Four possible new high-declination showers

Damir Šegon[1], *Peter Gural*[2], *Željko Andreić*[3], *Denis Vida*[4], *Ivica Skokić*[5], *and Filip Novoselnik*[6]

Four possible new meteor showers described in this paper are last ones resulting from our search for new meteor showers. All four of them seem to be connected to known parent bodies, currently classified as asteroids. All orbits from which associations had been done are orbits calculated by UFOOrbit software. Mean orbital parameters were computed using simple arithmetic average in an iterative way until stable set of orbits was found. Catalogues from 2007 to 2011 (SonotaCo) and 2007 to 2010 (CMN) were used in calculations. The radiants' dispersion is in all cases large and no clear radiant drift may be seen, possibly due to the fact that meteoroid streams from these parent bodies suffer from significant perturbations and we see these showers at different solar longitudes from year to year.

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1 Introduction

New showers found as the result of Croatian Meteor Network shower search (Šegon et al., 2014b) in SonotaCo (SonotaCo, 2009; SonotaCo, 2005–2013) and CMN (Šegon et al., 2012; Korlević et al., 2013) orbit databases (in total 133 652 orbits) were published in *WGN* since 2013. In this paper we present the most recent 4 ones resulting from our search, all of them possibly associated with parent bodies at the moment considered as asteroids. Mean orbital parameters were computed as described in (Šegon et al., 2014a), using a simple arithmetic average on the dataset in iterative way until stabile set of orbits has been found. Orbital data used ranges from 2007 to 2011 (SonotaCo) and 2010 (CMN), leaving space for further investigation of these possible new showers in other databases available at the present. As before, for orbital similarity a multiple D-criterion was used. In this procedure, the following three D-criteria are used: ($D_{\rm SH}$ (Southworth & Hawkins, 1963), $D_{\rm D}$ (Drummond, 1981) and $D_{\rm H}$ (Jopek, 1993)). All three have to be satisfied simultaneously, as follows: $D_{\rm SH} \leq 0.15$, $D_{\rm H} \leq 0.15$ and $D_{\rm D} \leq 0.075$.

The most important facts about 4 showers described in this article are summarized in the Table 5.

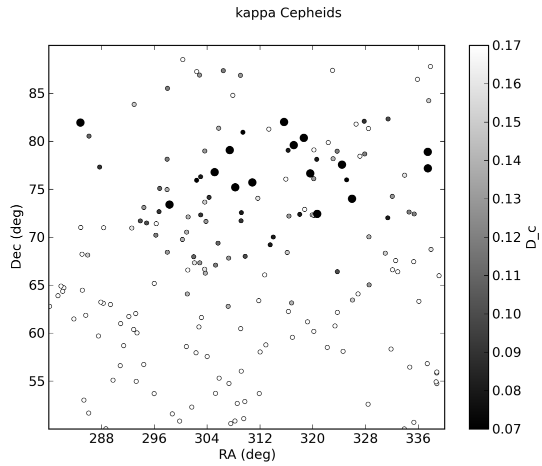

Figure 1 – The radiant plot of the κ Cepheids.

2 κ Cepheids

The κ Cepheids shower (Figure 1) is active from September 11 to September 23 with the maximum falling roughly on September 17. Individual radiants of meteors belonging to this shower are scattered over a relatively large area of the sky. The daily motion in RA turned out to be negative, a fact that we see often in connection with showers with possible asteroidal origin (Šegon et al., 2014). The activity seems to be more or less constant over most of the activity period. 17 individual meteor orbits were found by our search. The individual orbits are very compact, with average $D_{\rm SH}$ to the mean orbit of only 0.06, and the maximal $D_{\rm SH}$ found is 0.08. There are no known showers in the vicinity.

Table 1 – Comparison of orbital elements of κ Cepheids (mean orbit) and the orbit of asteroid 2009 SG18.

parameter	751 KCE	2009 SG18
q	0.983	0.993
e	0.664	0.672
ω	198.4	204.1
Ω	174.4	177.6
i	57.7	58.4
$D_{\rm SH}$	0.100	
$D_{\rm H}$	0.100	
$D_{\rm D}$	0.034	

[1]Astronomical Society Istra Pula, Park Monte Zaro 2, 52100 Pula, Croatia. Višnjan Science and Education Center, Istarska 5, 51463 Višnjan, Croatia. Email: damir.segon@pu.htnet.hr
[2]351 Samantha Drive, Sterling, VA 20164-5539, USA. Email: peter.s.gural@saic.com
[3]University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Pierottijeva 6, 10000 Zagreb, Croatia. Email: zandreic@rgn.hr
[4]Astronomical Society "Anonymus", B. Radića 34, 31550 Valpovo, Croatia and Faculty of Electrical Engineering, University of Osijek, Kneza Trpimira 2B, 31000 Osijek, Croatia. Email: denis.vida@gmail.com
[5]Astronomical Society "Anonymus", B. Radića 34, 31550 Valpovo, Croatia. Email: ivica.skokic@gmail.com
[6]Astronomical Society "Anonymus", B. Radića 34, 31550 Valpovo, Croatia and Faculty of Electrical Engineering, University of Osijek, Kneza Trpimira 2B, 31000 Osijek, Croatia. Email: filip.novoselnik@gmail.com

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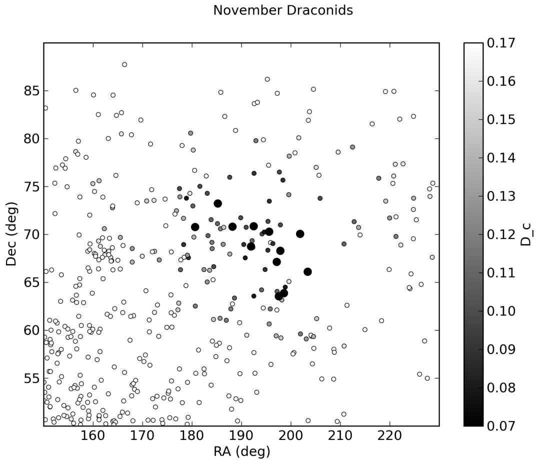

Figure 2 – The radiant plot of the November Draconids.

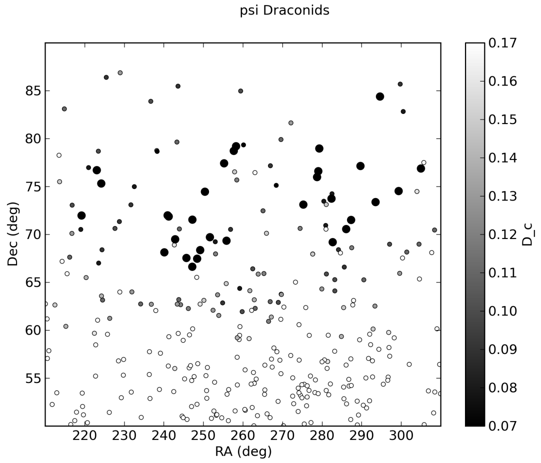

Figure 3 – The radiant plot of the ψ Draconids.

Additionally, the mean orbit of the shover is similar to the orbit of asteroid 2009 SG18 (see Table 1, indicating possible connection between them).

3 November Draconids

The November Draconids shower (Figure 2) is active from November 8 to November 20 with the maximum falling roughly on November 16. The radiant plot shows spread of individual meteor radiants due to the daily motion, but is otherwise compact. The activity seems to be more or less constant over most of the activity period. 12 individual meteor orbits were found by our search. Again, the individual orbits are very compact, with average D_{SH} to the mean orbit of only 0.06, and the maximal D_{SH} found is 0.08.

Nearby is one already known shower, the December alpha Draconids (334 DAD), for which IAU MDC database (Jopek & Kaňuchová, 2014) does not quote any orbital elements. We have, however, detected this shower too in our search, and were able to calculate its mean orbital elements. The comparison between mean orbits of 753 NED and 334 DAD is given in the Table 2.

Last, but not least, the mean orbit of this shower is similar to the orbit of asteroid 2009 WN25 (see Table 2), indicating possible connection between them.

Table 2 – Comparison of orbital elements of November Draconids (mean orbit), December alpha Draconids and asteroid 2009 WN25. Orbital element sets for both showers were determined from our data.

parameter	753 NED	334 DAD	2009 WN25
q	0.987	0.983	1.102
e	0.701	0.590	0.661
ω	183.7	178.2	180.9
Ω	232.8	254.1	232.1
i	73.5	72.7	72.0
D_{SH}		0.370	0.130
D_{H}		0.370	0.082
D_{D}		0.158	0.064

4 ψ Draconids

The ψ Draconids shower (Figure 3) is active from March 19 to April 12 with the maximum falling roughly on April 2. The radiant plot shows the spread of individual meteor radiants due to the daily motion, and is very diffuse. The activity seems to be more or less constant over most of the activity period. 31 individual meteor orbits were found by our search. As is the case with previously described showers, the individual orbits are very compact, with average D_{SH} to the mean orbit of only 0.06, and the maximal D_{SH} found is 0.08.

The phi Draconids (045 PDF) shower is nearby. Again, we calculated its mean orbital elements from our data (see Table 3). These two showers are clearly different, but could be related to each other. This will be further investigated in a forthcoming publication.

Last, but not least, the mean orbit of this shover is similar to the orbit of asteroid 2008 GV (see Table 3), indicating possible connection between them.

5 May ι Draconids

The May ι Draconids shower (Figure 4) is active from May 7 to June 6 with the maximum falling roughly on May 21. The radiant plot is very diffuse and does not show clear effects of daily motion. Calculations confirm this, showing very small daily motion in RA. The activity seems to be more or less constant over most of the activity period. 19 individual meteor orbits were found by our search. Again, the individual orbits are

Table 3 – Comparison of orbital elements of ψ Draconids (mean orbit), ϕ Draconids and asteroid 2008 GV.

parameter	754 POD	045 PDF	2008 GV
q	0.994	0.990	1.067
e	0.622	0.613	0.609
ω	179.3	184.4	177.6
Ω	11.8	353.0	15.6
i	30.9	39.4	30.1
D_{SH}		0.263	0.084
D_{H}		0.263	0.055
D_{D}		0.092	0.040

Table 4 – Comparison of orbital elements of May ι Draconids (mean orbit) and asteroid 2006 GY2.

parameter	755 MID	2006 GY2
q	0.989	0.936
e	0.604	0.496
ω	198.1	216.7
Ω	60.2	54.3
i	24.3	30.6
D_{SH}	0.212	
D_H	0.208	
D_D	0.117	

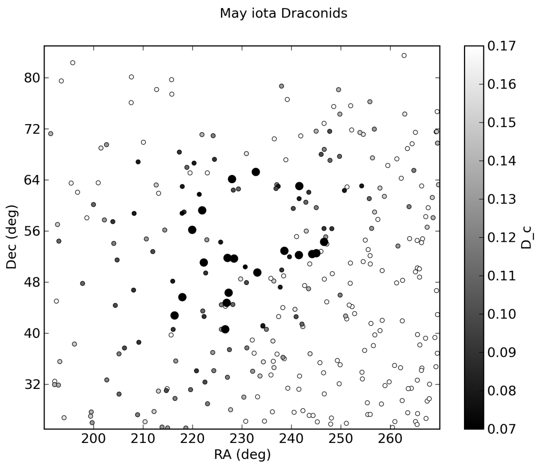

Figure 4 – The radiant plot of the May ι Draconids.

very compact, with average D_{SH} to the mean orbit of only 0.06, and the maximal D_{SH} found is 0.08.

The mean orbit of this shover is similar to the orbit of asteroid 2006 GY2 (see Table 4), indicating possible connection between them.

6 Conclusions

Four possible new meteor showers described in this paper are last ones resulting from our search for new meteor showers. Since all four of them seem to be connected to known parent bodies, a detailed analysis will be done and provided in a separate paper. What is important to point out is that all orbits from which associations had been done are orbits calculated by UFO-Orbit software, which does not take account of meteor deceleration – meaning that average meteor velocity has been used instead of initial velocity. This should not cause any severe errors in the case of swift meteors because the difference between those two values is not large and usually fits well inside observational error margin. However, in case of long lasting slow meteors this may be of importance since true radiant positions may be shifted due to the difference in applied zenith attraction correction, and resulting orbit as well. One may note that the plotted radiants dispersion is really large and no clear radiant drift may be seen - one of reasons for this may be due to not accounting for meteor deceleration, while the other one may lie in the fact that meteoroid streams from these parent bodies suffer from significant perturbations and we see these showers at different positions from year to year. Detailed analysis based on dynamical models, as well as more deceleration accounted orbits should shed more light on this.

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Table 5 – Mean orbits of the new showers.

ID	Name	$\lambda_\odot$	$\overline{\lambda_\odot}$	RA	DEC	dRA	dDE	v_g	q	e	ω	Ω	i	N
751 KCE	κ Cepheids	9–21	174.4	318.5	77.5	−1.45	0.39	33.7 ± 1.9	0.983 ± 0.01	0.664 ± 0.041	198.4 ± 5	174.4 ± 4	57.7 ± 3.9	17
753 NED	November Draconids	225–238	232.8	194.2	68.6	1.42	−0.45	42.0 ± 1.2	0.987 ± 0.002	0.701 ± 0.055	183.7 ± 5	232.8 ± 5	73.5 ± 2.3	12
754 POD	ψ Draconids	357–22	11.8	262.3	73.3	2.37	0.25	19.8 ± 1.7	0.994 ± 0.005	0.622 ± 0.035	179.3 ± 10	11.8 ± 7	30.9 ± 3	31
755 MID	May ι Draconids	46–75	60.2	230.8	52.5	0.19	0.62	16.7 ± 2.0	0.989 ± 0.019	0.604 ± 0.043	198.1 ± 9	60.2 ± 7	24.3 ± 4	19