Possible new meteor shower detected from CMN and SonotaCo data

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The Croatian Meteor Network was started in 2007, and, since then, 19 055 orbits were obtained. A new meteor shower was detected using CMN and SonotaCo data. Basic orbital and activity data of this shower are described and discussed.

1 Introduction

Early 2012, the Croation Meteor Network (CMN) was able to overcome a major obstacle. Software was developed for time synchronization between different stations. Before, the absence of such software prevented the calculation of high-precision orbits. Four years worth of data (2007–2010) were processed using the new software. For this period, 19 055 orbits have been acquired. It was decided to start searching for hitherto unknown meteoroid streams. The methods used and the first results are presented and discussed in this paper.

2 Croatian Meteor Network

The CMN was started in 2007 by a group of enthusiasts led by Damir Šegon. Since then, the CMN has grown into a large video meteor network with currently over 30 operational cameras (Andreić and Šegon, 2010; Andreić et al., 2010). The entire airspace over Croatia is currently covered by at least two cameras (Figure 1). The network uses 1004× surveillance cameras for night-sky imaging. They are build around a Sony 1/3″ EXView HAD CCD chip, and achieve a sensitivity of 3 mLux with an $f/1.2$ objective lens. They provide black and white images at standard 25 frames per second, which allows for simple coupling with a PC: almost any frame-grabber PC card or PC-TV card works with this camera. Readily available 4 mm $f/1.2$ objective lenses are used on most cameras. They provide a good compromise between sensitivity (the faintest meteors recorded with this objective are around magnitude +3.5) and image scale (which in this case is around 10′ per pixel). The image reduction procedure is described in detail by Vida and Novoselnik (2011).

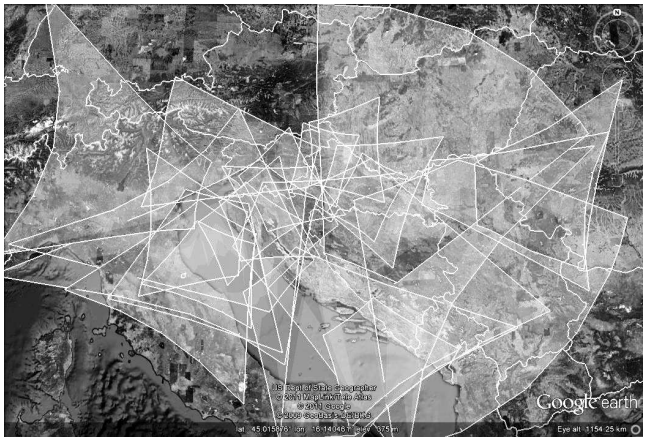

Figure 1 – Sky coverage at 100 km height at the end of 2011.

3 Finding unknown meteoroid streams

We first combined our data sets with those of SonotaCo[1]. After that, meteors belonging to known showers were excluded and the remaining meteors were plotted on a map of the sky. During plotting, the geocentric velocities of individual meteors were color-coded. Each day (solar longitude) had its own plot. These sky maps where visually searched for groups of dots of the same color. The exact position on the sky map and the range of solar longitudes were marked. After that, the data were run through our software called SelectedRangeFilter, which extracts orbital elements of meteoroids within the parameter range defined. The next step was to find the correlation of each meteoroid to every other meteoroid in this reduced data set. For that purpose, pyStreamFinder was used. This software compared each meteoroid to all other meteoroids to find orbital similarities using the D-criterion. We required the value of D_{SH} to be lower than 0.15. The literature describes different versions of the D-criterion method, but we implemented the original one (Southworth and Hawkins, 1963).

4 Results

After filtering out Antihelion and other known sources, we were left with several potential candidates for the new streams. Among them, we have chosen the most promising one to be studied first, and the results of this study are presented in this paper.

A total of 23 orbits (13 CMN and 10 SonotaCo) are possibly belonging to the new stream. The shower is active from $\lambda_\odot = 145°$ to $\lambda_\odot = 153°$. Mean orbital elements are given in Table 1. One can notice that they are similar to those of the Southern δ Aquariids (SDA) meteoroid stream, especially in eccentricity, perihelion distance, and geocentric velocity.

The consistency of velocities can be seen in Figure 2. All velocities are in the range from 33 to 41 km/s. The radiants span from $\alpha = 355°$ to $\alpha = 365°$ in right ascension and from $\delta = -04°$ to $\delta = -10°$ in declination.

Orbits are quite consistent, too, and close to each other, as can be seen in Figure 3.

4.1 Southern δ Aquariids

After completing the data reduction process including detection, astrometry, and photometry, the results were stored in a `.csv` file with all data required for orbit analysis. A total of 268 Southern δ Aquariid (SDA) orbits were found in the combined dataset for the 2007–2009 period. UFOOrbit software of SonotaCo was used for orbit visualization and analysis. (UFOOrbit settings were: $\mathrm{Q1}, \mathrm{Gm} = 2$, $\mathrm{dV} = 15$, $\mathrm{GD} > 10$). Southern

[1]Simultaneously observed meteor data sets SNM2007, SNM2008, and SNM2009; `http://sonotaco.jp/doc/SNM/`.

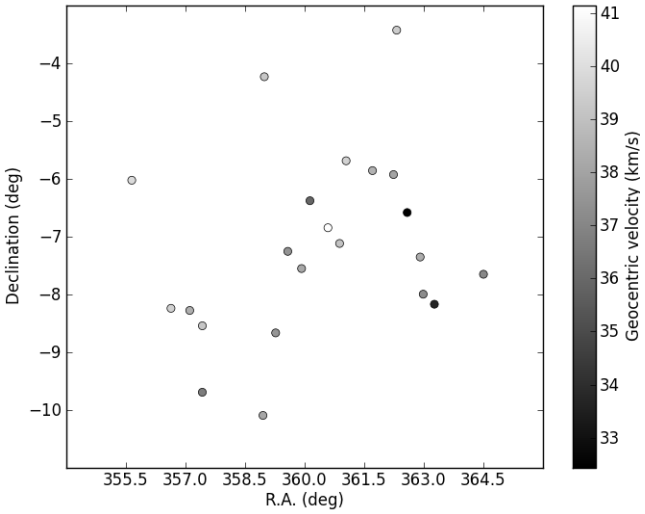

Figure 2 – Right ascension/declination plot with color-coded geocentric velocity of the new stream.

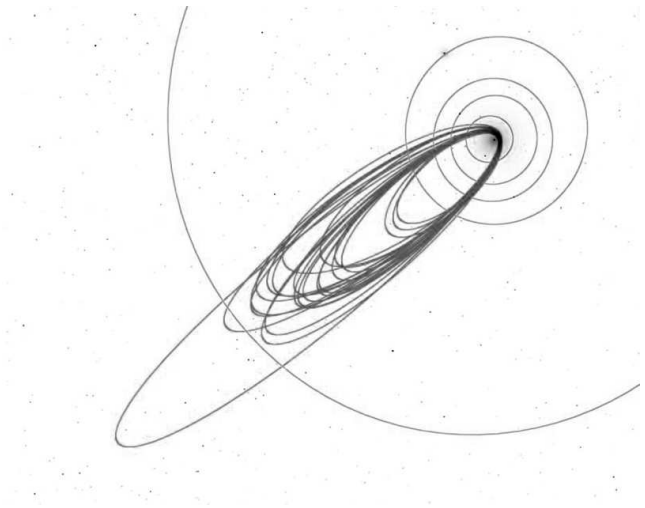

Figure 3 – Orbits of the new stream.

δ Aquariid activity was detected from $\lambda_\odot = 119°$ to $\lambda_\odot = 144°$. Mean orbital elements for this stream obtained from the orbits obtained are also given in Table 1.

4.2 Comparison of the new stream and SDA

The duration of the Southern δ Aquariid meteor shower covers the period from July 12 to August 19. They are shown in Figure 4 as gray orbits. The first meteors from our new shower appear on August 20 and last until September 8. The new stream is plotted in black on Figure 4. At first sight, some correlation seems to exist between both streams. The new stream appears to be a continuation of the Southern δ Aquariids, with similar (but not equal) orbital parameters.

To investigate further the reality of this apparent correlation, the right ascension/declination plot is shown in Figure 5. Southern δ Aquariid radiants are plotted in gray. They range from $\alpha = 332°$ to $\alpha = 355°$ in right ascension and from $\delta = -22°$ to $\delta = -10°$ in declination. At the end of the Southern δ Aquariids' activity

Table 1 – Mean orbital elements of the new stream compared to those of the Southern δ Aquariids (SDA).

Stream	α	δ	a	e	i	q	ω	Ω	$V_{\rm geo}$
New stream	0 ?4	−06 ?4	2.112 AU	0.951	20 ?5	0.097 AU	156 ?8	322 ?2	37.9 km/s
S δ Aquariids	341 ?9	−15 ?9	2.452 AU	0.961	26 ?2	0.087 AU	150 ?0	309 ?2	39.7 km/s

period, the new stream continues at almost exactly the same coordinates (black radiants) to end at $\alpha = 365°$ and $\delta = -04°$.

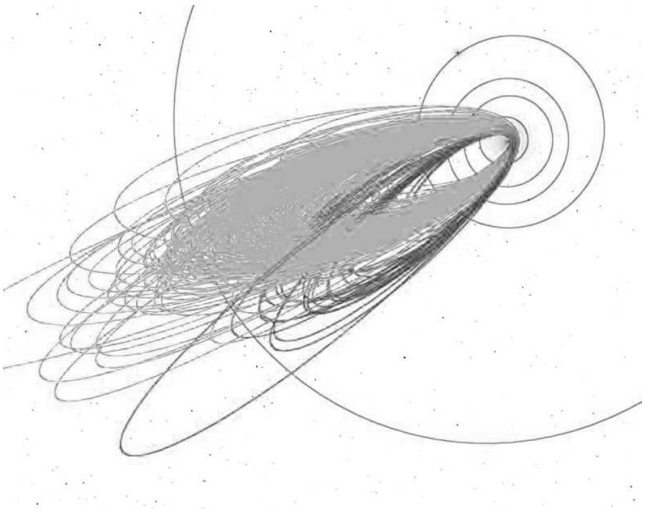

Figure 4 – Orbits of the Southern δ Aquariids (gray) and the new meteoroid stream (black).

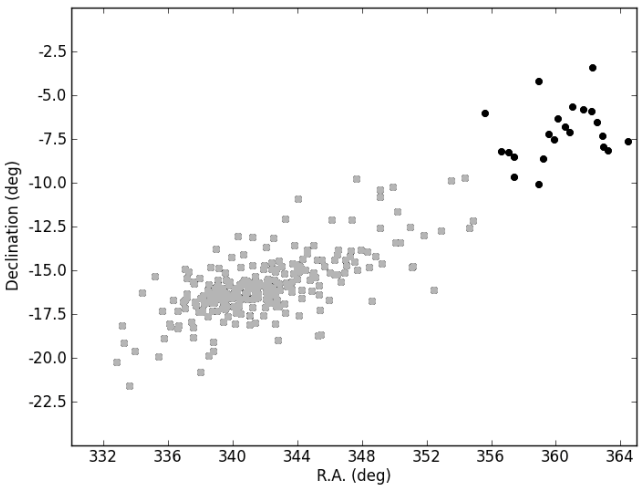

Figure 5 – Radiants of the Southern δ Aquariids (gray) and the new meteoroid stream (black).

5 Discussion

The comparison of Southern δ Aquariids to the new stream reveals similarities between them. On Figures 4 and 5, we see that the activity period of the new stream overlaps with the end of the Southern δ Aquariid activity. This may imply that the latter shower has a longer period of activity than previously thought. In this case, the parent body of the new stream may be another comet of the Machholz group, or possibly a fragment of the main parent body of the Southern δ Aquariid activity. However, a calculation of $D_{\rm SH}$ for each meteor (the mean orbits themselves differ by $D_{\rm SH} = 0.26$), using the mean orbit of the Southern δ Aquariids as a reference, reveals that $D_{\rm SH}$ is too large for the new stream to be a part of the Southern δ Aquariids, and, therefore, is in fact a previously unknown meteor stream. We presume this went unnoticed because the middle of the stream is located on the 360°/0° boundary, which is easily overlooked in automated algorithms for correlation analysis.

6 Conclusions

A possible new meteoroid stream is discovered which may be related to the Southern δ Aquariids. Based on the D-criterion, however, it is clear that these two are different meteoroid streams. Nevertheless, our data reveal that the new stream is continuation of the Southern δ Aquariids, with similar, but not identical, orbits. Further analysis and observations are needed to refine this conclusion. In October 2012, the new stream was registered with the IAU MPC under the name August ι Cetids and code 0505 AIC.

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, IMO, pages 16–23.

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, IMO, pages 26–30.

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

Vida D. and Novoselnik F. (2011). "Croatian Meteor Network: data reduction and analysis". In Asher D. J., Christou A. A., Atreya P., and Barentsen G., editors, *Proceedings of the International Meteor Conference*, Armagh, Northern Ireland, 16–19 September 2010, IMO, pages 96–100.