imaged from Doñana.

<table>
<tr><th colspan="4">Radiant data</th></tr>
<tr><th></th><th>Observed</th><th>Geocentric</th><th>Heliocentric</th></tr>
<tr><td>R.A. (º)</td><td>258.7±03</td><td>250.0±0.4</td><td>-</td></tr>
<tr><td>Dec. (º)</td><td>31.4±0.2</td><td>24.8±0.3</td><td>-</td></tr>
<tr><td>Ecliptical longitude(º)</td><td>-</td><td>-</td><td>205.6±0.3</td></tr>
<tr><td>Ecliptical latitude(º)</td><td>-</td><td>-</td><td>16.5±0.5</td></tr>
<tr><td>V_∞ (km/s)</td><td>18.4±0.4</td><td>15.0±0.4</td><td>38.4±0.4</td></tr>
<tr><th colspan="4">Orbital data</th></tr>
<tr><td>a(AU)</td><td>3.2±0.2</td><td>ω (º)</td><td>209.0±0.2</td></tr>
<tr><td>e</td><td>0.70±0.02</td><td>Ω (º)</td><td>103.1584±10^{-4}</td></tr>
<tr><td>q(AU)</td><td>0.963t±0.001</td><td>i (º)</td><td>16.9±0.5</td></tr>
<tr><td>Q(AU)</td><td>5.5±0.5</td><td></td><td></td></tr>
</table>

Table 1. Radiant and orbital data for the June Bootid fireball described in the text.

On the other hand, Fig. 1 also reveals the peculiar photometric behaviour of this fireball. The light curve (Fig. 4) was obtained from the analysis of the video frames. Brightness increased dramatically at ~60 km above the ground level, under an aerodynamic pressure, calculated in the usual way [10], of about 7.0±0.6×10^4dyn/cm^2. This curve has been employed to calculate the initial mass of the meteoroid [11] and a value of about 23.7 kg was obtained. Although the fireball continued its trajectory to heights lower than 43 km, a meteorite does not seem likely as at this point the estimated mass was of just about 54 g.

We also imaged the spectrum of this fireball from the station operating from Doñana. The signal in the spectrum was calibrated in wavelengths by using typical metal lines (Ca, Fe, Mg, and Na multiplets) and then corrected by taking into account the instrumental efficiency. The raw spectrum is shown on Fig. 5, where the synthetic spectrum obtained with our CHIMET software [12] is also included. Most prominent lines correspond to Fe I-5 (374.5 nm), Ca I-2 (422.6 nm), Mg I-2 (516.7 nm) and Na I-1 (588.9 nm). Atmospheric lines can also be noticed.

Conclusions: The continuous monitoring of the night sky is providing information about meteor and fireball activity over Spain and neighbouring areas. Thus, the analysis of the mag. -9±1 June Bootid fireball studied here has allowed us to obtain its atmospheric trajectory and has provided information about the orbit, mass and chemical composition of the corresponding meteoroid.

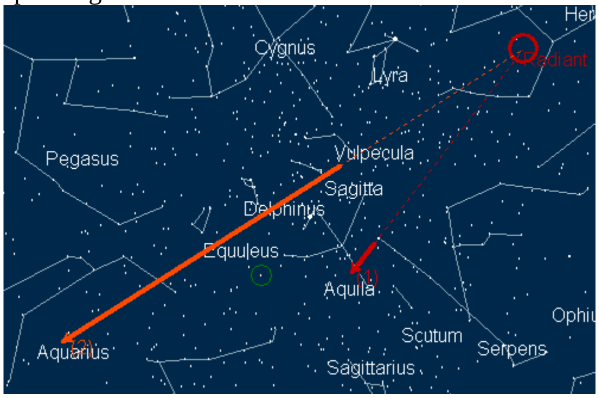

Figure 2. Radiant obtained by performing the astrometric calibration from the two meteor observing stations (1. Doñana and 2. Sevilla).

Figure 3. Projection on the ground of the atmospheric trajectory of the SPMN050709 fireball.

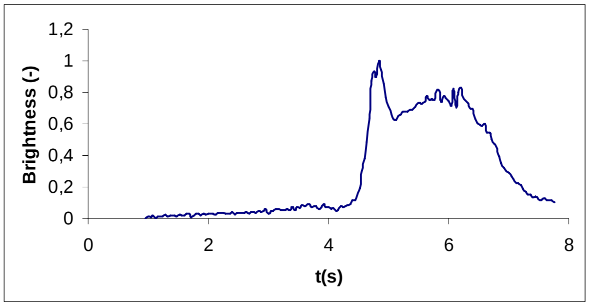

Figure 4. Light curve of the SPMN050709 fireball.

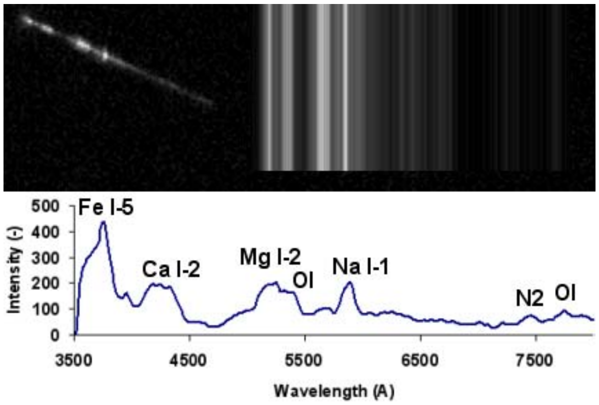

Figure 5. Raw and processed emission spectrum of the SPMN050709 June Bootid fireball.

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References: [1] Jenniskens, P. (2006) *Meteor Showers and their Parent Comets.* Cambridge University Press. [2] Konovalova, N.A. et al. (2011) *LPS XXXXII*, Abstract #1355. [3] Madiedo J.M. and Trigo-Rodriguez J.M. (2010) *41st LPSC*, Abstract #1504. [4] Madiedo J.M. and Trigo-Rodríguez J.M. (2007) *EMP* 102, 133-139. [5] Madiedo J.M. et al. (2010) *Adv.in Astron*, 2010, 1-5. [6] Trigo-Rodriguez, et al. (2009) *MNRAS*. 392, 367–375. [7] J.M. Trigo-Rodríguez et al. (2003) *MAPS* 38, 1283-1294. [8] Trigo-Rodríguez et al. (2004) *MNRAS* 348, 802-810. [9] Borovicka, J. (1993) *Astron. Astrophys*. 279, 627-645. [10] Bronshten V. A., 1981, *Geophysics and Astrophysics Monographs*. Reidel, Dordrecht. [11] Konovalova N.A. (2003) A&A 404, 1145-1152. [12] J.M. Madiedo et al. (2011), *EPSC-DPS Joint Meeting 2011*, Abstract #Vol. 6, EPSC-DPS2011-72.