A 2016 NORTH TAURID BOLIDE BRIGHTER AS THE FULL MOON IMAGED IN THE FRAMEWORK OF THE SPANISH FIREBALL NETWORK E. Blanch[1], J.M. Trigo-Rodríguez[2], J.M. Madiedo[3,4], P. Pujols[5], J. Izquierdo[6], J. Zamorano[6] and D. Altadill[1]. [1]Observatori de l'Ebre (OE, CSIC - Universitat Ramon Llull), Horta Alta, 38, 43520 Roquetes, Tarragona, Spain [2]Institute of Space Sciences (IEEC-CSIC). Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra [3]Facultad de Ciencias Experimentales, Universidad de Huelva (UHU), Huelva, Spain [3]Departamento de Fisica Atomica, Molecular y Nuclear. Universidad de Sevilla. 41012 Sevilla, Spain [5]Agrupació Astronómica d'Osona (AAO), Carrer Pare Xifré 3, 3er. 1a. 08500 Vic, Barcelona [6]Universidad Complutense de Madrid, Depto. Astrofísica y CC. de la Atmósfera, 28040 Madrid, Spain.

Introduction: The Spanish Meteor Network (SPMN) already operates about 200 cameras and 30 stations distributed around continental Spain, and giving a scientific and rational explanation to very bright fireball events. Our cooperative network has remained operational for the last twenty years, and has a special program to obtain very precise orbital information on 2P/Encke meteoroids that we think produce meteorites and might even contribute to impact hazard [1, 2]. Current evidence supports that evolved comets can produce meter-sized meteoroids that are potential meteorite droppers with significant danger by shock waves like e.g. the Chelyabinsk event [3]. We should not forget that the Tunguska event could have been produced by a fragment of comet 2P/Encke [4].

The orbital similitude is a clear evidence on the connection between comets and meteor streams [5-8]. The continuous sublimation of the ice-rich regions in cometary nuclei produces outgassing capable to release cm to μm-sized particles from cometary nuclei. This is the main way to produce meteoroid streams showers [5-7]. Another feasible physical process to produce cometary debris in heliocentric orbit is the disruption of a comet that explains the formation of at least ten meteoroid streams [7-9]. This second pathway produces far larger particles that sometimes can even be in the meter scale and can explain very bright bolides associated with some meteor showers [8]. Unfortunately, large bolides are rare events so in order to study them a continuous sky monitoring is required which is the only way to collect information on the dynamic origin and physical behavior of large bolides penetrating Earth's atmosphere. So far we have described different cases related to the Taurid complex [1,2]. Several Near Earth Objects (NEOs) have been dynamically associated with the Taurid complex clearly suggesting that the progressive disruption of a larger cometary progenitor is the source of this complex of bodies [9, 10]. In the current abstract we focus in a Taurid fireball named SPMN 151116C recorded on November 15th, 2016 at 20h06m33s UTC (Fig. 1).

Methods: 35 CCD and video stations are currently monitoring a surface area of 600,000 km^2. The cameras used are high-sensitivity 1/2" black and white CCD video cameras (Watec, Japan) attached to modified wide-field lenses covering a 120×80 degrees field of view. Coordinate positions of the fireball were obtained by creating a composite image of all frames where the stars coordinates were measured and taken as reference using our software package [11]. The fireball described here was imaged from IEEC-CSIC Catalan and UCM stations (Table 1). At Montsec a low-scan-rate CCD all-sky camera was used, while wide field video cameras were used at the other stations.

N	Station	Longitude	Latitude	Alt.
1	Folgueroles	02º 19´ 33"	41º 56´ 31"	580
2	Ebre Obs.	00º 29´ 44"	40º 49´ 16"	50
3	Montsec Obs.	00º 43´ 46"	42º 03´ 05"	1570
4	Madrid	-3° 39' 41"	40° 26' 57"	650
5	Villaverde del Ducado	-2° 29' 31"	41° 00' 05"	1150

Table 1. SPMN stations involved in the detections discussed in this chapter.

Results and discussion: From the astrometric measurements of the video frames and the trajectory length, the velocity of the bolide along the path was obtained. Radiant and orbital parameters were computed and are presented in Table 2. The pre-atmospheric velocity V_∞ was found from the velocity measured at the earliest part of the fireball trajectory, and defines the kinetic energy and consequently, the orbit. Figure 1a,b shows the magnificence of the bolide which reached an absolute magnitude of -13±1. This fireball started at a height of 90.1±0.6 km and ended at 40.8 ± 0.5 km with a bright flare at 58.8±0.9 km so a meteorite survival can be definitively ruled out.

Radiant data			
	Observed	Geocentric	Heliocentric
R.A. (º)	70.0±0.4	70.2±0.3	11.6±0.8
Dec. (º)	22.4±0.4	20.8±0.2	-1.2±0.3
V_∞ (km/s)	27.8±0.4	25.1±0.3	32.3±0.3

Orbital parameters			
a (AU)	1.18±0.03	**ω (º)**	129.4±0.7
e	0.75±0.01	**Ω (º)**	53.6147±10^{-4}
q (AU)	0.295±0.007	**i (º)**	1.8±0.5

Table 2. Radiant and orbital data (J2000).

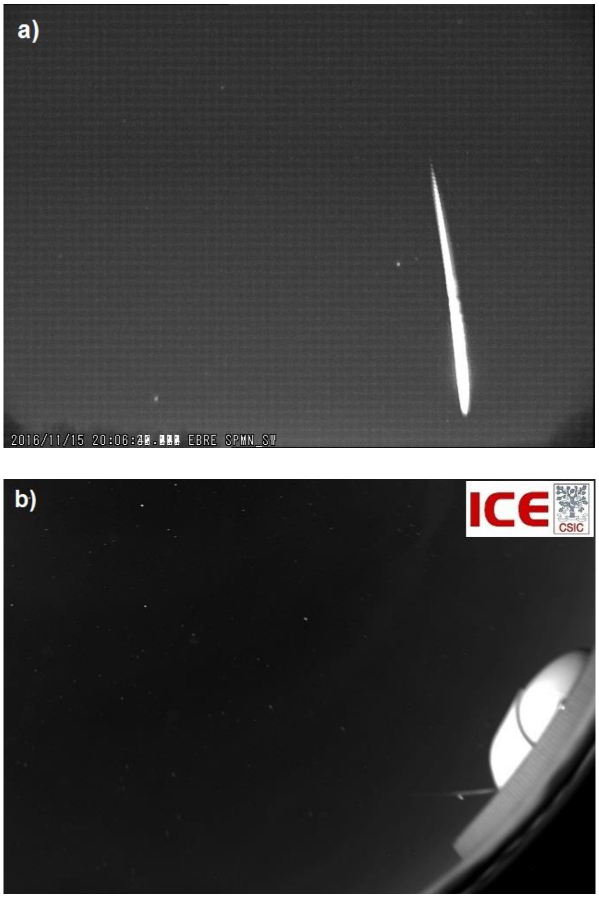

Figure 1. Composite image of SPMN 151116C fireball imaged from a) Ebre, and b) Montsec Observatories.

Conclusions:. The computed radiant and preatmospheric velocities of SPMN 151116C are in agreement with being a member of the North Taurid meteoroid stream that belongs to the Taurid complex. The orbital parameters of the progenitor meteoroid are also similar to those of the 2P/Encke comet (Table 2 and Fig. 3). According to the radiant and the initial velocity the bolide can be associated with the South Taurid branch (Fig.2-3). As we commented [2] we will continue increasing the number of Taurid bolides with reliable orbital parameters in order to learn more on the origin and evolution of short period comets and their meteoroid complexes.

Acknowledgements: This study was supported by the Spanish grants AYA 2015-67175-P (PI: JMTR), AYA2015-68646-P (JMM) and AYA2014-61357-EXP (JMM). EB and DA are supported by the Universitat Ramon Llull projects 2016-URL-Trac-001 supported by “Obra Social la Caixa” and 2016-URL-IR-001 supported by “Generalitat de Catalunya”. OE acknowledges O.Cid for his support on maintainging the ICT infrastructure.

References: [1] Madiedo J.M. et al. (2014) *Icarus 231*, 356. [2] Blanch E. et al. (2017) (2017) In Assessment and Mitigation of Asteroid Impact Hazards, Trigo-Rodríguez J.M., Gritsevich M. and Palme H. (eds.), Springer, New York, 185-197. [3] Trigo-Rodríguez J.M. and Williams, I.P. (2017) In Assessment and Mitigation of Asteroid Impact Hazards, Trigo-Rodríguez J.M., Gritsevich M. and Palme H. (eds.), Springer, New York, 11-32. [4] Kresak, L. (1978) Astron. Inst.s of Czechoslovakia. 29: 129 [5] Whipple F.L. (1951) *Ap.J.*, 113, 464-474. [6] Whipple F.L. (1955) *Ap.J.*, 121, 750-770 [7] Jenniskens P. and Vaubaillon J. (2008) *AJ*. 136, 725-730. [8] Trigo-Rodríguez J.M. et al. (2008) *MNRAS*, 394, 569-576. [9] Babadzhanov P.B. et al. (2008) *MNRAS*, 386, 1436-1442. [10] Napier W.M. (2010) *MNRAS*, 405, 1901-1906. [11] Madiedo J.M. et al. (2011) In NASA/CP-2011-216469, 330-337. [12] Trigo-Rodríguez J.M. et al. (2003) *MAPS*, 38, 1283-1294.

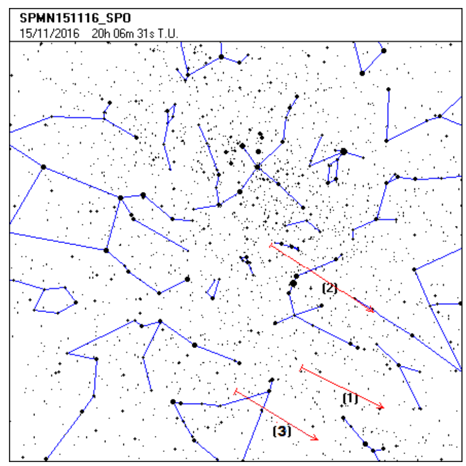

Figure 2. Apparent trajectory of SPMN 151116C as recorded from the IEEC-CSIC Catalan stations.

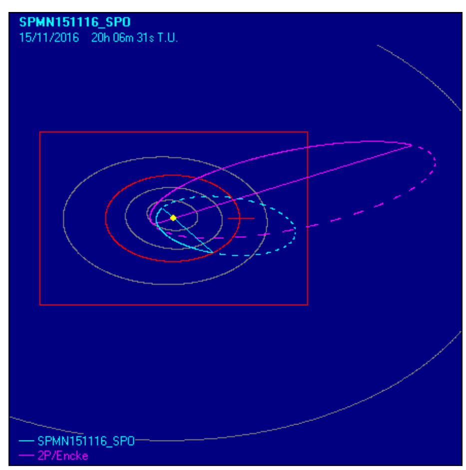

Figure 3. Projection on the ecliptic plane of the orbit of the meteoroid compared with 2P/Encke.