

LARGE METEORIODS ON MINOR COMETARY STREAMS: RECENT EVENTS DETECTED BY THE SPANISH FIREBALL NETWORK.

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Introduction: F. L. Whipple first modeled the formation of meteoroid streams from the continuous sublimation of the ice-rich regions in cometary nuclei [1,2,3]. Particles lifted off from ice-rich regions by the sublimated gas drag should be biased towards those fragile aggregates. Many cometary meteoroid streams crossing the Earth were formed in this way, but not all. Catastrophic disruption of cometary nuclei is another mechanism of producing meteoroid streams [4, 5, 6, 7]. Interestingly, this mechanism is able to produce large boulders as observed e.g. during the disruption of comet C/1999 S4 LINEAR [8]. It was believed that the large fragments released during break-up events will proceed to faint into the coma due to suffer a cascade fragmentation. The resolution of telescopic observations is not able to decipher if the final product of these events are mm- or m-sized meteoroids. Fortunately, we can use fireball observations from known meteoroid streams to find out if large meteoroids are able to survive. We describe here one bright bolide that flew over many of the instruments operated by the Spanish Meteor and Fireball Network (SPMN) so that measurements of its properties were obtained.

Methods: A continuous monitoring of the night sky all over Spain is being made currently from 24 stations. This observational challenge involves the recording over a very large surface area of about 500,000 km². In order to achieve this goal, state-of-the-art CCD and video cameras are operated by members and collaborators of the Spanish Meteor and Fireball Network (SPMN). We have used 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 measurements on the images were obtained for comparison stars and the bolide by using our implemented software package [9]. From the sequential measurements of the video frames and the trajectory length, the velocity of the bolide along the path was obtained. The pre-atmospheric velocity V_{∞} is found from the velocity measured at the earliest part of the fireball trajectory.

Preliminary results and discussion: From the astrometric measurements of the images the atmospheric trajectory, velocity and height are obtained. From the atmospheric trajectory and the computed initial velocity and geocentric radiant, the heliocentric orbit can be determined. Here we summarize (Fig 1 and 2) an unusual detection of an Earth-grazing bolide from the Puppis-Velid complex. Detection of large meteoroids from this source supports that this complex could be the product of a relatively recent cometary breakup.

Conclusions: We are identifying probable meteorite-dropping bolides from the ending heights, and computed terminal masses. Meteorites are valuable samples of other solar system bodies, but usually are recovered without information regarding their progenitors. Obtaining orbital information for meteorites that might land at some future date is vital if we are to understand the dynamical processes that deliver meteorites to the Earth. Recent results suggest that the main asteroid belt might not be the only source, Near Earth Objects (NEOs) and Jupiter Family Comets (JFCs) populations may also be significant.

References: [1] Whipple F.L. 1950 *Ap. J.* **111**, 375-394. [2] Whipple F.L. 1951 *Ap. J.* **113**, 464-474. [3] Whipple F.L. 1955 *Ap. J.* **121**, 750-770. [4] Jenniskens P., and J. Vaubailon., 2007, *Astron. J.* **134**, 1037. [5] Jenniskens P., and J. Vaubailon J., 2008, *Astron. J.* **136**, 725-730. [6] Trigo-Rodríguez J.M., Madiedo J. M., Williams I.P., and Castro-Tirado A.J. (2009) *Mon. Not. Royal Astron. Soc.* **392**, 367-375. [7] Trigo-Rodríguez J.M. et al.(2009) *Mon. Not. Royal Astron. Soc.* **394**, 569-576. [8] Weaver H.A. (2001) *Science* **292**, 1329-1334. [9] Jenniskens P. (2006) *Meteor Showers and their parent comets*. CUP. 790 pp.

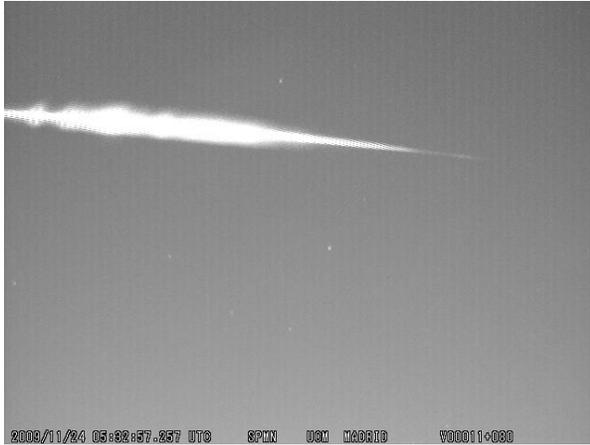


Figure 1. The Valhermoso bolide (SPMN 241109) was an Earth-grazing event imaged from high-resolution video cameras in the UCM station in Madrid and UCLM station in Toledo. The estimated absolute magnitude was -10 .

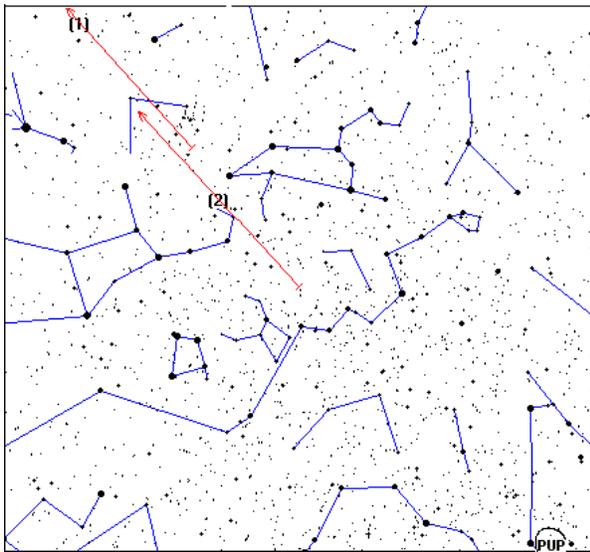


Figure 2. The astrometric calibration from two stations allowed to identify the radiant of the Valhermoso bolide (SPMN241109)