Meteor science

August ι Cetids, a Possible New Meteor Shower in August

Željko Andreić[1], Denis Vida[2], Filip Novoselnik[3], Damir Šegon[4], Korado Korlević[5], Filip Matijević[6], Džan Jašarević[7], Anton Perkov[8] and Ciobanu Tudor[9]

The Croatian Meteor Network Catalogs of Orbits for 2007 to 2010 contain 19055 orbits, of which 8410 can be attributed to previously known streams. The radiant analysis of the remaining orbits, plus the orbits from SonotaCo catalogs for 2007 to 2009, revealed a possible new stream. This stream was assigned IAU shower number 505 and three-letter code AIC. The analysis was recently rerun with orbits from SonotaCo databases for the years 2010–2011, resulting in a total of 120 orbits belonging to the AIC stream with refined mean orbit, radiant position and daily motion. The stream is active in August and September.

Received 2012 October 15

1 Introduction

The Croatian Meteor Network (CMN) was started in 2007. The network is described in more detail in (Andreić & Šegon, 2010) and (Andreić et al., 2010). The catalog of orbits for 2007 is already published (Šegon et al., 2012) and the catalogs for 2008–2009 are announced in this issue (Korlević et al., 2013).The analysis of the radiant plots of sporadic meteors from CMN catalogs for 2007 to 2010 and SonotaCo catalogs for 2007 to 2009 pointed to a potential new shower in august. This shower received a preliminary IAU MDC code 505 AIC and name August ι Cetids.

2 The new shower

The 23 individual orbits of meteoroids that could belong to a new shower were detected during the Višnjan School of Astronomy 2012 and were tested with the D-criterion, using the commonly used Southworth-Hawkins method (Southworth & Hawkins, 1963). The results of this analysis were presented at the IMC 2012 conference in La Palma (Vida et al., 2013) and are summarized in Table 1.

Table 1 – Results of radiant analysis for the members of the new shower, based on 23 orbits. Orbital data are given as: semi-major axis a (in A.U.), its reciprocal value $1/a$, perihelion distance q (in A.U.), eccentricity e, inclination i, longitude of the ascending node Ω and argument of perihelion ω. i, Ω and ω are given in degrees.

parameter	standard arithmetic average
a	1.96 (rough estimate)
$1/a$	0.50905 ± 0.03057
q	0.097 ± 0.004
e	0.951 ± 0.004
i	20.5 ± 1.0
Ω	322.2 ± 8
ω	156.8 ± 8
α (avg)	$0\,^{\circ}4$
δ (avg)	$-6\,^{\circ}4$
v_g (avg)	37.96 km/s
$\lambda_\odot$ min.	$145\,^{\circ}8$
$\lambda_\odot$ max.	$154\,^{\circ}0$

In accordance to the procedure of reporting new showers (Jenniskens et al., 2009) we contacted the IAU Meteor Data Center and proposed the name August ι-Cetids. In response, the shower was assigned IAU shower number 505 and tree-letter code AIC.

In the meantime, the SonotaCo catalogs for 2010 and 2011 were released and a new analysis of all available catalogs was performed, resulting in a total of 120 meteor orbits that satisfy $D < 0.15$) criterion. The radiant plot for these orbits is shown in Figure 1. The complete set of these orbits can be downloaded from the CMN web site (CMN, 2012). This analysis resulted in refined stream data, presented in Table 2. It was found that the period of activity is significantly longer than the one determined from visual analysis of radiant plots. We were also able to determine the mean daily motion of the radiant, the position of the mean radiant itself is slightly shifted in both coordinates, and the ac-

[1]University of Zagreb, Faculty of Mining, Geology and Petroleum Engineering, Pierottijeva 6, 10000 Zagreb, Croatia.
Email: zandreic@rgn.hr
[2]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
[3]Astronomical Society "Anonymus", B. Radića 34, 31550 Valpovo, Croatia and Faculty of Electrical Engineering, University of Osijek, Kneza Trpimira 2B, 31000 Osijek, Croatia.
Email: novoselnikf@gmail.com
[4]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
[5]Višnjan Science and Education Center, Istarska 5, 51463 Višnjan, Croatia.
Email: korado@astro.hr
[6]Vladimir Prelog Science School, Vukovarska 269, 10 000 Zagreb, Croatia.
Email: filipmatijevi96@gmail.com
[7]Srednja elektrotehnička škola Sarajevo, Safeta Zajke 2 Sarajevo, Bosna i Hercegovina , 71000
Email: jasarevic.dzan@gmail.com
[8]Observatory of Astronomical Society Istra Pula, Park Monte Zaro 2, 52100 Pula, Croatia.
Email: tonicic@net.hr
[9]International Computer High School of Bucharest, Mihai Bravu Street No 428, Sector 3, Bucharest, Romania
Email: tudor_ciobanu@ymail.com

IMO bibcode WGN-412-andreic-aicetids
NASA-ADS bibcode 2013JIMO...41...40A

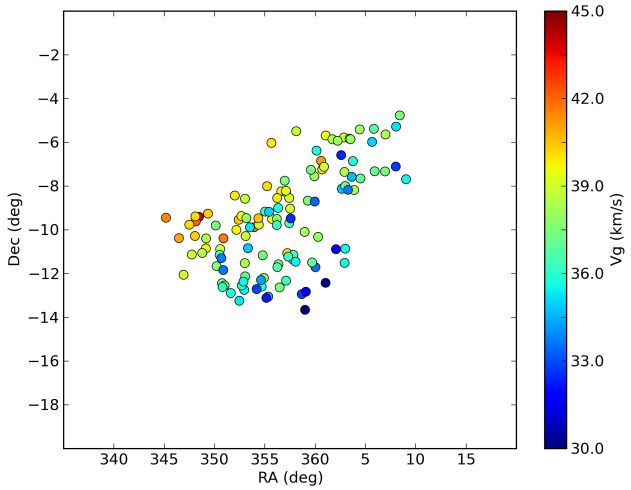

Figure 1 – Radiant plot of all AIC orbits found by the authors to date.

curacy of the radiant position is significantly improved. The radiant position can be calculated from:

$$\alpha = 0.71°(\lambda_\odot - 145.°4) + 356.°8 \quad (1)$$

$$\delta = 0.21°(\lambda_\odot - 145.°4) - 9.°6 \quad (2)$$

We also compared the mean AIC orbit with the mean Southern δ-Aquariids (SDA) orbit whose radiant is close to the AIC radiant. To do this, we first calculated the mean SDA orbit from 932 orbits in the before mentioned databases we used. We found that the mean orbits of AIC and SDA are clearly different. Only 2 orbits that would satisfy $D < 0.15$ criterion for both showers were found. UFOOrbit classified both as SDA. The mean orbits are also different, especially in the perihelion distance and the eccentricity. The mean orbits themselves differ by $D_{SH} = 0.26$, a significant but not very large difference. This could mean that both showers have a common parent body, or originate from different fragments of the same body.

Table 2 – Refined results of radiant analysis for the members of the new shower, based on all available catalogs (CMN 2007 to 2010 and SonotaCo 2007 to 2011).

parameter	refined value
a	1.825 ± 0.053 (rough estimate)
$1/a$	0.54788 ± 0.016
q	0.106 ± 0.003
e	0.942 ± 0.002
i	21.3 ± 0.3
Ω	325.4 ± 0.7
ω	148.2 ± 0.5
α (avg)	$356.°8$
daily motion:	$+0.°7$
δ (avg)	$-9.°6$
daily motion:	$+0.°2$
v_g (avg)	37.24 ± 2.6 km/s
$\lambda_\odot$ min.	128°
$\lambda_\odot$ max.	164°

Table 3 – IMO data about AIC.

$\lambda_\odot$ [°]	α [°]	δ [°]	rel. strength
147	357.5	−8	8.5
148	358.8	−6.5	7.8
149	359.4	−9	5.8
150	359.4	−9.5	7.5
151	0.5	−9.5	8
152	1.5	−9.5	5.2
153	2.5	−6	6.5
154	3	−6.5	8.9
155	3.5	−6.5	10.2
156	4.5	−7	7.2
157	5	−6	6.2
158	6	−6	5.2
159	7	−4.5	8.1
160	7	−5	8.7
161	9	−3	6.6
162	10	−3	7.7
163	10.5	−4	6.5
164	11	−3	5.6
165	12.5	−2	3.1

Finally we checked the IMO Million Meteors pages (Molau, 2012), and found that this radiant has been detected during the last analysis, too. Radiant positions fit pretty well with our observations, and relative strength (activity) show that the maximum could be somewhere around $\lambda_\odot = 155°$, but that cannot be confirmed since the actual activity cannot be seen during the period of SDA activity. Results obtained by IMO are presented in Table 3.

3 Discussion

All together in the CMN and SonotaCo databases we found 120 AIC orbits that satisfy $D_{SH} < 0.15$. Such a large number of orbits allows refining the average orbital elements and a good estimate of radiant position and mean daily motion (Table 2).

Parent body search for AIC yields no known object at their average orbit. There are some obvious thoughts/questions jumping out at this point. The AIC parent body could be an unknown comet, could be a long separated fragment of the SDA parent body, or the AIC could be in fact a heavily perturbed SDA filament.

Despite similarity of SDA and AIC orbits, our strong opinion is that these two groups of meteoroids should be considered as two separate meteor showers. In order to confirm such statement, more detailed analysis of SDA and AIC should be done.

4 Conclusions

Altogether, 120 orbits fitting mean orbital parameters by D-criteria inside $D_{SH} < 0.15$ in CMN catalogs for 2007 to 2010 and SonotaCo catalogs for 2007 to 2011 have been found. The available data show that the radiant is active from 128–164° solar longitude, corresponding roughly to August 1 – September 6, with max-

imum very roughly around 155° solar longitude (August 27). Radiant position at the middle of the activity period ($\lambda_\odot = 145\,^\circ\!.4$) is at $\alpha = 356\,^\circ\!.8$, $\delta = -9\,^\circ\!.6$ with $v_g = 37.2$ km/s. The mean daily motion was found to be $+0\,^\circ\!.71$ in right ascension and $+0\,^\circ\!.21$ in declination. IAU MDC named the shower August ι-Cetids with the temporary number 505 and a tree-letter code AIC.

Acknowledgments

Our acknowledgments go to all members of Croatian Meteor Network, in alfabetical order (first name first): Alan Pevec, Aleksandar Borojević, Aleksandar Merlak, Alen Žižak, Berislav Bračun, Dalibor Brdarić, Damir Matković, Damir Šegon, Dario Klarić, Dejan Kalebić, Denis Štogl, Denis Vida, Dorian Božićević, Filip Lolić, Filip Novoselnik, Gloryan Grabner, Goran Ljaljić, Ivica Ćiković, Ivica Pletikosa, Janko Mravik, Josip Belas, Korado Korlević, Krunoslav Vardijan, Luka Osokruš, Maja Crnić, Mark Sylvester, Mirjana Malarić, Reiner Stoos, Saša Švagelj, Sonja Janeković, Tomislav Sorić, VSA group 2007, Zvonko Prihoda, Željko Andreić, Željko Arnautović and Željko Krulić. Also, to Peter Gural for constructive discussions on meteor shower problematics.

This work was partially supported by the Ministry of Science, Education and Sports of the Republic of Croatia, Višnjan Science and Education Center and by private funds of CMN members.

References

Andreić Ž. and Šegon D. (2010). "The first year of Croatian Meteor Network". In Kaniansky S. and Zimnikoval P., editors, *Proceedings of the International Meteor Conference, Šachtička, Slovakia, 18-21 September 2008*, pages 16–23. International Meteor Organization.

Andreić Ž., Šegon D., and Korlević K. (2010). "The second year of Croatian Meteor Network". In Andreić Ž. and Kac J., editors, *Proceedings of the International Meteor Conference, Poreč, Croatia, 24-27 September 2009*, pages 26–30. International Meteor Organization.

CMN (2012). "Full table of 505 – ICE shower orbits". `http://cmn.rgn.hr/downloads/downloads.html` .

Jenniskens P., Jopek T. J., Rendtel J., Porubčan V., Spurný P., Baggaley J., Abe S., and Hawkes R. (2009). "On how to report new meteor showers". *WGN, Journal of the IMO*, **37:1**, 19–20.

Korlević K., Šegon D., Željko Andreić, Novoselnik F., Vida D., and Skokić I. (2013). "Croatian Meteor Network catalogues of orbits for 2008 and 2009". *WGN, Journal of the IMO*, **41:2**, 48–51.

Molau S. (2012). "Million meteors in the IMO Video Meteor Database". `http://www.imonet.org/showers/` .

Southworth R. B. and Hawkins G. S. (1963). "Statistics of meteor streams". *Smithsonian Contr. Astrophys.*, **7**, 261–285.

Vida D., Novoselnik F., Andreić Ž., Šegon D., Korlević K., Matijević F., Jašarević D., Perkov A., and Tudor C. (2013). "A possible new meteor shower detected from CMN and SonotaCo data". In *International Meteor Conference, La Palma Island, Canary, Spain, 20-23 September 2012*. (article will appear in the proceedings of the conference).

Šegon D., Andreić Ž., Korlević K., Novoselnik F., and Vida D. (2012). "Croatian Meteor Network catalogue of orbits for 2007". *WGN, Journal of the IMO*, **40:3**, 94–97.

Handling Editor: Carl Hergenrother

This paper has been typeset from a LaTeX file prepared by the authors.