Meteor science

8 new showers from Croatian Meteor Network data

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The Croatian Meteor Network Catalogues of Orbits for 2007 to 2010 contain 10 645 orbits of sporadic meteors. The radiant analysis that included all these orbits, plus the orbits from SonotaCo catalogues for 2007 to 2011, revealed 8 possible new streams. The streams were reported to the IAU MDC and got temporary IAU shower numbers and three-letter codes. We present the basic orbital, radiant and activity data for these streams.

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1 Introduction

The Croatian Meteor Network (CMN) is in operation since 2007. The network itself is described in more detail in Andreić & Šegon (2010) and Andreić et al. (2010). The catalogues of orbits for 2007 to 2009 are already published (Šegon et al., 2012a; Korlević et al., 2013) and the catalogue for 2010 will be issued soon.

2 New showers

Radiant analysis of 133 653 orbits from CMN catalogues for 2007 to 2010 and SonotaCo catalogues from 2007 to 2011 (SonotaCo, 2012) resulted in 8 potential new showers that had not yet been reported to the IAU database. For each of these showers the individual orbits of meteoroids were selected with the D-criterion as in Šegon et al. (2012b), using the commonly employed Southworth-Hawkins method (Southworth & Hawkins, 1963; Jopek & Froeschlé, 1997). For each shower, a mean orbit was calculated from the individual orbits that satisfy $D_{SH} < 0.15$. The results of this analysis are summarized in Table 4. The file with all individual orbits of the new showers mentioned in this article can be downloaded from the CMN download page:

`http://cmn.rgn.hr/downloads/downloads.html`

It should be noted here that all these showers 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 temporary shower numbers were obtained for them. Comet and near-Earth asteroid databases were also searched for possible parent bodies, with results listed below where appropriate.

2.1 κ Virginids – 509 KVI

This shower is active from March 3 to April 14. With 58 known orbits, we have enough data to see some interesting properties of this shower. The most obvious one is that the radiant seems to be spread over quite a large area of the sky (Figure 1). Similarly, the orbits are quite dispersed from the mean orbit of the shower. This could indicate an old shower or a shower composed of several filaments. This assumption is further supported by the long duration of the shower. However, the radiant plot clearly shows the effects of daily motion of the radiant, so the large spread of the radiant can be at least partially attributed to the daily motion. Due to the relatively large number of known orbits it is possible to determine the mean daily motion of the radiant: ΔRA $= 0.92°$/day, ΔDEC $= -0.35°$/day. Also, the radiant plot does not show any noticeable clustering that would indicate the existence of different filaments. But, for a more firm conclusion a lot more orbits are needed.

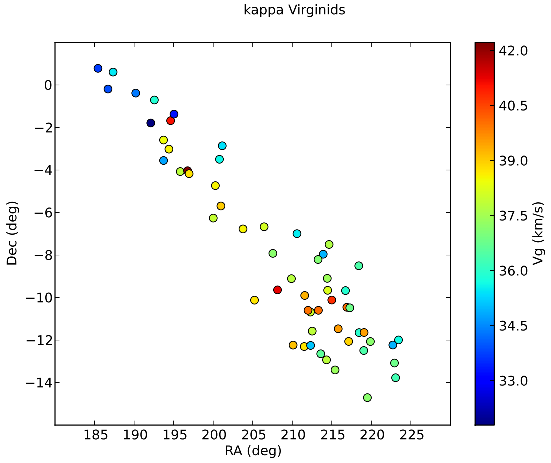

Figure 1 – Radiant plot of κ Virginids.

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Table 1 – Comparison of orbital elements of κ Virginids (mean orbit) and the orbit of asteroid 2011 BT_{59}.

parameter	509 KVI	2011 BT_{59}
q	0.139	0.128
e	0.938	0.949
ω	321	303.0
Ω	6	39.0
i	8	3.6

The parent body search reveals asteroid 2011 BT_{59} as a weak match to the mean shower orbit, with $D_{SH} = 0.262$ (see Table 1).

2.2 June ρ Cygnids – 510 JRC

Contrary to the previous shower, the June ρ Cygnids have a very well defined radiant (Figure 2). The mean orbit is also well defined, regardless of the small number of known orbits (16). The shower is active from June 6 to June 20, the short activity period indicating a relatively young shower. The mean daily motion of the radiant is roughly ΔRA $\approx 0.4°$/day, ΔDEC $\approx 0.6°$/day, but due to the small number of known orbits these values are not accurate.

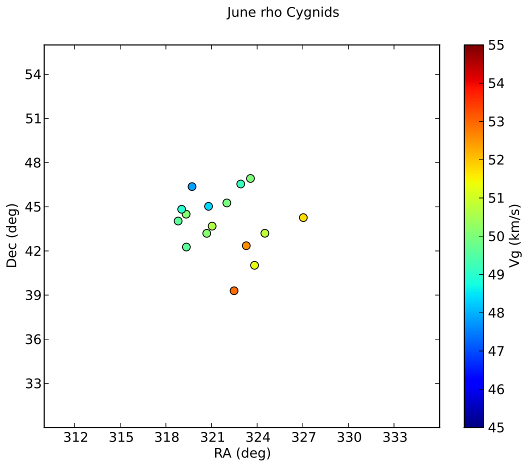

Figure 2 – Radiant plot of June ρ Cygnids.

2.3 15 Lyncids – 511 FLY

This shower is active from October 10 to October 24, but the activity is low, resulting from only 18 known orbits of this shower. The radiant plot is scattered (Figure 3), but this is expected with such a low number of orbits. The spread in radiant data and orbital elements is moderate, and a very rough estimate of mean daily motion of the radiant can be obtained: ΔRA $\approx 1.3°$/day, ΔDEC $\approx -0.1°$/day.

2.4 ρ Puppids – 512 RPU

The 16 orbits of this stream are spread over a time period of about 11 days, showing a nice, tidy radiant plot with large daily motion in right ascension (Figure 4). The shower is active from October 30 to November 10. The mean orbit is well defined and the mean daily motion of the radiant is roughly ΔRA $\approx 0.8°$/day, ΔDEC $\approx -0.2°$/day.

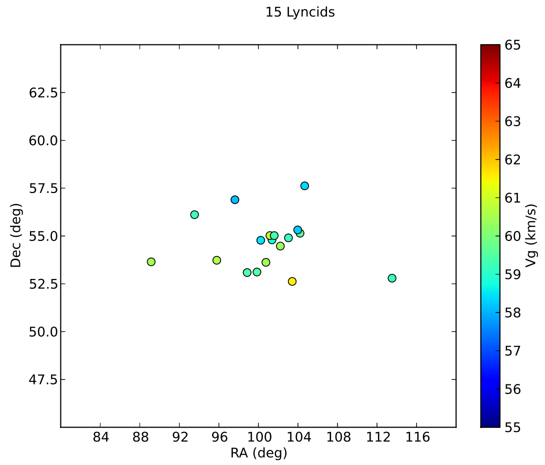

Figure 3 – Radiant plot of 15 Lyncids.

Comet C/1879 M1 (Swift) has been found to be a possible parent body of 512 RPU, with $D_{SH} = 0.18$. Comparison of orbital data is presented in Table 2. According to the JPL database, C/1879 M1 (Swift) has eccentricity equal to 1, meaning we are dealing with a comet on a parabolic orbit. But if this comet is the parent body of 512 RPU, then C/1879 M1 (Swift) is a long period periodic comet – since no uncertainty data on the comet's orbital parameters are available, this could still be true.

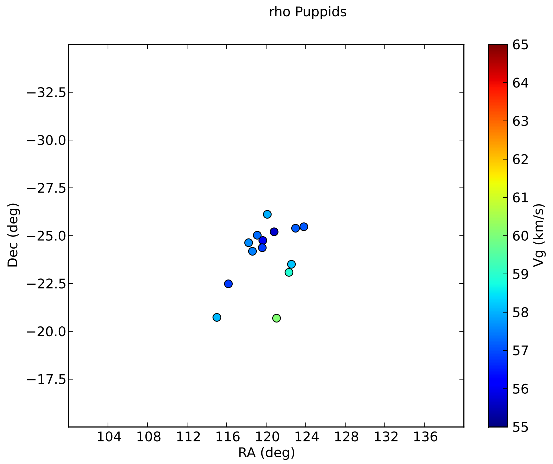

Figure 4 – Radiant plot of ρ Puppids.

Table 2 – Comparison of orbital elements of ρ Puppids (mean orbit) and the orbit of comet C/1879 M1 (Swift).

parameter	512 RPU	C/1879 M1 (Swift)
q	0.985	0.897
e	0.913	1.000
ω	9	3.8
Ω	43	47.5
i	106.4	107.0

2.5 ε Virginids – 513 EPV

Another long lasting shower with a lot of known orbits (77). The meteors of this shower span the time period from November 27 to December 18. The radiant plot nicely shows the effects of daily motion (Figure 5) with

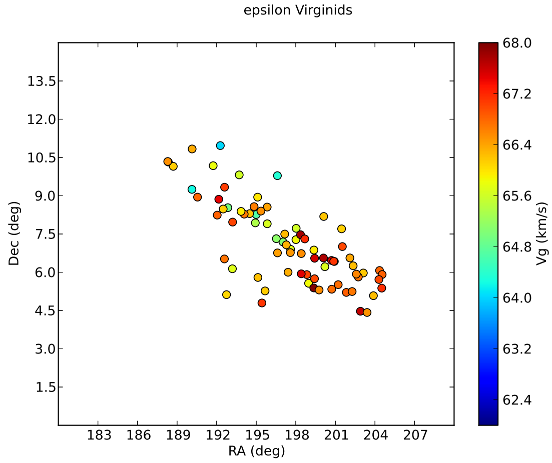

Figure 5 – Radiant plot of ε Virginids.

ΔRA = 0.79°/day, ΔDEC = −0.24°/day. The mean orbit is also well defined.

The last check of the IAU MDC and the literature revealed that this shower is already known under the name December σ Virginids (428 DSV), reported in 2012 by Greaves (Greaves, 2012). However, our data indicate a period of activity of considerably longer duration than the one given by Greaves, without overlapping with the period quoted by Greaves (the activity of 513 EPV ends 3 days before the beginning of the main concentration of 428 DSV, as quoted by Greaves). However, in the table of orbits (Greaves, 2012, Table 1), solar longitudes of the observed meteors are in the range 262°.3 – 270°.0, thus the end of the observed period of 513 EPV overlaps with the beginning of the period of 428 DSV. Based on the similarity of the mean orbits, we are dealing with one and the same shower with a long period of activity, but we will leave this to the IAU MDC to settle. The shower is also recently described by Shiba & Ueda (2013) with an even larger period of activity: December 1 to January 10 (but this article was published too late to be included in our analysis).

It is interesting to note that our analysis revealed 3 orbits with $D_{SH} < 0.15$, but with a different radiant and activity period. This could mean that the stream intersects the Earth's orbit twice, a very interesting case. We thus include this 'twin shower' in our list, with the proposed name ω Capricornids (514 OMC). The three known orbits cover the time span between May 19 to June 6.

Greaves (2012) also identifies a possible parent body, comet C/1846 J1 (Brorsen). Our parent body search confirmed this connection too, with $D_{SH} = 0.112$. The comparison of orbital data is presented in Table 3. The similarity of the orbits is striking, thus the probability of physical connection between the stream and the comet is quite high.

Table 3 – Comparison of orbital elements of ε Virginids (mean orbit) and the orbit of comet C/1846 J1 (Brorsen)

parameter	513 EPV	C/1846 J1 (Brorsen)
q	0.573	0.634
e	0.980	0.990
ω	99	99.7
Ω	258	264.0
i	151	150.7

2.6 o Leonids – 515 OLE

This shower is also active over a long time period of about a month, from January 2 to January 28, but 38 known orbits are enough for good data on the mean orbit and mean daily motion of the radiant: ΔRA = 0.67°/day, ΔDEC = −0.27°/day. The radiant plot (Figure 6) also clearly shows the effects of daily motion of a compact radiant.

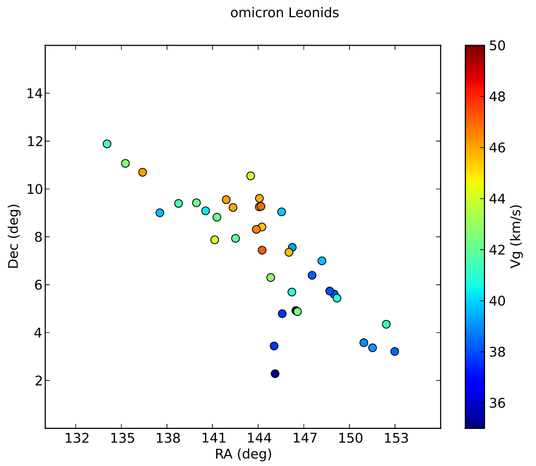

Figure 6 – Radiant plot of o Leonids.

2.7 February μ Virginids – 516 FMV

Another weak shower with moderate duration, from February 7 to February 27. The radiant plot (Figure 7) again shows clear effects of daily motion, but more data are needed to define it better. The rough values for daily motion are ΔRA ≈ 0.8°/day, ΔDEC ≈ −0.4°/day. Note that geocentric velocity is very well defined for this shower, which may indicate a relatively young shower.

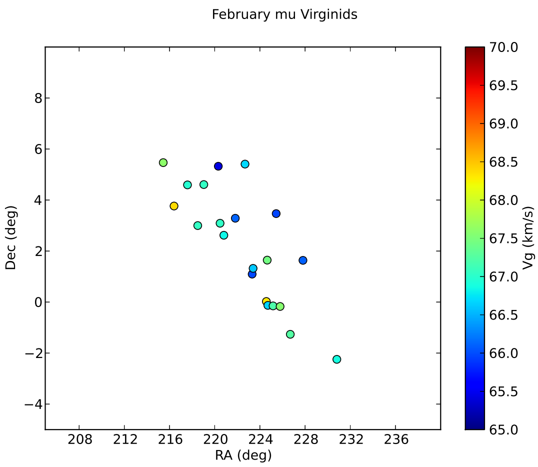

Figure 7 – Radiant plot of February μ Virginids.

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, 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 the case of RA and DEC there is a contribution of the daily motion to the dispersion of the radiants.

ID	name	$\lambda_\odot$	RA	DEC	v_g	a	q	e	ω (peri)	Ω (node)	i	N
509 KVI	κ Virginids	345–25	208 ± 10	-8 ± 4	37.4 ± 2.1	2.5	0.139 ± 0.039	0.938 ± 0.023	321 ± 6	6 ± 11	8 ± 4	58
510 JRC	June ρ Cygnids	81–90	321.8 ± 2.3	43.9 ± 2.0	50.2 ± 1.4	21	1.007 ± 0.005	0.931 ± 0.047	190 ± 3	84.2 ± 1.7	90 ± 3	16
511 FLY	15 Lyncids	193–211	101 ± 5	54.6 ± 1.3	59.6 ± 1.0	3.6	0.853 ± 0.023	0.755 ± 0.045	228 ± 4	202 ± 4	121.6 ± 2.3	18
512 RPU	ρ Puppids	217–228	120.0 ± 2.4	-24.0 ± 1.6	57.5 ± 1.1	13	0.985 ± 0.005	0.913 ± 0.062	9 ± 4	43 ± 3	106.4 ± 2.3	16
513 EPV	ε Virginids	245–267	197 ± 4	7.2 ± 1.6	66.4 ± 0.8	28	0.573 ± 0.034	0.980 ± 0.040	99 ± 4	258 ± 3	151 ± 2	77
514 OMC	ω Capricornids	59–73	315	-30	64.6 ± 0.8	27	0.535 ± 0.023	0.982 ± 0.032	87 ± 4	246 ± 6	142.4 ± 0.1	3
515 OLE	o Leonids	281–308	144 ± 4	7 ± 3	41.5 ± 3.8	1.8	0.079 ± 0.029	0.968 ± 0.029	151 ± 6	116 ± 6	23 ± 4	38
516 FMV	February μ Virginids	318–338	223 ± 4	2.2 ± 2.2	66.9 ± 0.7	16	0.770 ± 0.028	0.929 ± 0.039	237 ± 4	327 ± 5	146 ± 3	21

3 Conclusions

Altogether 8 new showers were discovered in the combined CMN (2007–2010) and SonotaCo (2007–2011) databases, 6 of which seem to be genuine, one is suspected (514 OMC) and one is probably already known (513 EPV may be 428 DSV). The main properties of individual showers are discussed in the appropriate sections above.

The case of 513 EPV stresses the need for the IAU MDC to be more frequently updated and to include data about the whole period of activity, as it is the main tool we have to check our findings against already known showers. Some search tools for it would also be of great help to researchers. We have written a web tool for stream searches of the MDC database and it can be accessed at:
`http://cmn.rgn.hr/in-out/search.html`

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