A POTENTIAL METEORITE-DROPPING FIREBALL RECORDED OVER SPAIN IN 2011.

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Introduction: Although most meteoroids impacting our atmosphere ablate completely, some fireball events may produce, under favourable conditions, a non-zero terminal mass. In these cases these materials reach the ground as meteorites. By recovering these meteorites we can obtain unique samples coming from other celestial bodies that provide helpful information about the origin and evolution of our Solar System. As a matter of fact, one of the aims of the SPanish Meteor Network (SPMN) is the analysis of potential meteorite-producing fireballs. For this purpose we are performing a continuous monitoring of meteor and fireball activity over Spain and neighbouring countries by means of different recording techniques. We also focus on meteor spectroscopy in order to obtain chemical information from the emission spectrum produced when meteoroids ablate in the atmosphere. In this context, we present here the first results of the analysis of a potential meteorite-dropping event that took place over south-west Spain on March 21, 2011. This was registered in the framework of the continuous spectroscopic campaign we are performing since 2010 from our meteor observing station located at the Sierra Nevada Astronomical Observatory.

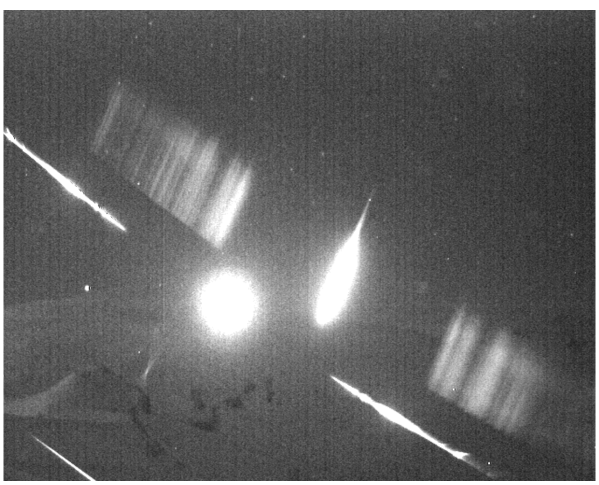

Figure 1. Composite image of the SPMN210311 fireball as recorded together with its emission spectrum from Sierra Nevada.

Instrumentation and methods: The meteor observing station at the Sierra Nevada Astronomical Observatory is based on an array of high-sensitivity CCD video devices [1, 2]. These systems work in an autonomous way by means of a software package developed by us. Most of these cameras are configured as spectrographs by means of transmission diffraction gratings attached to the objective lens. When the observing session finishes at sunrise, the images are automatically sent to our FTP server in order to start the data reduction procedure.

The March 21 event: One of our spectral cameras installed at Sierra Nevada recorded a mag. –11±1 fireball on March 21, 2011 at 20h42m07.0±0.1s UTC (Figure 1). Its apparent trajectory as seen from this location is shown in Figure 2. Unfortunately, no other SPMN stations imaged this event because of unfavourable weather conditions and no casual eyewitnesses' reports were received.

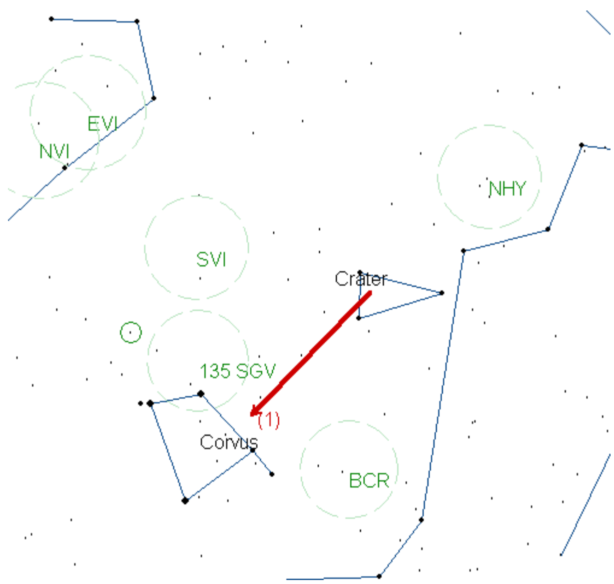

Figure 2. Apparent trajectory of the SPMN210311 fireball.

The bolide exhibited no fragmentation. The final part of the trajectory could not be imaged, as the fireball disappeared behind a mountain before reaching the terminal point of the luminous path. The emission spectrum was also recorded, as can be seen in Fig 1.

Atmospheric trajectory, radiant and orbit: For multi-station events we employ our AMALTHEA software for data reduction. This employs the planes intersection method [3] to calculate the atmospheric trajectory and radiant. However, as the fireball considered here was imaged from only one observing station, a different approach was followed. Thus, we have used the FB_ENTRY software, developed by E. Lyytinen [4]. This software can be employed to reconstruct the atmospheric trajectory of single-station events. In order to do this, several assumptions about this trajectory must be made. Thus, according to our fit, the entry velocity was of about 17.5 km/s, with a zenith angle of 38.1º. The fireball arrived from the azimuth direction 161.7º (as measured from North) and its luminous phase started at a height of about 90 km. It disappeared from the camera's field of view when it was located at 40 km above the ground level. However, the analysis of the deceleration reveals that the velocity at that point was about 1 km/s less than the entry. This would imply that the fireball would have continued yet for quite a long path before reaching the terminal point and possibly it even experienced fragmentation events. The direct track would cross the sea-level at about 36.46º N, 2.12º W. This means that the meteorite would have fallen in the Mediterranean Sea.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	138.57	138.55	-
Dec. (º)	-0.59	-5.61	-
V_∞ (km/s)	17.50	13.38	39.02
Orbital parameters			
a (AU)	3.43	**ω (º)**	33.20
e	0.730	**Ω (º)**	180.726
q (AU)	0.928	**i (º)**	7.14

Table 1. Radiant and orbital data (J2000) inferred for the analysis of the SPMN210311 fireball.

Emission spectrum: The spectrum obtained for the SPMN210311 fireball was reduced by following the same procedure described in [4]. Thus, after the images were background-substracted and flat-fielded, the signal was calibrated in wavelengths by identifying typical lines appearing in meteor spectra. Then, the spectrum was corrected by means of the spectral sensitivity curve of the recording device. This was performed with our CHIMET software. The raw and processed signals are shown in Figure 3. Main emission lines identified in the spectrum have been highlighted in Figure 4. As can be noticed, the spectrum is dominated by the H and K lines of ionized calcium in the ultraviolet. Besides, the Mg I-2 emission predominates over the Na I-1 contribution. Several Fe I multiplets have been also identified. The contribution from atmospheric N_2 can also be seen. Further analysis will be performed in order to infer the relative abundances of the chemical elements in the meteoroid.

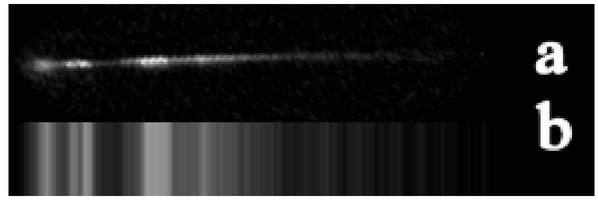

Figure 3. Raw (a) and processed (b) emission spectrum of the SPMN210311 fireball.

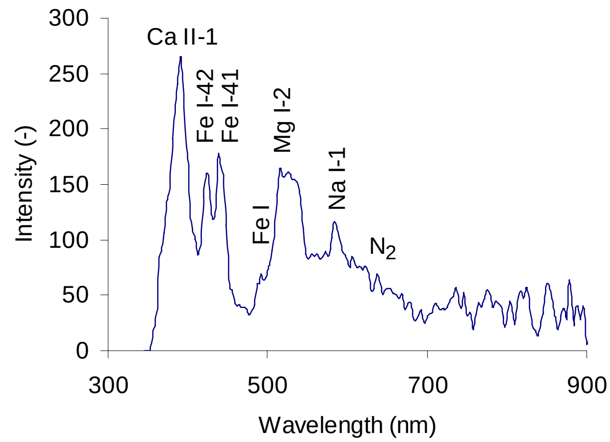

Figure 4. Main emission lines identified in the spectrum of the SPMN210311 bolide.

Conclusions: We have analyzed a potential meteorite-dropping sporadic fireball recorded over Spain in 2011. As this was a single-station event, its precise trajectory, radiant and orbital parameters could not be derived. However, we have used a different approach based on the FB_ENTRY software to infer the likely atmospheric path and meteoroid orbit. According to this, the landing point of the meteorite produced by this bolide would be located on the Mediterranean Sea. On the other hand, the emission spectrum imaged by our spectral cameras provided information about the chemical nature of the meteoroid.

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References: [1] Madiedo J.M. and Trigo-Rodríguez J.M. (2008) *EMP* 102, 133-139. [2] Madiedo J.M. et al. (2010) Adv.in Astron, 2010, 1-5. [3] Ceplecha Z. (1987) Bull. Astron. Inst. Czechols. 38, 222-234. [4] Lyytinen E. and Gritsevich M. (2012), Proceedings of the IMC Conference (submitted). [5] J.M. Trigo-Rodríguez et al. (2003) MAPS 38, 1283-1294.