A SPORADIC METEOROID FOLLOWING A SUN-GRAZING ORBIT RECORDED ON 8th MAY 2015.

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Introduction: The continuous monitoring of the night sky by means of high-sensitivity CCD video devices provides valuable information about major and minor meteor showers, but also about the diverse sources of sporadic activity. Fireball networks are able to obtain a significant number of sporadic events to gain insight in the origin of bright fireballs that are not linked with meteor showers. The physical parameters of sporadic meteoroids ablating in the atmosphere can be also obtained. These include trajectory, radiant, orbit, mass and tensile strength [1, 2]. The determination of such orbits is one of the aims of the SPanish Meteor Network (SPMN). Thus, as a result of our continuous meteor monitoring over the Iberian Peninsula, two of our video stations recorded on May 8, 2015 a mag. -10 sporadic fireball that was catalogued as SPMN080515A. The origin of this fireball event is presented here.

Figure 1. The SPMN080515A fireball imaged from Folgueroles (Barcelona).

Instrumentation: We have employed an array of high-sensitivity CCD video devices (models 902H Ultimate, from Watec Co.) to image the fireball analyzed here. The wide-field lenses provide a spatial resolution of few arc-minutes that is obtained in each astrometric measurement of the fireball position compared with background stars. The video cameras operate using the PAL video standard. A detailed description of these systems, and the reduction procedure is given in previous publications [1, 3].

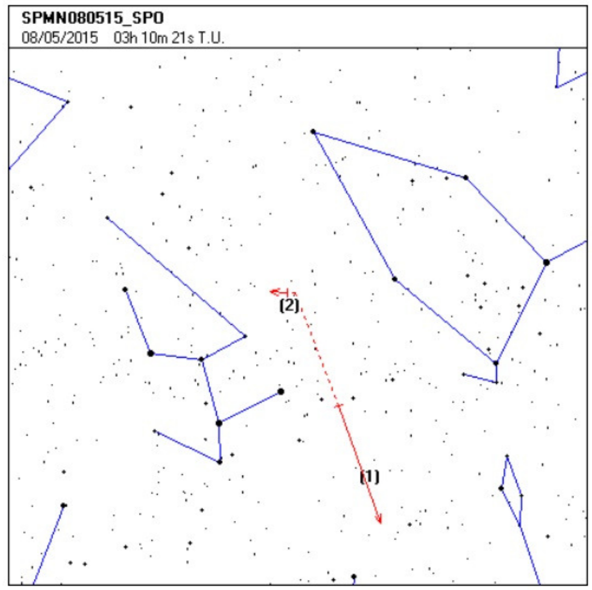

Figure 2. Apparent trajectory of the SPMN080515A fireball as recorded from (1) Folgueroles and (2) Montseny.

Results: The fireball analyzed in this work was imaged over Barcelona province from two stations on May. 8, 2015 at 3h10m20.8±0.1s UTC. These operated from our meteor stations in Montseny and Folgueroles. The fireball was quite spectacular and exhibited several fulgurations along its atmospheric path that are often consequence of progressive fragmentation of the meteoroid during atmospheric deepening (Fig. 1), indicating it is quite fragile [7]. Its apparent magnitude, obtained from the photometric analysis of the video images, was -9±1. By using the method of planes intersection [8] 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 111±1 km above the ground level, with a preatmospheric velocity V_∞=40.7±0.5 km/s. This velocity was determined from the extrapolation of the velocities measured at the beginning of the meteor trail. The terminal point of the trajectory was reached at a height of 56±1 km. The geocentric radiant was located at α_G=342.7±0.8º, δ_G=-1.3±0.8º. With this information, we calculated the orbit followed by the meteoroid that produced this fireball by applying the procedure described in [4, 5]. Radiant and orbital parameters are summarized on Table 1.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	341.9±0.8	342.7±0.8	31.1±1.8
Dec. (º)	-0.07±0.8	-1.3±0.08	11.5±1.7
V_∞ (km/s)	40.7±0.6	38.8±0.6	18.7±0.6
Orbital parameters			
a (AU)	0.630±0.009	**ω (º)**	7.5±0.8
e	0.963±0.007	**Ω (º)**	47.02769±10^{-5}
q (AU)	0.023±0.004	**i (º)**	143.1±5.1

Table 1. Radiant and orbital data (J2000) for the SPMN080515A fireball.

Cometary family	q (AU)	i (º)	ω (º)	Ω (º)
Kreutz	0.005	144.6	82.2	3.2
Meyer	0.035	72.1	57.3	73.5
Marsden	0.05	26.0	28.1	81.6
SPMN080515	0.05	139.1	8.13	47.02

Table 2. The mean values of the main orbital elements of sungrazing comets as outlined in [9]

Discussion: The perihelion distance of the heliocentric orbit of the meteoroid SPMN080515A is small enough (q = 0.05 ± 0.01 AU) to attribute its potential origin to a sun-grazing comet. Sun-grazing comets typically have perihelion distances of the order q < 0.1 AU and they are strong contributors of meteoroids to the terrestrial atmosphere [8]. The list of comets which can be classified as sun-grazing is constantly being updated as can be witnessed via SOHO's Sungrazer Project [10] which has a current discovery count of 3168 comets [9]. As regards the orbital characteristics of sungrazers, there are four main distinguishable families of sun-grazer comets as shown in Table 2. The vast majority of sun-grazers observed by SOHO as part of the Sun-grazer Project [10] are from the Kreutz family. The meteoroid SPMN080515A does not consistently agree with any of the four families in terms of its main orbital elements hence it is most likely a sporadic sungrazer originating from the Oort cloud.

The sun-grazing state is particularly common amongst the evolution of long period, high inclination (~90º) comets which originally have small perihelion distances (q < 2 AU) [11]. Long term secular perturbations alter the heliocentric orbital elements, i, e and q in particular. This results in the comet entering a temporary state whereby the perihelion distance is extremely small. The majority of comets, especially smaller ones, don't survive the passage around the Sun. They tend to be completely evaporated and destroyed due to solar heating at the tiny perihelion. However larger comets may survive and they often exhibit fragmentation due to strong tidal forces [11]. When these comets pass very close to the sun more particles are ejected, on similar orbits, due to solar heating facilitating the sublimation of ices [12].

Another possible origin for sun-grazers is that they are dynamically new comets which are arriving at the inner solar system after being disrupted from the Oort cloud. It is probable that the composition of these comets consists of volatiles which increases the possibility of out-gassing [12]. These compositions would also result in the production of large meteoroids that are able to produce bright fireballs such as SPMN080515 which had a -10 absolute magnitude.

Conclusions: As a result of SPMN continuous monitoring of the night sky, we record meteor events of unusual origin from time to time. This was the case of this SPMN080515 fireball. The analysis of this event has provided its atmospheric trajectory, radiant, and heliocentric orbit of the corresponding meteoroid. For our surprise the meteoroid exhibits an orbit very similar to the Sun-grazer family of comets.

Acknowledgements: We acknowledge support from the Spanish Ministry of Science and Innovation (projects AYA 2015-67175-P and AYA2015-68646-P)

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