

A BRIGHT FIREBALL WITNESSED ON AUGUST 17, 2011 OVER THE IBERIAN PENINSULA. J. A. Docobo¹, J. M. Madiedo² and J. M. Trigo-Rodríguez³, ¹Observatorio Astronómico Ramón María Aller (OARMA), Universidade de Santiago de Compostela, Avda. Das Ciencias, Campus Sur, Santiago de Compostela, Spain, jose-angel.docobo@usc.es. ²Facultad de Ciencias Experimentales, University of Huelva, Avda de las Fuerzas Armadas S/N, 21071 Huelva, Spain, madiedo@uhu.es. ³Institute of Space Sciences (CSIC-IEEC), Campus UAB, Facultat de Ciències, Torre C5-p2, 08193 Bellaterra, Spain, trigo@ieec.uab.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. In this context, a very bright fireball (at least mag. -12) was observed over the Iberian Peninsula during the evening twilight of August 17, 2011. However, unfavourable weather conditions in most of the regions where our meteor observing stations were working did not allow us to record any video or image of this fireball. Fortunately, because of excellent weather over Galicia and other areas in northwest Spain, the observation of this event was very favourable for numerous visual witnesses that could account for it. These were interviewed by a team belonging to the *Ramón María Aller Astronomical Observatory* (OARMA). This made possible a reliable reconstruction of the fireball trajectory in a systematic way as made in previous events [see e.g. 3]. We present here the preliminary analysis of this event. The data provided by the eyewitnesses reveal that, in fact, this could have been a meteorite-dropping fireball, although the meteorite would have landed on the Atlantic Ocean.

Observational data: During the evening twilight of August 17, 2011 the sky was partially covered over a significant part of the Iberian Peninsula, and flashes produced by lightning interfered with the operation of most of the CCD cameras employed by the SPMN to monitor the night sky, in such a way that these systems could not work properly. Thus, no images could be recorded of the event that took place at 19 h 57 min 30±30 s UTC, although fortunately visual witnesses could account for it. According to these, the fireball experienced three fragmentations along its atmospheric trajectory. No sounds related to this fireball were reported. 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, observers in Galicia were interviewed and precise visual measurements were performed with a theodolite at the same locations where the fireball was witnessed. Observers in other regions of Spain and Portugal were interviewed by telephone, and careful

indications were given to these on how to proceed and which tools could be used (e.g.: Google Earth and Google Maps) to provide us with the information necessary to define the event. Each observer provided the position of the initial and final points of the fireball's apparent trajectory. In some cases, however, these points corresponded to the position of an object (house, tree, hill, etc.) that occulted the fireball. Thanks to the collaboration of several media (mainly the digital editions of *El Correo Gallego* and *La Voz de Galicia*) about 300 witnesses contacted the OARMA, but only those that provided us with reliable information were taken into account. Eyewitness reports are in Table 1, where the azimuth was measured from the North.

Calculation of the luminous atmospheric trajectory: We have used the Amalthea software [4, 5, 6] to obtain the luminous atmospheric trajectory of this event. This package employs the planes intersection method [7] to perform this calculation. The best solution yields a beginning point located at $\varphi=40.633^\circ$, $\lambda=-7.203^\circ$, $H=93.9$ km, with the end point at $\varphi=41.727^\circ$, $\lambda=-9.159^\circ$, $H=25.2$ km and an apparent radiant located at $R.A.=309.4^\circ$, $Dec=-12.5^\circ$. Figure 1 shows the projection on the ground of the atmospheric luminous trajectory of the fireball.

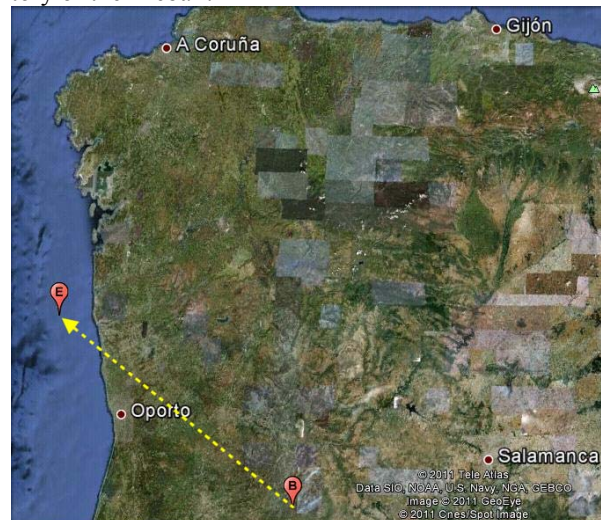


Figure 1. The trajectory projected on the ground of the SPMN170811 fireball witnessed on August 17, 2011, at 19 h 57 min 30±3 s UT.

Analysis of the landing area: Because of the low height calculated for the terminal point of the luminous trajectory (about 25.2 km), a meteorite fall seems to be likely. In any event, the calculations show that this would have taken place over the Atlantic Ocean, which makes the recovery of the corresponding meteorite impossible.

The wind profile provided by the Spanish Weather Agency (AEMET) has been employed to model the dark flight of the meteoroid. In any case, to estimate the landing point several assumptions must be made about different parameters, such as, for instance, the density of the meteoroid, its shape, the terminal mass and the terminal velocity. We have used the Amalthea software [4, 5] to perform this calculation by considering a spherical particle with a density of about 2,4 g/cm³. The data provided by the witnesses do not allow for a precise estimation of the terminal velocity and, so, we have assumed a typical value of about 4 km/s for this parameter. With respect to the terminal mass, several values ranging from 1g to 5 kg have been employed. For a particle with a mass of 1 kg, for instance, the landing point would be located at the coordinates $\varphi=41.753^\circ$, $\lambda=-9.197^\circ$.

Conclusions: A very bright fireball was observed over the Iberian Peninsula on August 17, 2011. Witnesses were interviewed and the luminous part of the fireball's atmospheric trajectory has been calculated. According to this analysis, this could have been a meteorite-producing event, although the landing point would be located on the Atlantic Ocean, at about 26 km from the western coast of Portugal.

Acknowledgements: We acknowledge all of the witnesses for their collaboration. Second author also acknowledges support from the Spanish Ministry of Science and Innovation (grant nr. AYA2009-13227). JMTR acknowledges grants CSIC#201050I043 and AYA2011-26522.

References: [1] Docobo J.A. et al. (1998) *Meteorit. Planet. Sci.* 33, 57–64. [2] Docobo, J. A. et al (1999) *Astron. Astrophys. Suppl. Ser.* 138, 1–9. [3] Docobo, J. A. et al. (2009) *EMP* 102, 537–542. [4] Trigo-Rodríguez J.M. et al. (2009) *MNRAS* 394, 569–576. [5] J.M. Madiedo et al. (2011), *EPSC-DPS Joint Meeting 2011*, Abstract #Vol. 6, EPSC-DPS2011-67. [6] Trigo-Rodríguez J.M. et al (2010) *MAPS* doi: 10.1111/j.1945-5100.2010.01029.x [7] Ceplecha, Z. (1987) *Bull. Astron. Inst. Cz.* 38, 222–234.

Obs #	Coordinates		Initial point		Final point	
	φ (°)	λ (°)	A (°)	h (°)	A (°)	h (°)
1	43° 29' 31"00	-8°11'17"38	153	6	190	5
2	43°01'15"32	-8°39'24"88	147	16	200	8
3	42°53'37"01	-8°31'46"44	153	16	198	11
4	42°52'33"24	-8°36'43"43	155	30	240	15
5	42°52'33"24	-8°36'43"43	150	18	197	12
6	42°50'28"00	-7°29'51"65	215	20	240	10
7	42°47'16"95	-8°58'40"49	145	18	193	13
8	42°39'34"89	-8°33'24"58	155	20	205	15
9	42°38'08"52	-7°45'54"73	200	16	240	8
10	42°36'53"41	-8°52'09"09	170	20	200	15
11	42°36'32"26	-8°56'01"65	155	20	193	15
12	42°36'04"88	-8°46'00"98	145	25	240	15
13	42°34'44"38	-8°57'28"11	150	20	197	17
14	42°34'10"48	-8°58'26"15	145	20	190	16
15	42°33'23"63	-7°23'37"17	180	30	245	10
16	42°33'19"82	-8°59'17"15	175	17	188	15
17	42°31'22"24	-7°30'27"86	187	16	210	13
18	42°30'11"78	-5°53'38"93	187	20	220	15
19	42°27'50"32	-7°42'37"24	155	20	240	10
20	42°26'19"42	-8°04'53"51	200	17	236	12
21	42°26'04"04	8°50'44"71	137	25	177	20
22	42°23'24"09	8°49'56"52	143	30	208	25
23	42°20'04"71	-7°47'46"42	160	25	255	8
24	42°17'53"45	-8°40'45"00	190	30	220	25
25	42°16'31"39	-8°39'56"81	180	30	220	25
26	42°10'32"58	-8°30'13"34	185	30	205	20
27	42°09'04"00	-4°41'26"00	220	35	260	20
28	42°05'31"24	-6°37'47"08	175	20	265	10
29	42°03'10"78	-8°39'23"89	129	35	228	19
30	41°58'59"26	-8°43'58"49	127	32	206	20
31	40°48'06"34	-5°16'43"24	280	35	290	25
31	40°30'45"56	-6°01'27"88	260	30	297	15
33	40°20'53"64	-3°54'07"67	270	40	295	15
34	40°19'40"07	-5°54'58"90	270	60	303	10
35	40°04'07"18	-4°43'57"59	286	45	298	20
36	38°52'07"83	-6°57'50"46	15	45	335	15
37	38°41'31"96	-6°22'56"79	0	35	330	10

Table 1. Geographical coordinates of the visual witnesses, with the observed azimuth (A) and altitude (h) of the initial and final points of the fireball analyzed in the text. Azimuths are measured from the North.