ANALYSIS OF A VERY BRIGHT METEOR EVENT GENERATED OVER THE NORTH OF AFRICA.

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Introduction: The SMART (Spectroscopy of Meteoroids by means of Robotic Technologies) project is being developed since 2006 with the aim to obtain information about the chemical composition of meteoroids ablating in the atmosphere. This survey, which is being conducted by the Southwestern Europe Meteor Network (SWEMN), employs an array of automated cameras and spectrographs deployed at a series of meteor-observing stations in different locations in Spain, including the major astronomical observatories in this country [1-3]. We focus special attention on large meteoroids entering our atmosphere, since under special conditions, if these are tough enough, these may survive and reach the ground as meteorites. Large cometary meteoroids have in general not enough mechanical strength and so they are more prone to be completely ablated at high altitude in the atmosphere, giving rise to high-luminosity events. In both cases, however, these materials can be very useful to determine the flux of large rocks in the Earth-Moon environment, and so their analysis is very important to quantify the impact hazard for our planet. In fact, SMART works in very close connection with the MIDAS survey (Moon Impacts Detection and Analysis System), which is also being conducted by the SWEMN network in order to detect and analyze the impact of large meteoroids with the lunar ground [4]. In this context, we present here a preliminary analysis of an extraordinary fireball that was spotted over the north of Africa on 2023 August 20. Its peak luminosity was equivalent to an absolute magnitude of -15.

Instrumentation and methods: To record the fireball analyzed here we have employed an array of low-lux CCD video cameras manufactured by Watco Co. (models 902H and 902H2 Ultimate). Some of these devices are configured as spectrographs by means of 1000 lines/mm diffraction gratings [5]. CMOS color cameras were also employed [6]. These cameras monitor the night sky and operate in a fully autonomous way by means of software developed by J.M. Madiedo [1, 2]. The atmospheric trajectory and orbital data of the event were obtained with the SAMIA software which was also written by the same researcher [1, 3].

The 2023 August 20 meteor: We spotted this extraordinary fireball from the SWEMN meteor-observing stations located at Huelva, La Hita (Toledo), Calar Alto (Almería), Sierra Nevada, La Sagra (Granada), and Sevilla. The event was recorded on 2023 August 20, at 1h56m32.0±0.1s UT. The peak luminosity this bright meteor was equivalent to an absolute magnitude of -15.0±1.0. It was listed in the SWEMN meteor database with the code SWEMN20230820_015632.

It was deduced by analyzing the trajectory in the atmosphere of the fireball that this event overflew Morocco. This atmospheric path is shown in Figure 2. The luminous event began at an altitude \(H_b=96.7\pm0.5\) km. The bright meteor penetrated the atmosphere till a final height \(H_e=31.4\pm0.5\) km. The apparent radiant was lo-
cated at the equatorial coordinates $\alpha=308.00^\circ$, $\delta=27.44^\circ$. Besides, we deduced that the meteoroid hit the atmosphere with a velocity $V_\infty=16.9\pm0.3$ km/s. The orbit of the progenitor meteoroid is shown in Figure 3.

<table>
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<th>$a$ (AU)</th>
<th>$e$</th>
<th>$\omega$ (°)</th>
<th>$\Omega$ (°)</th>
<th>$q$ (AU)</th>
<th>$i$ (°)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.63±0.03</td>
<td>0.45±0.01</td>
<td>232.1±0.07</td>
<td>146.496235±10^{-5}</td>
<td>0.889±0.004</td>
<td>15.6±0.4</td>
</tr>
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Table 1. Orbital data (J2000) of the progenitor meteoroid.

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

The bright meteor was named "Beni Oukil", because the bolide overflew this locality during its final phase. The orbital parameters of the progenitor meteoroid before its encounter with our planet have been included in Table 1. The geocentric velocity of the meteoroid was $V_\infty=13.1\pm0.4$ km/s. From the value estimated for the Tisserand parameter referred to Jupiter ($T_J=4.15$), we found that the meteoroid followed an asteroidal orbit before striking the Earth's atmosphere. We found that these radiant and orbital data do not match any of the meteoroid streams listed in the IAU meteor database. So, we concluded that this event was produced by the sporadic background.

**Emission spectrum:** We obtained the emission spectrum of the fireball by means of the spectrographs operated by the SMART survey. This signal was calibrated in wavelength by employing typical lines appearing in meteor spectra, and then corrected by taking into account the sensitivity of these spectrographs. In the resulting signal most of the emissions correspond to neutral iron. In addition to these Fe I multiplets, the most remarkable emissions correspond to Na I-1 (588.9 nm) and Mg I-2 (516.7 nm). The contribution from atmospheric N$_2$ was also observed in the red region of the spectrum.

**Conclusions:** We have described an extraordinary mag. -15 fireball event associated with the sporadic meteoroid environment of our planet. This bright meteor overflew Morocco, and was recorded by the meteor observing stations operated from Spain by the SWEMN network. This deep-penetrating bolide reached a terminal altitude of about 31 km. Its parent meteoroid followed an asteroidal orbit before its encounter with our planet. The emission spectrum of the event was also obtained in the framework of our SMART survey. This spectrum can provide important data about the chemical nature of this particle and its parent body.

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