SPMN100215: A HELION SOURCE DAYLIGHT BOLIDE RECORDED FROM EBRE OBSERVATORY.

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Introduction: Bright daylight fireballs are rarely studied due to the lack of data, and the difficulty to calibrate the trajectory descriptions given by eyewitnesses. Only in few occasions casual recordings have been able to get orbital information of daylight bolides. Fortunately, modern video detectors can be also adapted for monitoring the sky during broad daylight and we present here some first results. In 2006 we started a continuous monitoring of large bolides over Catalonia during the night with the goal of recording meteorite-dropping bolides and recover new meteorites. Multiple station fireball monitoring in broad daylight was extended during early 2014. With such a goal the Institute of Space Sciences (CSIC-IEEC) installed a new meteor video-detection station at the Ebre Observatory (EO, URL-CSIC) to be complementary with the CSIC-IEEC station already operational at Montseny. Both stations are part of the Spanish Meteor and fireball Network (SPMN) initiative [1]. The strategic location of this station will allow the observation and registration of bolides during daytime over the Spanish north-east sky, and particularly over Catalonia. Here we discuss the origin of the daylight bolide named SPMN100215 and disrupted over Catalonia on Feb. 10th, 2015 recorded during the first year of continuous operation (see Fig. 1).

Methods: Ebre Observatory video-detection station consists of several video cameras, one of them pointing to the sky in North direction, recording Aragon and Catalonia. Both cameras use sophisticated software that allows detecting fireballs in the sky and recording the image that will be used astrometrically. Given the location of the OE, the orientation of the camera installed in the observatory looking northward is strategic for SPMN researchers because it prevents the transit of the Sun and can provide coverage to all objects flying over the sky of Aragon and Catalonia, 24 hours a day, 7 days a week. The camera data obtained here is a *Presentco* digital video camera with a half inch interline transfer CCD chip with a 2:1 interlaced scanning system. It provides images of 640×480 pix^2. A standard video lens allows getting a maximum horizontal field of view of ~100º. This video system, once orientated correctly with a software implemented to patrol the same atmospheric volume than nearby stations [2], allows obtaining tens of meteoroid orbits every night, increasing the coverage of the SPMN network and allowing the detection of elusive daytime fireballs.

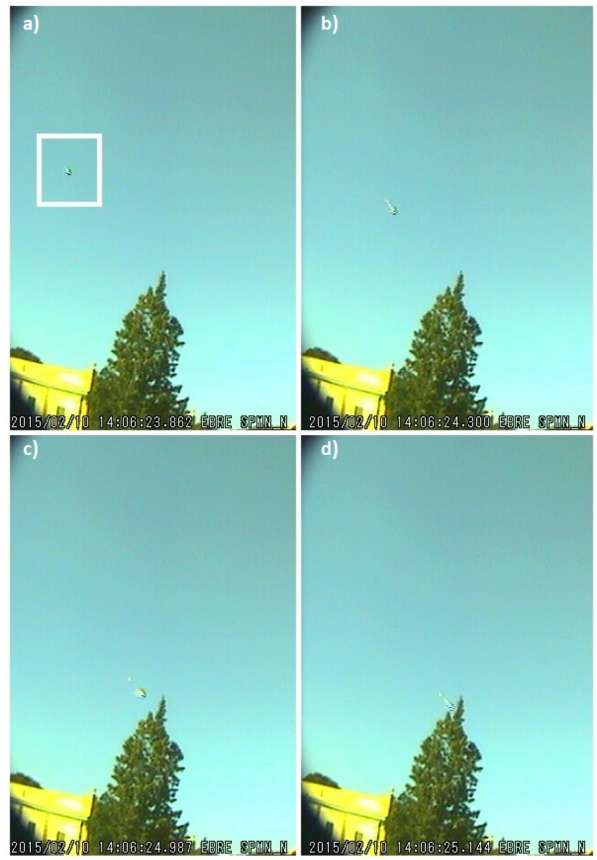

Figure 1. SPMN100215 daylight bolide sequence as recorded from OE. a) Frame #56 at 14:06:23.9 UT, b) #67 at 24.3 s, c) #84 at 24.9 s and d) #88 at 25.1 s.

Observatory	Location coordinates
Observatory de l'Ebre (OE)	Lon. 00º 29´ 44" E Lat. 40º 49´ 16" N Alt. 50 m
Montseny	Lon. 02º 31´ 14" E Lat. 41º 43´ 17" N Alt. 300 m.
Obs. Ast. del Montsec (OAdM)	Lon. 00º 43´ 46" E Lat. 42º 03´ 05" N Alt. 1570 m

Table 1. Observatories involved in this daylight monitoring over Catalonia and neighboring regions.

Results and discussion: We measured 18 individual frames of the daylight fireball, along the entry track. With these we derived a one station solution, using an approximated analytic formula for velocity and the standard atmosphere density values [3]. Unfortunately the very beginning of the bolide is not visible in the video to try to scale with this, so only a range of orbital values can be obtained (Tables 2 and 3). In that table three different entry velocity 20, 25 and 30 km/s were considered. The fireball came from an azimuth-direction of 210º (with uncertainties of ~2 degrees for each velocity value alternative solutions), and with a slope of about 29.5 degrees at the beginning of the luminous flight. The different velocity solutions differ only by a few tenths of a degree between them.

V_∞ (km/s)	α (º)	β (º)	σ (s^2/km^2)
20	11.8	3.17	0.048
25	38.5	2.97	0.028
30	113	2.77	0.018

Table 2. Trajectory geometry and ablation coefficient (σ) and as a function of the meteoroid velocity at infinity (V_∞).

The solutions for each velocity allow deriving the alpha and beta using the procedure described in [3]. Also the meteoroid ending mass are inferred, As is expected the mass-values are strongly dependent of the velocity because bigger velocity means higher in the atmosphere and less dense atmosphere. These inferred ablation coefficient values are given in Table 2. In any case the quite fast velocity means that the meteoroid ablated practically to end. In the 20 km/s alternative the terminal mass would have been something like 77 g, and a few grams in the second alternate velocity and below one gram in the 30 km/s alternative.

In the 25 km/s alternative the height at the start of measurements, frame #25 is 68 km, which is quite low for this velocity beginning height but the fireball it is already quite bright at this stage and may have started a lot earlier. The last measurable frame #102 had the height of 33.9 km.

V_∞ (km/s)	q (A.U.)	a (A.U.)	e	i (º)	ω (º)	Ω (º)
20	0.593	1.33	0.55	2.19	263.1	141.3
25	0.540	2.13	0.74	1.97	266.6	141.3
30	0.497	7.37	0.93	1.80	268.3	141.3

Table 3. Range of orbital elements of SPMN100215, Equinox (2000.00).

Conclusions: We have first applied video cameras to patrol the skies over Iberian Peninsula in broad daylight, 24 hours a day, 7 days a week [4]. Now we are successfully testing high-resolution video cameras that allow obtaining very relevant information on the origin of daylight bolides. From the inferred trajectory and orbital data obtained in the case studied here we can conclude that the SPMN100215 fireball was of sporadic origin, but particularly coming from the so-called "hellion" source. We note that the 'sporadic source regions' within the radiant distribution comprise useful groupings of orbital types. The main radiant groupings of Helion-type bolides are concentrated about the ecliptic in the directions of the apex of the Earth's way, the antihelion and the helion [5-6]. These regions are also poorly monitored by telescope surveys due to their unfavorable observing geometry so can be unexpected source of hazardous asteroids like e.g. Chelyabinsk [7]. To get new insight about the ablation properties of these materials that are highly shocked is of key relevance to develop efficient deflection approaches in case of detection of future impact hazard to Earth [8-9]. The only difference between the orbits detected in the antihelion and hellion regions is whether the meteoroid impacted our planet pre- or post-perihelion in its orbit as described in [10].

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