

A VERY BRIGHT DAYLIGHT BOLIDE WITNESSED ON MAY 17, 2016 OVER GALICIA, SPAIN J. A. Docobo¹, P. P. Campo¹, J. M. Trigo-Rodríguez², and J. M. Madiedo³, ¹Observatorio Astronómico Ramón María Aller (OARMA). Universidade de Santiago de Compostela, Avenida das Ciencias, Campus Vida. Santiago de Compostela, Spain, joseangel.docobo@usc.es, pedropablo.campo@usc.es ²Institute of Space Sciences (IEEC-CSIC), Campus UAB, Carrer de Can Magrans s/n, 08193 Cerdanyola del Vallés (Barcelona), Spain, trigo@ice.csic.es ³Facultad de Ciencias Experimentales. University of Huelva. Avenida de las Fuerzas Armadas S/N, 21071 Huelva, Spain, madiedo@uhu.es

Introduction:The detailed study of bright fireball events is one of the aims of the Spanish Meteor Network (SPMN) as these allow us to collect very valuable information on the origin of the relatively rare meteorite-dropping bolides. OARMA has actively participated in the monitoring of bright bolides over the NW of Spain and, since 2009, two video monitoring stations in Santiago de Compostela and Lugo have been detecting night-time events within the framework of the SPMN. As a result of this monitoring effort, very bright fireballs over Galicia were reported [1-3]. However, as the very bright fireball (brighter than mag. -12) that was observed over Galicia on May 17, 2016 occurred at 14h02m00s±30s UTC (duration of 2-3 seconds), this daytime event was not able to be tracked by our video cameras. Nevertheless, we were able to interview 13 visual witnesses and study a photograph of the bolide end in order to obtain a reliable reconstruction of the fireball trajectory as carried out previously [see e.g. 3].

As a by-product of such an effort, a preliminary analysis of this event, called SPMN170516 (As Neves), is presented here. The data provided by the eyewitnesses revealed that, in fact, this could have been a meteorite-dropping fireball.

Observational data:On the afternoon of May 17, 2016, the sky was clear over Galicia and many people were outside as it was a regional holiday. The event was reported to the mass media by the lucky eyewitnesses and also directly reported through our SPMN bolide report homepage (<http://www.spmn.uji.es/ESP/reporte.html>).

During several weeks, the eyewitnesses were telephonically interviewed to identify the best locations to be visited with a theodolite. According to these, the fireball fragmented only at the end of its atmospheric trajectory. Audible sound (three consecutive detonations) was reported from four locations: Nigrán, O Rosal, Tomiño, and Budiño, which support the fragmentation. The brightness of the fireball is difficult to establish, but, according to visual reports, we estimate that the absolute magnitude was -12 or even brighter.

In order to analyze this fireball, the same procedure employed in previous events was followed [1, 2, 3]. Thus, each of the 13 observers were interviewed by an OARMA team and precise visual measurements were performed with a theodolite at the same locations

where the fireball was witnessed. Each observer provided the position of the initial and final points of the fireball's apparent trajectory. Eyewitness positions, their reports, and the weight assigned to them are included in Table 1, where the azimuth was measured from the North. Weights from 0 to 10 were assigned to the witnesses based on the quality of the information.

Weight 10 corresponds to observation number 8, in which a picture of the final point with land references was reported (see Figure 1).



Figure 1. Photography of the fireball train at its final point, where two main dust clouds are associated with two main fragmentations. A cable used for its calibration can be seen near of the horizon.

Calculation of the luminous atmospheric trajectory: We have used our SPMN network software [4, 5] to obtain the luminous atmospheric trajectory of this event. The apparent trajectories in the sky from the different locations were obtained and an average was calculated using the planes intersection method [6] to perform this calculation. The best solution yields a beginning point located at $\varphi=42.026^\circ\text{N}$, $\lambda=8.567^\circ\text{W}$, $H=74.6\text{ km}$, with the final point close to As Neves village at $\varphi=42.102^\circ\text{N}$, $\lambda=8.428^\circ\text{W}$, $H=25.8\text{ km}$ and

exhibiting an apparent radiant located at R.A.=59±4°, Dec.=+29±3°. Figure 2 shows the projection on the ground of the atmospheric luminous trajectory of the fireball, for which we assumed a beginning around a height of 95 km. Due to the sky brightness in broad daylight most observers reported the beginning of the bolide at a height of ~75 km.

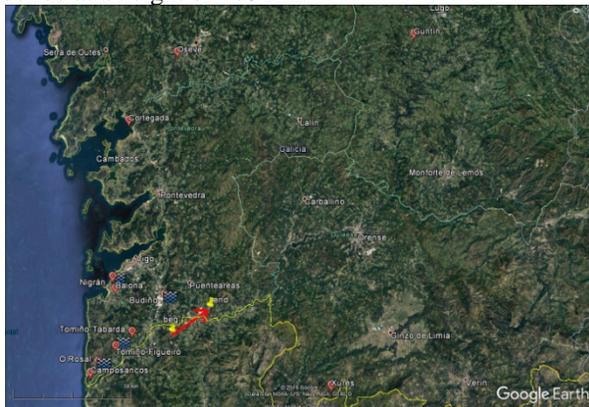


Figure 2. The trajectory projected on the ground of the SPMN170516 fireball witnessed on May 17, 2016 at 14 h 02 UTC. Observing locations (red marks) and the waves represent reports of audible sound. The trajectory almost intersected Portugal’s border.

| Obs# | Coordinates | | Initial point | | Final point | | Weight |
|------|-------------|---------|---------------|-------|-------------|-------|--------|
| | φ (°N) | λ (°W) | A (°) | h (°) | A (°) | h (°) | |
| 1 | 42.91152 | 7.66748 | 220 | 25 | 215 | 15 | 9 |
| 2 | 42.82454 | 8.61511 | 167 | 40 | 180 | 20 | 7 |
| 3 | 42.61308 | 8.78939 | 165 | 45 | 150 | 25 | 8 |
| 4 | 42.15822 | 8.80411 | 140 | 65 | 106 | 40 | 7 |
| 5 | 42.12678 | 8.78993 | 130 | 70 | 95 | 40 | 5 |
| 6 | 42.11547 | 8.59828 | n.o. | n.o. | 80 | 50 | 6 |
| 7 | 42.00637 | 8.71286 | 85 | 80 | 65 | 48 | 6 |
| 8 | 41.96329 | 8.77212 | 71.5 | 75 | 60.8 | 40 | 10 |
| 9 | 41.94639 | 8.85370 | 75 | 50 | 65 | 30 | 6 |
| 10 | 41.92850 | 8.83770 | 70 | 65 | 60 | 35 | 5 |
| 11 | 41.91775 | 8.83461 | 65 | 70 | 55 | 35 | 4 |
| 12 | 41.88784 | 7.94349 | 248.5 | 50 | 300 | 30 | 8 |
| 13 | 41.88543 | 8.86033 | 60 | 60 | 50 | 27 | 3 |

Table 1. Geographical coordinates of the visual witnesses, with the observed azimuth (A) and altitude (h) of the fireball beginning and ending points and the weight assigned to them. Azimuths are measured from the North. Observing places plotted in Fig. 1 are: 1) Guntín, 2) Oseve, 3) Illa de Cortegada, 4) Nigrán, 5) Baiona, 6) Budiño, 7) Tomiño-Tabarda, 8) Tomiño-Figueiró, 9, 10, 11) O Rosal, 12) Xurés, and 13) Camposancos.

Survival of meteorites and landing area: Because of the low height calculated for the terminal point of the luminous trajectory (~25.8 km), a meteorite fall seems to be likely. In any case, the overall uncertainty of the data makes the recovery of the corresponding meteorite very difficult.

For a particle with a mass of 1 kg, for instance, the landing point would be located at the coordinates φ=42.118° N, λ=8.398° W if wind effects are ignored. Further analysis will be performed in order to include these effects in the calculations.

Conclusions: A very bright daylight fireball of sporadic origin was observed over the Iberian Peninsula on May 17, 2016. Thirteen witnesses were interviewed by an OARMA team and the luminous part of the fireball’s atmospheric trajectory has been calculated. According to this preliminary analysis, this event could well have produced meteorites because the luminous path seems to have dropped below a height of 25 km over the sea level. The landing point would be located between Arbo and As Neves in the SE corner of Pontevedra province, close to the Portugal border. A plausible orbital solution places the meteoroid aphelion in the main asteroid belt (see Fig. 3).



Figure 3. Tentative meteoroid orbit assuming a geocentric velocity of 18 km/s. The meteoroid followed a few degrees inclination orbit relative to the ecliptic. Venus, Earth (in red), and Mars orbits are shown.

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