PROPERTIES OF LARGE FRAGMENTS FROM COMET 2P/ENCKE: SPECTROSCOPIC ANALYSIS. I. Salas[1] and J.M. Madiedo[2]. [1]Observatorio Galileo, 41012 Sevilla, Spain. [2]Instituto de Astrofísica de Andalucía, CSIC, Apt. 3004, 18080 Granada (Spain).

Introduction: One of the goals of the Southwestern Europe Meteor Network (SWEMN) is the study of the properties of large meteoroids interacting with the Earth's atmosphere. For this purpose we are conducting the SMART project (Spectroscopy of Meteoroids by means of Robotic Technologies), which is being developed since 2006. This survey employs an array of automated spectrographs deployed at 10 meteor-observing stations in Spain [1, 2]. SMART also provides valuable information for our MIDAS project, which we conduct to study lunar impact flashes generated when large meteoroids hit the Moon [3-7]. With SMART we can determine the atmospheric trajectory of meteors and the orbit of their parent meteoroids, but also the evolution of the conditions in meteor plasmas from the emission spectrum produced by these events [8-15]. In particular, it can provide useful data to improve our knowledge about cometary meteoroid streams and the mechanisms that deliver these materials to the Earth. One of these is the Taurid complex, whose parent body is comet 2P/Encke. This is known to have suffered catastrophic disruption processes in the past, as this swarm is known to contain m-sized meteoroids and several NEOs have been identified as part of this complex. The determination of precise orbital parameters of large meteoroids, together with the spectroscopic analysis, can provide new clues on the formation, evolution, and chemical composition of this stream. With this aim, we present here a preliminary analysis of one of the Taurid fireball recorded in 2020 in the framework of SMART.

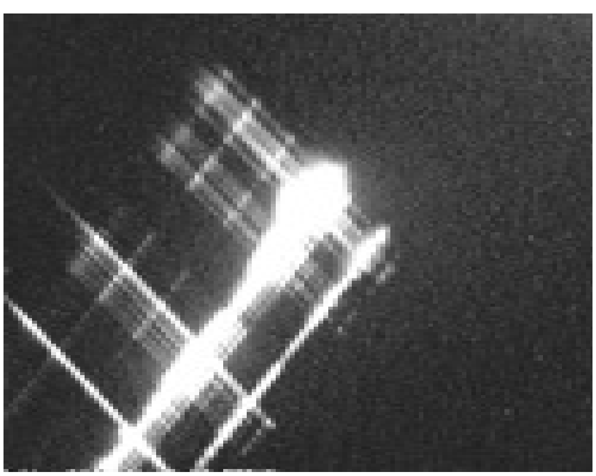

Figure 1. Sum-pixel image of the emission spectrum of the Taurid fireball discussed in the text as recorded from La Sagra Astronomical Observatory.

Instrumentation and methods: To record the fireballs presented in this work and their emission spectrum we have employed an array of low-lux CCD video cameras manufactured by Watec Co. (models 902H and 902H2 Ultimate), some of which are configured as spectrographs by means of 1000 lines/mm diffraction gratings. CMOS color cameras were also employed [18]. 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 Amalthea software, which was also written by the same researcher [19].

Observations: The meteor event presented here was observed on 2020 November 21, at 1h32m26.8±0.1s UT. Its maximum luminosity was equivalent to an apparent stellar magnitude of –11±1. It was spotted from the meteor-observing stations operated by SWEMN at the astronomical observatories of Sierra Nevada, La Sagra, La Hita and Sevilla. The emission spectrum of this event was also recorded by three spectrographs located at La Hita, La Sagra and Calar Alto (Figure 1).

The bolide overflew the province of Jaén, in Andalusia (south of Spain) . It begun at an altitude H_b=105.1±0.5 km over the sea level. The meteoroid hit the atmosphere with an initial velocity V_∞=27.9±0.4 km/s and the apparent radiant was located at the equatorial coordinates α=275.73º, δ=0.08º. The bolide penetrated till a final height H_e=52.6±0.5 km

a (AU)	2.2±0.1	**ω (º)**	102.6±0.2
e	0.79±0.01	**Ω (º)**	58.89869±10^{-5}
q (AU)	0.454±0.005	**i (º)**	8.2±0.1

Table 1. Orbital data (J2000) of the progenitor meteoroid before its encounter with our planet.

The orbital parameters of the parent meteoroid before its encounter with our planet are listed in Table 1. These data and the calculated radiant confirm that the event was associated with the Southern Taurids (STA).

Emission spectrum: The emission spectrum of the bolide was recorded by means of three videospectrographs operated by SWEMN in the framework of the SMART project, and it was analyzed by means of the CHIMET software, developed by J.M. Madiedo [1, 2]. The signal was corrected by taking into account the instrumental efficiency, and then calibrated in wavelength by using typical metal lines appearing in meteor spectra (Ca, Fe, Mg, and Na multiplets). The raw and calibrated spectra are shown in Figures 1 and 2, respectively. In the latter, the most important contributions to the signal have been highlighted. As usual in meteor spectra, most lines identified in this signal correspond to neutral Fe, which is common in meteor spectra [16-20].. Thus, as Figure 4 shows, several multiplets of this element have been identified, among them Fe I-21, Fe I-21, Fe I-4, Fe I-41, Fe I-42, Fe I-318 and Fe I-15. But the most important contribution comes from the emission from Fe I-4. The emission lines of the Na I-1 doublet (588.9 nm) and the Mg I-2 triplet (516.7 nm) are also very remarkable. The detailed conditions in the meteor plasma are currently under analysis. For this purpose, the relative intensities of Mg I-2, Na I-2 and Fe I-15 will be compared, as has been done with previous events [17-25]. This will provide an insight into the chemical nature of the progenitor meteoroid.

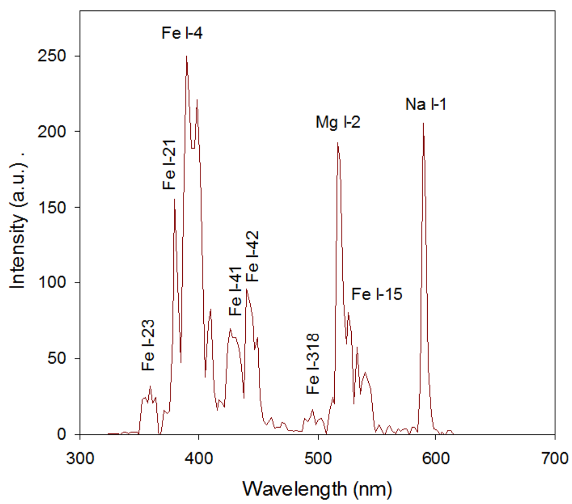

Figure 2. Calibrated and corrected emission spectrum of the fireball.

Conclusions: This work presents a preliminary analysis of a mag. -11 deep-penetrating fireball recorded over Spain on 2020 November 21. The progenitor meteoroid belonged to the Southern Taurid meteoroid stream. The event reached a final height of about 52.6 km over the sea level. The emission spectrum of the bolide was also recorded, and contained as main contributions those of Mg I-2, Na I-1 and Fe I-4.

Acknowledgements: JM Madiedo acknowledges support from the Spanish Ministry of Science and Innovation (project PID2019-105797GB-I00).

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