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Video observations of the 2011 Draconids by the all-sky camera AMOS

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Our contribution to the 2011 Draconids campaign by using the all-sky camera AMOS of the Slovak Video Meteor Network (SVMN) is presented. The ground-based observations were performed in cooperation with the Central European Meteor Network (CEMeNt), the Polish Fireball Network (PFN) and the Italian Meteor and TLE Network (IMTN). The airborne observations were performed in cooperation with the Astronomical Institute of the Czech Academy of Sciences and the Deutsches Zentrum für Luft- und Raumfahrt, Germany, within the EUFAR program. The processing of the data obtained by the AMOS camera during the Airborne DLR expedition is described.

1 Introduction

The observational campaign set up for the 2011 Draconids 2011 led to a broad international cooperation. We took part in both the ground-based and the airborne expeditions. The main equipment we used was the AMOS camera (All Sky Meteor Orbit System), developed and constructed at the Astronomical and Geophysical Observatory of the Comenius University, located in Modra (Zigo et al., 2013).

2 Ground-based observations

Due to uncertain weather condition in Central Europe, several groups of observers moved their equipment to northern Italy. Members of the Slovak Video Meteor Network (SVMN—Comenius University Bratislava) set up double-station observations together with observers of the Central European Meteor Network (CEMeNt—amateur network consisting of several observers in the Czech and Slovak Republics).

The observations were performed by one SVMN all-sky video camera AMOS and by three video cameras of the CEMeNt network. The equipment has been described by Tóth et al. (2011a; 2011b). The first station was located near the town of Bettola (observers Štefan Gajdoš, Roman Piffl, and Jozef Világi), and the second one close to the village of Cavandola (observers Jakub Koukal, Martin Popek and Sylvie Gorková), 71 km to the south-east from the first station. Independently, double-station video observations were set up by members of the Polish Fireball Network (PFN), at Nogara and close to the town of Bettolino di Novellara, 39 km to the south-west from Nogara. The local stations of the Italian Meteor and TLE Network (IMTN) were located at the site of the Cuneo Ass. Astrofili Bisalta, at Fanano (Modena), Contigliano (Rieti), Tortoreto (Teramo), and Ferrara. In total, 9 stations with 14 cameras participated in this joined campaign. The configuration of the stations is shown in Figure 1.

Figure 1 – Location of the ground-based video meteor stations of SVMN, CEMeNt, PFN, and IMTN in northern Italy during the 2011 Draconids campaign.

Video signal from most cameras were detected with the UFOCapture software (SonotaCo, 2009). The meteor data had been analyzed by each experienced observer with UFOAnalyzer (SonotaCo, 2009). The data from two Polish stations were recorded and analyzed using the MetRec software (Molau, 1999). These data were later converted to the UFOOrbit format.

Sixty-two meteors were identified as Draconids simultaneously observed by video techniques in the time interval from 17^h56^m to 23^h22^m UT on October 8. The elevation of the Draconid's radiant changed from 68° to 29° during the observation. The ground projection of the individual meteor trails as seen by the multi-station observations is depicted in Figure 2. After the precise reduction and inspection, 43 Draconids with sufficient precision were selected. Next, 19 possible Draconids were excluded due to a too small convergence angle or to a too small number of measured meteor positions or other geometrical and astrometrical concerns which could have led to a large trajectory uncertainty. As an illustration, several heliocentric orbits projected onto the ecliptic plane are shown in Figure 3.

Table 1 – Mean values of orbital elements, geocentric radiants, and their standard deviations of 43 Draconid meteors, observed on October 8-9, 2011. For comparison, the orbit of the parent comet 21P/Giacobini-Zinner (JPL), numerically integrated to the epoch of observation is also presented.

	a (AU)	q (AU)	e	i	ω	Ω	α	δ
Mean value	3.58	0.996	0.720	31°.70	173°.51	194°.944–195°.167	263°.25	+55°.61
St. dev.	0.29	0.001	0.023	0°.34	1°.10		1°.47	1°.00
Comet	3.52	1.032	0.707	31°.91	172°.57	195°.403	263°.20	+55°.80

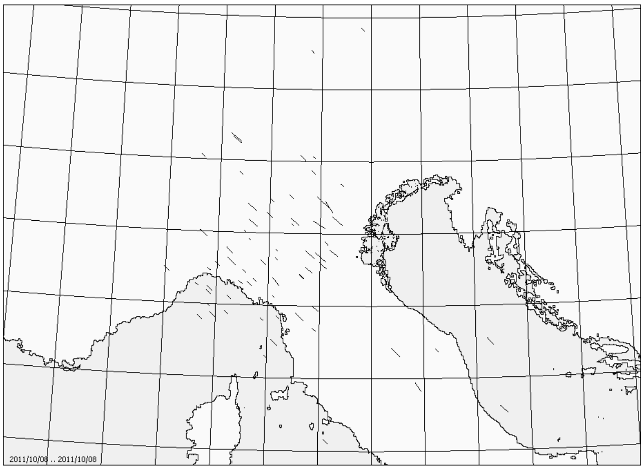

Figure 2 – Ground projection of the detected Draconid trails over northern Italy.

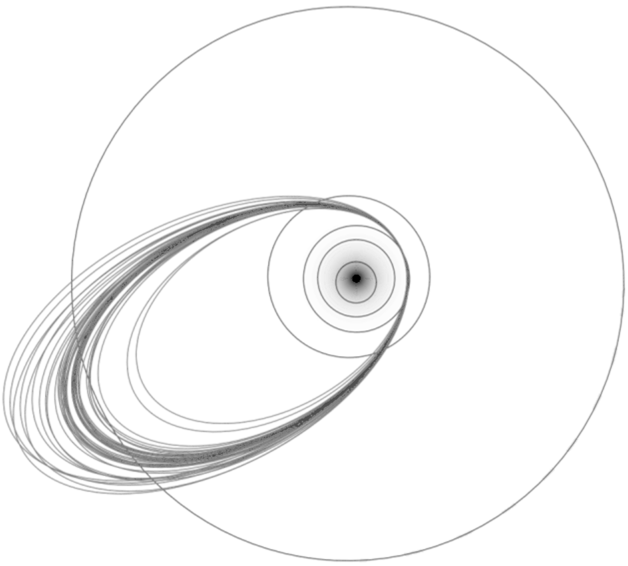

Figure 3 – Multi-station orbits of Draconids 2011 detected by 9 video stations in northen Italy. The largest circle is the orbit of Jupiter. The orbits are projected onto the ecliptic plane. The direction to the vernal equinox is to the right.

Due to strong fragmentation, the measurement of meteoroid velocities is problematic and could be determined only with large uncertainties. Therefore, following Borovička et al. (2007) and Koten et al. (2007), we assumed the initial velocity of the Draconids to be 23.57 km/s. The preliminary mean orbit and geocentric radiant are in Table 1, but a more detailed analysis is needed, and the corresponding results will be published later.

3 Airborne expedition

Juraj Tóth took part in the airborne observation aboard the DLR Falcon aircraft.

Before the flight, the expected first peak was covered from Kiruna airport using the all-sky camera AMOS during the time interval 17^h00^m–18^h28^m UT. In total, 16 Draconids and 5 sporadic meteors were recorded. The search for any second-station observation of these meteors in the Swedish ALIS cameras of Aurora Research brought no positive match (Pellinen-Wannberg, 2012).

We obtained the upper flat window in the plane, so it was possible to use a wide field of view for the AMOS camera (Figure 4). The observations from the air were performed from 19^h15^m to 21^h44^m UT. Due to technical problems, a blackout occurred between 20^h12^m and 20^h28^m UT.

Figure 4 – Upper window of the DLR Falcon plane. The AMOS camera is on the left.

It was not possible to detect meteors using UFOCapture because of light turbulence which caused the sky background to move during the flight. Therefore, two minutes continuous records with short breaks were taken to save each one. Also, the quality of the video background varied considerably with time. Since the AMOS also contains the image intensifier, the amount of noise was noticeably increased, especially after 20^h00^m UT, when the aurora started.

Detections of meteors in recorded clips were performed manually because of the high background level mentioned above. After that, a short clip containing only a part surrounding a meteor was created for every detected meteor by using Boilsoft Video Splitter[1].

[1]http://www.boilsoft.com/videosplitter/.

To perform the astrometry with UFOAnalyzer (UA), a stacked image was created for each meteor. In case the airplane moved during the short clip, we have cut a single frame from the clip with the VirtualDub software[2]. The position of the plane camera for the actually measured meteor was available from GPS data[3]. As the data were obtained by the all-sky system, the UA astrometric output was corrected for precession, nutation, and aberration. A correction for refraction was not needed. The data are prepared for being combined with the airborne observations from the French Safire aircraft (CNRS) and to compute orbits.

The first result we can present is that more than 250 Draconids with brightness ranging from magnitudes −3 to +3 were recorded with the AMOS camera of SVMN. The activity profile is shown in Figure 5, but due to strong aurora phenomenae, mainly after 21^{h} UT, the graph is not representative for the real shower activity, as many faint meteors might have been missed. Nevertheless, it is obvious that Draconids activity was decreasing at that time. The composite image of the 2011 Draconids obtained by AMOS aboard the DLR aircraft on October 8 is presented in Figure 6.

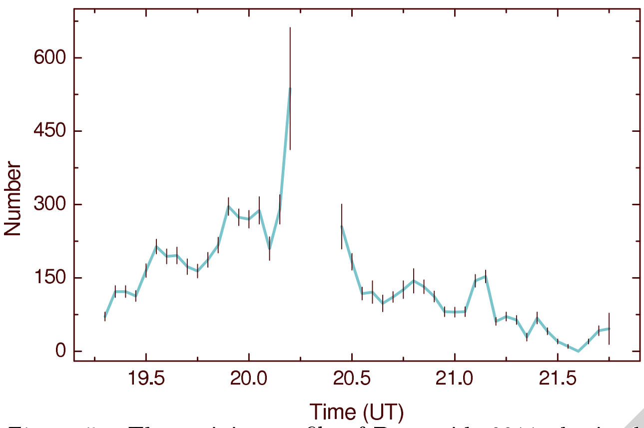

Figure 5 – The activity profile of Draconids 2011 obtained by AMOS aboard the DLR aircraft on October 8.

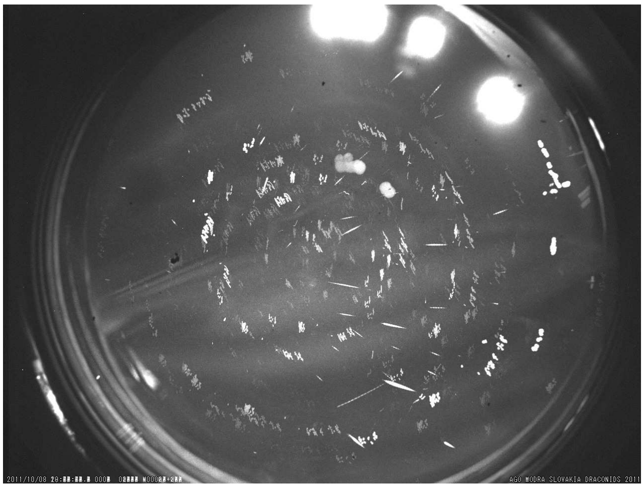

Figure 6 – Composite image of the 2011 Draconids obtained by AMOS aboard the DLR aircraft on October 8. The bright light at the top is the Full Moon.

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[2] `http://www.virtualdub.org/`.
[3] Flight level of about 11 300 m.