Meteor science

Ten possible new showers from the Croatian Meteor Network and SonotaCo datasets

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The Croatian Meteor Network Catalogues of Orbits for 2007 to 2010 and the SonotaCo catalogues for 2007 to 2011 were searched for possible new showers. Altogether 133 653 orbits were included in the search that revealed 18 possible new streams. The first 8 are already described in a previous paper (Šegon et al., 2013), and the remaining 10 are described here. These 10 streams already received temporary IAU shower numbers and three-letter codes. We present here the basic orbital, radiant and activity data for them. Possible parent bodies were identified for two of these showers. Additionally, one of the newly discovered showers (520 MBC) seems to be a twin shower, associated with the previously known shower 335 XVI. Last, but not least, new data about one stream from the IAU MDC list of established showers (175 JPE) is obtained.

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1 Introduction

The Croatian Meteor Network (CMN) was started in 2007. Further details of the network are given by Andreić & Šegon (2010) and Andreić et al. (2010) . The catalogues of orbits for 2007, 2008 and 2009 are already published (Šegon et al., 2012a; Korlević et al., 2013) and the catalogue for 2010 is available on the CMN download web page:
`http://cmn.rgn.hr/downloads/downloads.html`

The well known SonotaCo network (SonotaCo, 2012) also published catalogues for 2010 and 2011 recently, and older catalogues are already public. Combining all these datasets we compiled a database of 133 653 orbits that was systematically searched for new showers.

2 New showers

The search resulted in 18 potential new showers not yet reported to the IAU MDC database, plus a few that later on turned out to be already known. For each shower the individual orbits of meteoroids were tested with the D-criterion (Šegon et al., 2012b), employing the widely used Southworth-Hawkins method (Southworth & Hawkins, 1963), and a mean orbit was calculated from the individual orbits that satisfy the criterion $D_{SH} < 0.15$. The results are summarized in Table 4. The first 8 showers are already described in Šegon et al. (2013), and the remaining 10 are described here, along with one shower (Section 2.5) that appears to be already known. The file with all individual orbits of the new showers mentioned in this article can be obtained from the CMN download page.

All these radiants are present in the IMO Video Meteor Database (IMO, 2012). The showers were reported to the IAU, following the standard procedure (Jenniskens et al., 2009), and received temporary shower numbers. Searches for possible parent bodies (using the JPL orbit database) were also performed, and revealed possible parent bodies for three showers. They are described where appropriate.

2.1 April λ Ophiuchids – 517 ALO

This shower is active from April 1 to April 10, with maximum around April 5. Although at the moment only 20 orbits are known, the meteors of this shower

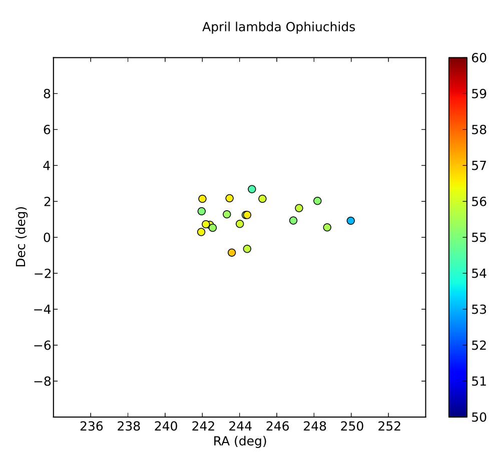

Figure 1 – Radiant plot of April λ Ophiuchids.

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were present in each year from 2007 to 2011. The radiant plot shows the effect of radiant drift clearly (Figure 1), but apart from that seems to be quite compact.

2.2 April 102 Herculids – 518 AHE

This shower is active from April 19 to 27, with maximum around April 23. Only 9 orbits for this shower are known, divided almost equally among all the years from 2007 to 2011, excepting 2008, when none was found. The radiant plot covers an area of about 2° (Figure 2). Regardless of the small number of orbits, the mean shower orbit is quite well defined, with maximal D_{SH} between the mean orbit and a single meteoroid orbit not exceeding 0.07.

Another interesting property of this shower is that meteors were all very bright, with observed magnitudes between 0 and −5.

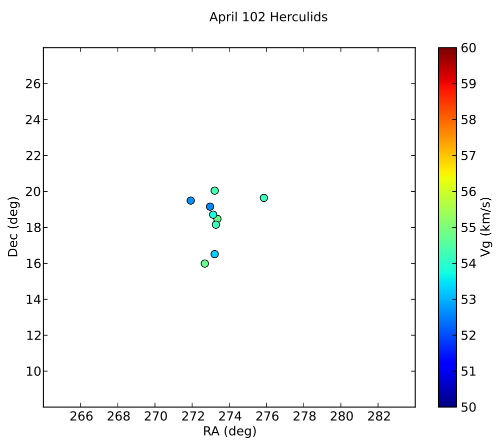

Figure 2 – Radiant plot of April 102 Herculids.

2.3 β Aquarids – 519 BAQ

This shower is active from April 23 to May 20, with maximum around May 6. 20 orbits for this shower are known. The radiant plot clearly shows effects of daily motion (Figure 3), otherwise is well defined.

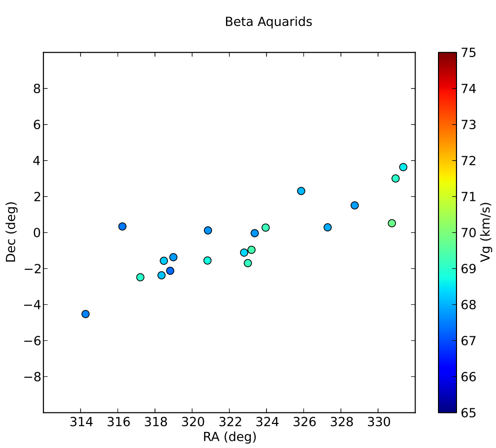

Figure 3 – Radiant plot of β Aquarids.

2.4 May β Capricornids – 520 MBC

This shower is active from May 15 to 27, with maximum around May 17. 13 orbits for this shower are known, from all 5 years. The radiant plot (Figure 4) is stretched horizontally due to the daily motion, but is compact.

This shower has an orbit very similar to the orbit of the December χ Virginids (335 XVI), but with a totally different period of activity. It is possible that it is the same shower, with two orbit intersection points. The comparison of available data is given in Table 1. As the IAU MDC lacks any orbital data for 335 XVI, we calculated them from 53 orbits we have found in our combined database. The orbital similarity is striking, with $D_{SH} = 0.08$, which strongly supports our assumption that we are dealing with the same shower that intersects the earth's orbit twice, before and after perihelion.

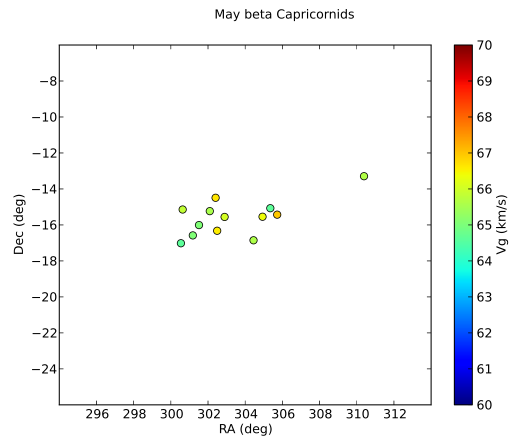

Figure 4 – Radiant plot of May β Capricornids.

Table 1 – Comparison of May β Capricornids and December χ Virginids.

parameter	520 MBC	335 XVI (IAU MDC)	335 XVI (CMN)
$\lambda_\odot$	53–66		236–261
$\lambda_\odot$ Max.	56.8	256.7	253.6
RA	303	186.8	184.8
Dec	−15.6	−7.9	−6.9
dRA	0.74	0.2	0.72
dDec	0.17	−0.14	−0.35
v_g	65.7	67.8	68.0
N	13	31	53
q	0.554		0.579
e	0.942		0.981
ω	266		280
Ω	57		74
i	171		171
D_{SH}			0.08

2.5 Southern α Pegasids – 522 SAP

This shower is active from July 3 to 23, with maximum around July 14. 93 orbits for this shower are known. The radiant plot (Figure 5) is well defined with clear evidence of daily motion, which in this case could be accurately determined, together with the mean orbit.

The IAU MDC database mentions 462 JGP with its radiant nearby ($RA = 359°$, $Dec = +14°$) and with maximum activity around $\lambda_{\odot} = 120{.}^{\circ}8$, almost 9 days later than 522 SAP. No orbital data for this shower are known, making any further conclusions impossible.

According to recent work (Ueda, 2012; Holman & Jenniskens, 2013) about the July Pegasids (175 JPE), it turns out that 522 SAP orbital elements and activity data fit very well to 175 JPE so they are almost certainly the same shower. Thus, 522 SAP should be removed from the IAU MDC list.

The search for possible parent bodies revealed C/1771 A1 (Great comet) with $D_{SH} = 0.09$, the same comet already listed as a possible parent body by Holman & Jenniskens (2013). It should be noted here that Ueda (2013) identified C/1979 Y1 (Bradfield) as a possible parent body, but we confirmed the conclusion made by Holman & Jenniskens (2013), i.e. that C/1771 A1 is a slightly better candidate for the parent body.

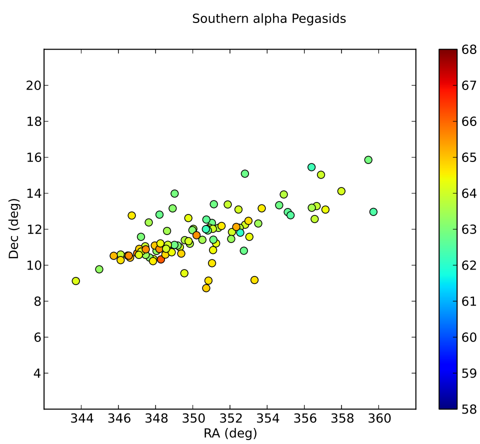

Figure 5 – Radiant plot of Southern α Pegasids.

2.6 August γ Cepheids – 523 AGC

This shower is active from August 21 to September 4, with maximum around August 28. 44 orbits for this shower are known. The radiant plot (Figure 6) is diffuse, without signs of daily motion.

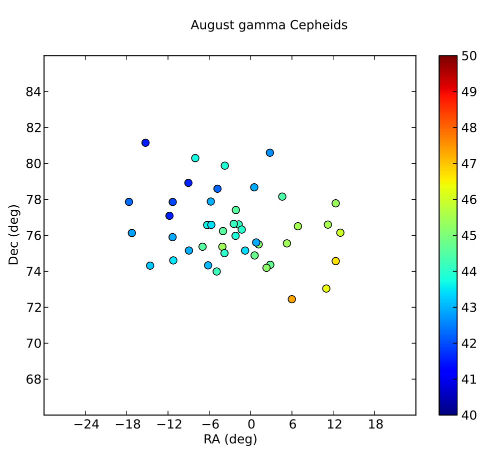

Figure 6 – Radiant plot of August γ Cepheids.

2.7 λ Ursae Majorids – 524 LUM

This shower is active from October 24 to November 1, with maximum around October 28. 29 orbits for this shower are known. The radiant plot (Figure 7) is diffuse.

The IAU MDC database mentions 339 PSU with its radiant nearby ($RA = 168°$, $Dec = +45°$) and with maximum activity around $\lambda_{\odot} = 253°$, about a month later than 524 LUM. Geocentric velocity is also very similar (61 versus 60.3 km/s), but due to the large difference in solar longitudes it is questionable if they are the same shower. Orbital data for this shower are not provided, making any further conclusions difficult.

Another nearby shower is 382 BUM, with radiant at $RA = 161°$, $Dec = +57°$, and $\lambda_{\odot} = 184°$, but the orbit is totally different so it is clearly a different shower.

The search for possible parent bodies revealed comet C/1975 T2 (Suzuki-Saigusa-Mori) with $D_{SH} = 0.14$ as a possible parent body. The comparison of orbital data of the 524 LUM and the comet is given in Table 1.

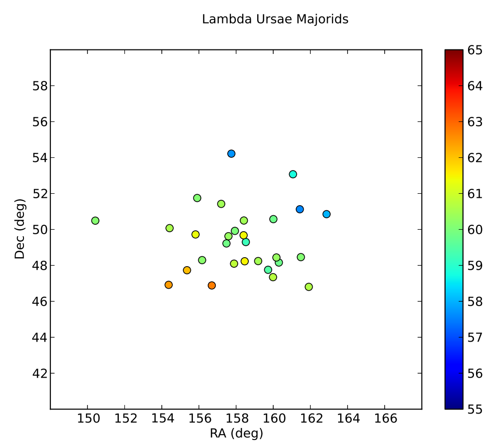

Figure 7 – Radiant plot of λ Ursae Majorids.

Table 2 – Comparison of orbits of λ Ursae Majorids and comet C/1975 T2 (Suzuki-Saigusa-Mori).

parameter	524 LUM	C/1975 T2
q	0.917	0.838
e	0.931	0.986
ω	147	152.0
Ω	215	216.8
i	115	118.2
D_{SH}		0.14

2.8 ι Cygnids – 525 ICY

This shower is active from October 16 to November 19, with maximum around October 31. 40 orbits for this shower are known. The radiant plot (Figure 8) is very diffuse. The elements of the mean orbit are similar to the two previously known showers 282 DCY ($D_{SH} = 0.22$) and 83 OCG ($D_{SH} = 0.23$). Most probably all three are just one shower, but observations accounting for deceleration are needed to make this clear.

The search for possible parent bodies revealed asteroid 2001 SS_{287} with $D_{SH} = 0.16$ as a possible parent

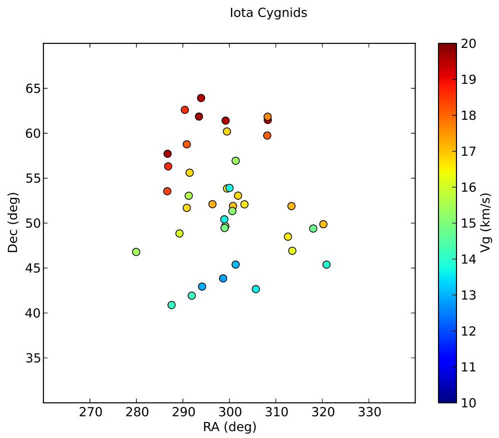

Figure 8 – Radiant plot of ι Cygnids.

body. The comparison of orbital data of the 525 ICY and the asteroid is given in Table 3. There is a whole family of asteroids with similar orbits and the next best possible candidates, with D_{SH} in parentheses, are: 2010 TK_{167} (0.18), 24445 2000 PM_8 (0.19), 2012 UB_{69} (0.20), 2001 SD_{170} (0.21), 2010 TC_{55} (0.21), etc.

Table 3 – Comparison of orbits of ι Cygnids and asteroid 2001 SS_{287}.

parameter	525 ICY	2001 SS_{287}
q	0.982	1.052
e	0.631	0.675
ω	190	173.9
Ω	218	230.8
i	24	18.5
D_{SH}		0.16

2.9 Southern λ Draconids – 526 SLD

This shower is active from November 1 to 5, with maximum around November 3. 26 orbits for this shower are known. The radiant plot (Figure 9) is compact and elongated by the daily motion.

The IAU MDC database mentions 383 LDR with its radiant nearby ($RA = 156°$, $Dec = +75°$) and with maximum activity around $\lambda_\odot$=196°, 3 weeks earlier than 526 SLD. Orbital elements and geocentric velocity differ a lot, so we do not consider this as the same shower.

Another nearby shower is 385 AUM ($RA = 175°$, $Dec = +65°$), with maximum activity around $\lambda_\odot = 209°$, 2 weeks earlier than 526 SLD. Again, orbital elements and geocentric velocity differ too much for these two to be the same shower.

2.10 υ Ursae Majorids – 527 UUM

This shower is active from November 16 to 26, with maximum around November 22. 27 orbits for this shower are known. The radiant plot (Figure 10) is compact and elongated by the daily motion. The elements of the mean orbit have good accuracy.

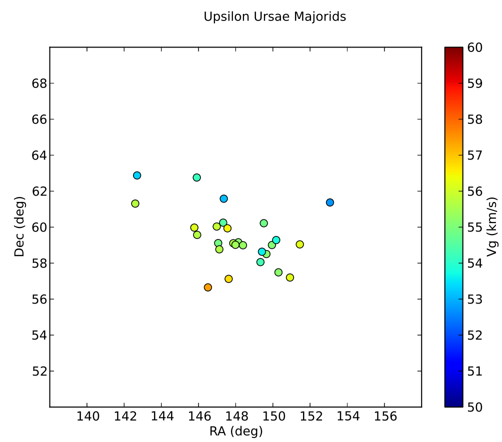

Figure 10 – Radiant plot of υ Ursae Majorids.

2.11 January ζ Draconids – 528 JZD

This shower is active from December 25 to January 11, with maximum around January 4. Only 13 orbits for this shower are known. The radiant plot (Figure 11) is quite scattered. The mean orbit of the shower is similar to orbits of Apollo asteroids which makes this shower quite interesting as it could be a genuine asteroidal stream, but more orbits are needed to refine the

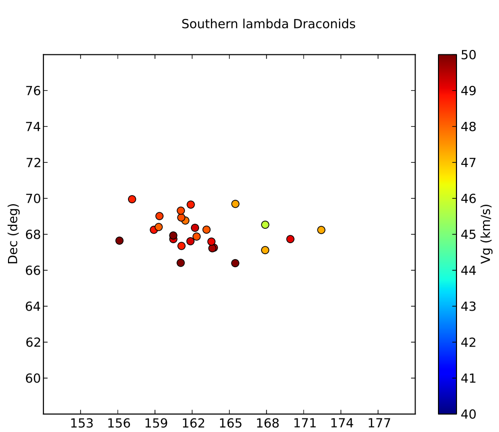

Figure 9 – Radiant plot of Southern λ Draconids.

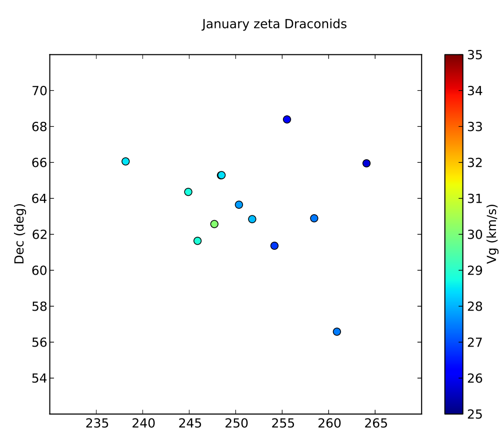

Figure 11 – Radiant plot of January ζ Draconids.

accuracy of data for this shower and make further conclusions possible.

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Table 4 – Mean orbits of the new showers. ID is the IAU identification of the shower, name the proposed name of the shower, $\lambda_\odot$ solar longitudes between which the shower was active, mean the average (mean) solar longitude of all meteors available, RA and Dec are coordinates of the mean radiant, v_g is geocentric velocity, a is the semimajor axis of the orbit, q perihelion distance, e eccentricity, ω argument of perihelion, Ω longitude of ascending node, i inclination and N is the number of known orbits belonging to the corresponding shower. The $\pm$ values are standard deviation of the meteors selected for the corresponding shower. Note that in case of RA and Dec there is a contribution of the daily motion to the standard deviations.

ID	name	$\lambda_\odot$	mean	RA	Dec	v_g	a	q	e	ω (peri)	Ω (node)	i	N
517 ALO	April λ Ophiuchids	12–21	15.5	244.6 ± 2.4	1.1 ± 0.9	55.7 ± 0.9	14	0.287 ± 0.022	0.980 ± 0.033	296 ± 3	15.5 ± 2.2	110.6 ± 1.7	20
518 AHE	April 102 Herculids	29–37	33.8	273.3 ± 1.0	18.5 ± 1.3	53.6 ± 0.8	10	0.777 ± 0.026	0.922 ± 0.048	238 ± 4	33.8 ± 1.9	98.3 ± 2.0	9
519 BAQ	β Aquarids	34–60	46.3	323 ± 5	-0.4 ± 1.9	68.4 ± 0.7	11	0.937 ± 0.027	0.914 ± 0.050	149 ± 6	46 ± 7	156.2 ± 1.8	20
520 MBC	May β Capricornids	53–66	56.8	303 ± 3	-15.6 ± 1.0	65.7 ± 0.7	5.4	0.554 ± 0.024	0.942 ± 0.045	266 ± 3	57 ± 4	171.0 ± 1.5	13
522 SAP	Southern α Pegasids	102–121	112.0	351 ± 3	11.7 ± 1.4	63.9 ± 0.9	16	0.564 ± 0.032	0.964 ± 0.044	265 ± 4	112 ± 4	148.8 ± 2.0	93
523 AGC	August γ Cepheids	149–162	155.1	358 ± 8	76.4 ± 1.9	44.0 ± 1.4	9	1.005 ± 0.003	0.892 ± 0.049	188 ± 3	155 ± 3	76 ± 3	44
524 LUM	λ Ursae Majorids	211–219	215.0	158.2 ± 2.6	49.4 ± 1.8	60.3 ± 1.2	13	0.917 ± 0.014	0.931 ± 0.052	147 ± 3	215.0 ± 1.8	115 ± 3	29
525 ICY	ι Cygnids	203–237	218.4	299 ± 10	53 ± 6	16.4 ± 2.0	2.7	0.982 ± 0.011	0.631 ± 0.049	190 ± 9	218 ± 9	24 ± 4	40
526 SLD	Southern λ Draconids	219–223	221.6	163 ± 4	68.1 ± 0.9	48.7 ± 1.1	4.0	0.986 ± 0.004	0.744 ± 0.052	189 ± 3	221.6 ± 1.2	88.0 ± 1.8	26
527 UUM	υ Ursae Majorids	234–244	240.4	148.0 ± 2.3	59.4 ± 1.5	55.1 ± 1.1	18	0.823 ± 0.020	0.954 ± 0.057	229 ± 3	240.4 ± 2.4	99.9 ± 2.4	27
528 JZD	January ζ Draconids	274–290	283.9	251 ± 7	64 ± 3	28.1 ± 1.3	2.6	0.982 ± 0.003	0.617 ± 0.054	181 ± 6	284 ± 5	46.6 ± 2.5	13