THE 2011 GIACOBINID OUTBURST: METEOROID FLUX DETERMINATION AND ORBITAL DATA BY USING VIDEO IMAGERY FROM THE SPANISH FIREBALL NETWORK.

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Introduction: On October 8th, 2011 the Earth encountered the dust trails left by comet 21P/Giacobini-Zinner during its XIX and XX century perihelion approaches. The encounter was forecasted in great detail [1, 2, 3]. Geometic circumstances were very favourable to produce a meteor storm, but unfortunately the trails were older than in previous 1933 and 1946 historical encounters. As a consequence of the decreased flux number density in the comet trails, during the 2011 Draconid night the Zenital Hourly Rate (ZHR) only just reached the outburst level with about 400 meteors/hour, and the display was strongly attenuated for visual observers due to the Moon observing circumstances [4]. Despite this, the possibility of recording usual meteor activity coming from a low-geocentric velocity meteoroid stream motivated us to develop a special observing campaign. The encounter of our planet with dense meteoroid streams in such favourable geometric circumstances could be representative of the organic and water delivery processes that probably participated in the terrestrial enrichment due to the massive disruption of comets that occurred at the time of the Late Heavy Bombardment [4]. Consequently, we put all our effort in studying this present-day rare encounter using the multistation CCD and video monitoring available in the Spanish Meteor Network (SPMN) infrastructure together with additional amateur monitoring stations. SPMN high sensitivity CCD and video cameras were able to record hundreds of meteors that are allowing us to get valuable flux and orbital information on the meteoroids that produced the outburst. Some of the campaign highlights are really astonishing as, for example, the detection of a -11 absolute magnitude Draconid bolide over Andalusia, Spain produced by a 14 kg Giacobinid meteoroid [5]. In this abstract we present some preliminary results on the magnitude of the meteoroid flux arrived to Earth and the first orbits computed so far by our team.

Technical procedure: The Draconid flux was estimated using the photographic and SPMN visual data collected by several observers. To compile the results we used the software that we developed to study the flux of Leonid storms [6,7]. From the estimated population index of the shower meteors we were able to compute the meteoroid flux in each observational range (video and visual, all given in 10^{-3} km^{-2} h^{-1}).

On the other hand, the orbital data is being obtained from the SPMN stations with clear skies at that night, and from other stations set up just to observed the outburst with small fields of view for obtaining higher accuracy. Hundreds of multiple-station meteors were recorded, and the most geometrically favourable are being selected to be accurately reduced. Reducing the data is a great challenge as our stations were covering a very large surface area of about 400,000 km^2. State-of-the-art CCD and video cameras are operated by members and collaborators of the Spanish Meteor and Fireball Network (SPMN). High-sensitivity 1/2" black and white CCD video cameras (Watec, Japan) were attached to modified wide-field lenses covering different fields of view. Coordinate measurements were made using background stars by using our implemented software package [8]. The fireballs studied here were imaged by high-resolution video cameras located in different SPMN nodes in Andalusia, Castilla-La Mancha and Catalonia. 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_∞ was found from the velocity measurements obtained at the earliest part of the trajectory. A –4 magnitude Giacobinid recorded on Oct. 8 2011 at 20h48m00.6s UTC is given as example in Fig.1. The astrometric reduction from more than 20 stars was completed (Fig.2). Finally the orbit is computed with our recently developed Amalthea package [8]. It computes the corrected radiant and orbital elements together with the respective errors and has been successfully tested with other professional packages.

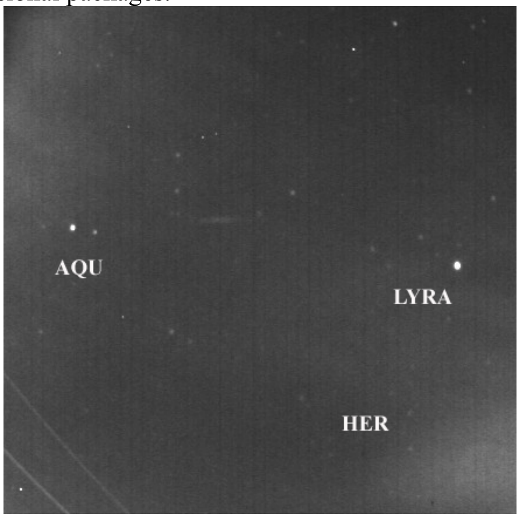

Figure 1: Composite image of SPMN081011_204801 as recorded from the (1) Folgueroles video station in Barcelona province operated by AAO.

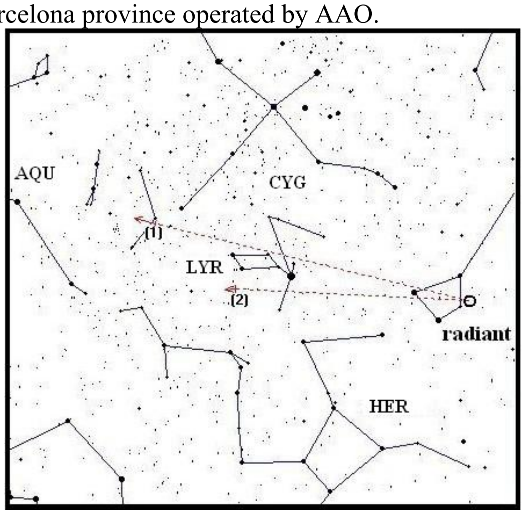

Figure 2. The apparent radiant determination seen from (1) Folgueroles and (2) Montseny stations.

Discussion and conclusions: The determined flux in the]-∞, +5] magnitude visual range was occurring in solar longitude 195.03º (Oct. 8th, 2011 at 20h00m UT) when the flux reached (95±20)×10^{-3} km^{-2} h^{-1}. The flux was about one order of magnitude lower for bright meteors recorded by video cameras with +3 limiting magnitude that night. Orbital data for 10 high-resolution selected Draconid 2011 meteors are presented. The main orbital elements of such orbits are compiled in Table 1, and compared with the main orbit expected for the 1900 dust trail meteoroids according to the radiant and average velocity given by M. Maslov [3]. Significant differences are found as most recorded meteors show a different apparent radiant, and a higher velocity that the given by M. Maslov. However, our orbits are similar to those reported for the 1998 outburst compiled in [1]. We think that the previous 1933 and 1946 dust trails encounters with Earth could affect significantly the orbits. Additional orbits are being obtained, from which we expect to get clues on the ejection times of 21P meteoroids crossed by Earth on Oct. 8th, 2011.

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Code	Stream	q (AU)	a (AU)	e	i (º)
SPMN*_184038	GIA	0.99583±0.00008	3.37±0.23	0.704±0.020	31.55±0.37
SPMN*_191930	GIA	0.99431±0.00010	3.50±0.33	0.716±0.027	31.60±0.49
SPMN*_194759	GIA	0.99672±0.00007	3.72±0.29	0.732±0.021	31.07±0.36
SPMN*_195157	GIA	0.98728±0.00017	3.32±0.22	0.702±0.020	31.57±0.37
SPMN*_200453	GIA	0.98913±0.00015	3.75±0.29	0.736±0.021	30.90±0.36
SPMN*_201355	GIA	0.99402±0.00030	3.86±0.31	0.743±0.021	30.23±0.36
SPMN*_201440	GIA	0.99135±0.00013	3.64±0.27	0.727±0.020	31.42±0.37
SPMN*_201453	GIA	0.99911±0.00001	3.37±0.23	0.703±0.020	31.83±0.37
SPMN*_201850	GIA	0.99695±0.00027	3.82±0.31	0.739±0.021	30.76±0.36
SPMN*_204801	GIA	0.99138±0.00034	2.52±0.09	0.606±0.091	29.78±0.29
1900 trail	-	0.991	2.16	0.54	28.18

Table 1. Orbital elements of selected 2011 Giacobinid meteors. The asterisk (*) corresponds to the label 081011 that is common to all meteors. The 1900 dust trail average orbit was computed from the expected radiant position and average velocity given in [3]. Note that all orbital elements are given for the 2000.00 Equinox.