The interesting case of the ι-Cygnids (525 ICY)

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One of the showers recently reported by the Croatian Meteor Network, the ι-Cygnids (525 ICY), is described. From the 40 available orbits, the mean orbit of the shower and some other parameters were obtained. The ι-Cygnids were detected from October 16 ($\lambda_\odot = 203°$) to November, 19th ($\lambda_\odot = 237°$), with a slightly higher activity around October 31 ($\lambda_\odot = 218°$). The possible parent body is Asteroid 2001 SS_{287}, with $D_{SH} = 0.16$, indicating that 525 ICY is probably asteroidal in origin. However, a few more asteroids have $D_{SH} < 0.20$, so the question of the parent body requires a more detailed study to be solved. In depth analysis of IAU MDC has found two showers that are quite similar to the 525 ICY: 83 OCG and 282 DCY. By gathering additional data outside the IAU MDC, we found out that 282 DCY is a rediscovery of 83 OCG. Also, 525 ICY is identical to 83 OCG, but this fact was not recognized before, probably due to incorrect coordinates for the 83 OCG radiant in the IAU MDC database and the lack of information about the activity period of the showers in the IAU MDC database.

1 Introduction

Since 2007, the Croatian Meteor Network (CMN) has been monitoring the night sky over Croatia. The network is described by Andreić and Šegon (2010) and Andreić et al. (2010). The catalogues of orbits for 2007 (Šegon et al., 2012a), 2008 and 2009 (Korlević et al., 2013), and the catalogue for 2010 are available on the CMN download web page[1].

The well-known SonotaCo network catalogues[2] up to 2011 are public. Combining all these data sets, we compiled a database of 133 653 orbits that was systematically searched for new showers. Eighteen potential new showers were found this way. 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, 1963), and a mean orbit was calculated from the individual orbits that satisfy the criterion $D_{SH} < 0.15$.

Meteors from all these showers can be found in the IMO Video Meteor Database[3] The showers were reported to the IAU, following the standard procedure (Jenniskens et al., 2009)

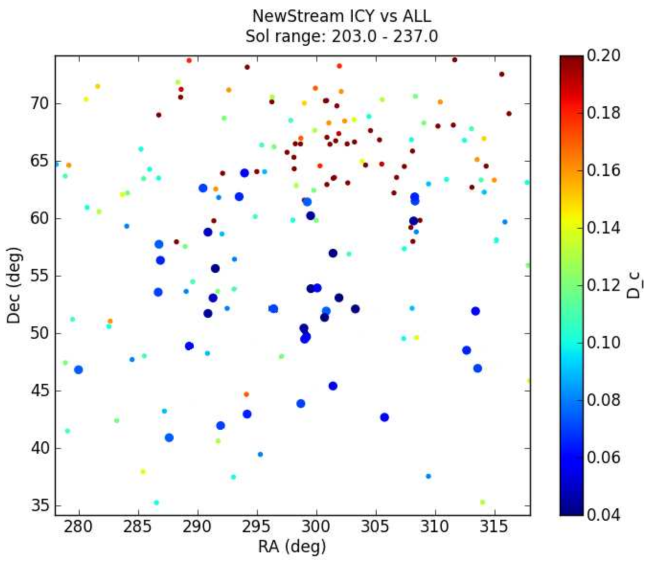

Figure 1 – Search plot of ι-Cygnids. All orbits from the dataset that satisfy $D_{SH} < 0.15$, together with all orbits with radiants in the same right ascension-declination window are shown here. The D_{SH} values are color-coded, and the ICY members are identified by larger circles.

The basic data for the first eight showers are published by Šegon et al. (2013), and the data for the remaining ten are in print. One of the showers found this way is 525 ICY.

[1] `http://cmn.rgn.hr/downloads/downloads.html`.
[2] `http://sonotaco.jp/doc/SNM/index.html`.
[3] `http://www.imonet.org/database.html`.

2 ι-Cygnids—525 ICY

Forty orbits for this shower were identified by our search. The shower is active from October 16 to November 19, with a maximum around October 31. The "search" plot is shown in Figure 1. The ι-Cygnids clearly stand out of the sporadic background.

The radiant plot (Figure 2) is diffuse but quite evenly populated, without obvious daily motion. It shows a general trend of meteors with larger geocentric velocities having larger radiant declinations, but we did not pursue this fact further. The daily motion is about $-0.7°$ in right ascension and $-0.1°$ in declination, but the scatter of data is quite large (see Figure 3).

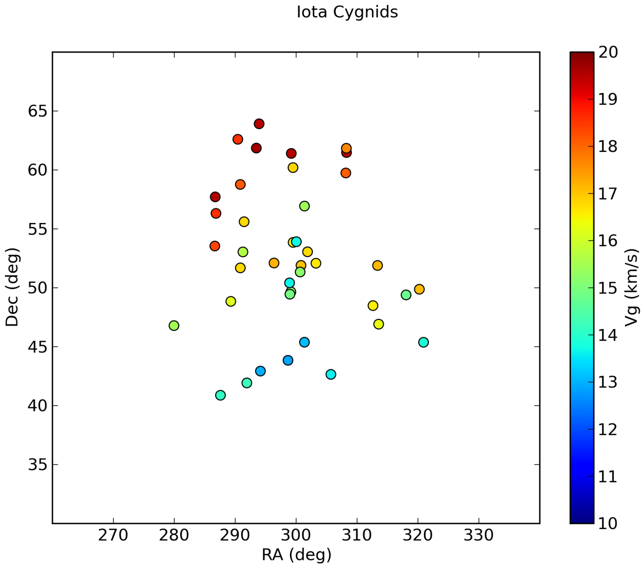

Figure 2 – Radiant plot of ι-Cygnids. Only members of the stream are plotted. The geocentric velocity of each meteor is color-coded.

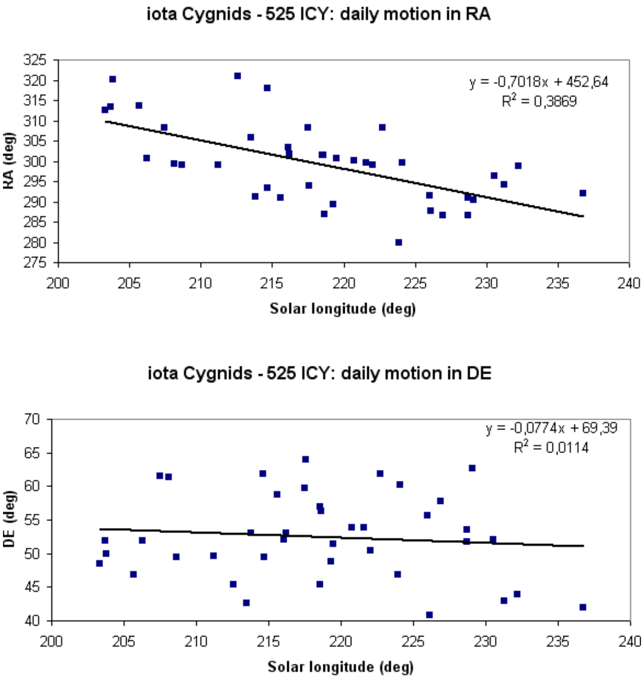

Figure 3 – The daily motion of ι-Cygnids. Note that the scatter of data around the linear fit is quite large.

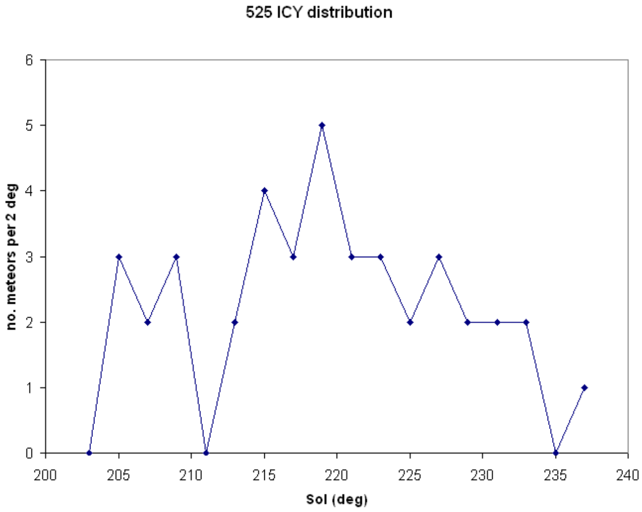

Figure 4 – The distribution of ι-Cygnids in time. Due to the small number of meteors known, the number of meteors per two-day bin is used.

In our search, the ι-Cygnids were detected from October 16 ($\lambda_\odot = 203°$) to November 19 ($\lambda_\odot = 237°$), with slightly stronger activity around October 31 ($\lambda_\odot = 218°$). The rough activity graph can be seen in Figure 4.

The mean orbit of the shower (Figure 5) is quite interesting, with $a = 2.7$ AU going right into the middle of the asteroidal belt. The possibility that this shower is asteroidal in origin is further supported by the results of the parent body search that revealed Asteroid 2001 SS_{287} with $D_{SH} = 0.16$ as a possible parent body. The comparison of orbital data of the 525 ICY stream and the asteroid is given in Table 1. Moreover, there is a whole family of asteroids with similar orbits, the next best possible candidates being, with D_{SH} in parentheses 2010 TK_{167} (0.18), 24 445 2000 PM_8 (0.19), 2012 UB_{69} (0.20), 2001 SD_{170} (0.21), and 2010 TC_{55} (0.21).

Table 1 – Comparison of orbits of ι-Cygnids and Asteroid 2001 SS_{287}.

Parameter	525 ICY	2001 SS_{287}
a	2.7 AU	3.2 AU
q	0.982 AU	1.052 AU
e	0.631	0.675
ω	190°	173.°9
Ω	218°	230.°8
i	24°	18.°5
D_{SH}		0.16

3 ι-Cygnids, October Cygnids, and δ-Cygnids

Although our search contained a check against the IAU MDC data, it failed to find any existing matches with the ι-Cygnids. However, the later manual check of our data against the IAU MDC identified two showers that seem to be similar to the ι-Cygnids: the October Cygnids (83 OCG) and the δ-Cygnids (282 DCY).

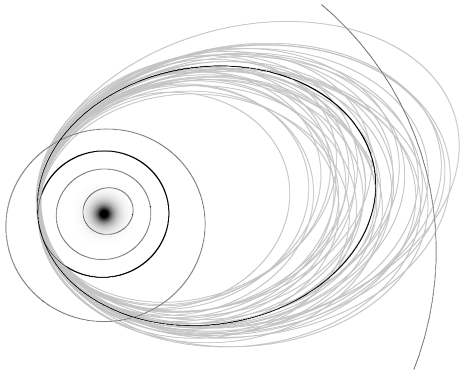

Figure 5 – The orbits of ι-Cygnids (gray) and the mean shower orbit (dark).

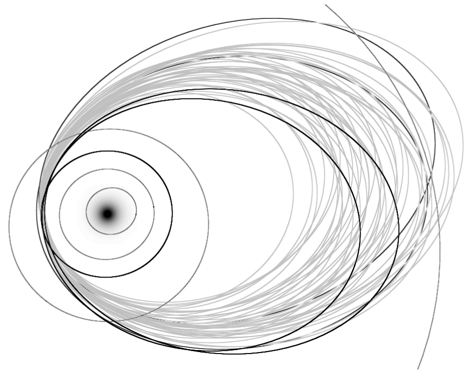

Figure 6 – Mean orbit of the ι-Cygnids (gray), orbits of the asteroids 2001 SS_{287} and 2010 TK_{167} (outer dark orbits), and mean orbits of 83 OCG and 282 DCY (inner dark orbits).

October Cygnids (83 OCG) were reported by Sekanina (1973) (this shower was called δ-Cygnids in Sekanina's article). The shower properties were determined from seven available meteor orbits, obtained by the radar observations. The mean orbits of ι-Cygnids and October Cygnids differ by D_{SH}=0.21, indicating a lot of similarity, but not exactly a match. The IAU MDC states $\lambda_\odot = 6^\circ$ as the time of maximum activity, 12 days before the strongest activity of 525 ICY. We missed this shower in our first check of data due to the fact that its radiant lies 19° from the radiant of 525 ICY, mostly in the direction of right ascension, with a 12° difference in solar longitudes of maximum activity.

The δ-Cygnids (282 DCY) were reported in the book of Jenniskens (2006, p. 750). Only five orbits were used for defining this shower. The mean orbits of ι-Cygnids and δ-Cygnids also differ by D_{SH}=0.21. The IAU MDC states $\lambda_\odot = 201^\circ$ as the moment of maximum activity, 17 days before the strongest activity of 525 ICY. We missed this shower in our first check of data due to this large difference in solar longitudes. Moreover, the geocentric velocity of 282 DCY is much lower than the one we derived for 525 ICY (14 versus 16.4 km/s). On the other hand, the radiant of 282 DCY is only about 5° away, mostly in the direction of declination.

Radiant positions for these showers are shown in Figure 7.

As is nicely illustrated by this case, the fact that the IAU MDC only states the solar longitude of the shower's supposed maximum activity complicates checking for already existing showers a lot. Therefore, we consulted the original publications to see if we can get more data about the whole period of the 83 OCG and 282 DCY activity. The results are summarized in Figure 8. The mismatch in stated times of maximum activity (vertical red lines) is obvious, but it is clearly seen that the activity periods (green) of all three showers overlap.

This raises another question of how we define the solar longitude of maximum activity. In case of well-known showers of which thousands of meteors are observed each year, the solar longitude of maximum activity is determined from graphs of shower activity versus time, with data still mostly gathered visually, or from single-station camera observations. However, in case of minor showers, with only a few meteors observed over the whole period of activity, this procedure is impossible. What is done instead is to quote the average of solar longitudes of individual meteors. Even with a decent 40 orbits for 525 ICY, the resulting graph is very rough (see Figure 8), and accuracy of the guessed maximum activity is low. We should therefore speak in terms of average (or mean) solar longitude of the shower and the activity period, which we define as the solar longitudes of the earliest and the latest meteor observed.

If we apply this approach to the problem of the showers discussed here, we see that there is a considerable overlap of activity periods of 525 ICY, 83 OCG, and 282 DCY. Additionally, the D_{SH} between 83 OCG and 282 DCY is only 0.11, a strong indication that we deal with a single shower, i.e., 282 DCY is actually identical to 83 OCG.

Moreover, the original Sekanina (1973) article states that the radiant of 83 OCG is at $\alpha = 300\overset{\circ}{.}3$ and $\delta = 51\overset{\circ}{.}3$, putting it almost head-on onto the 525 ICY radiant. We do not know how the other radiant coordinates

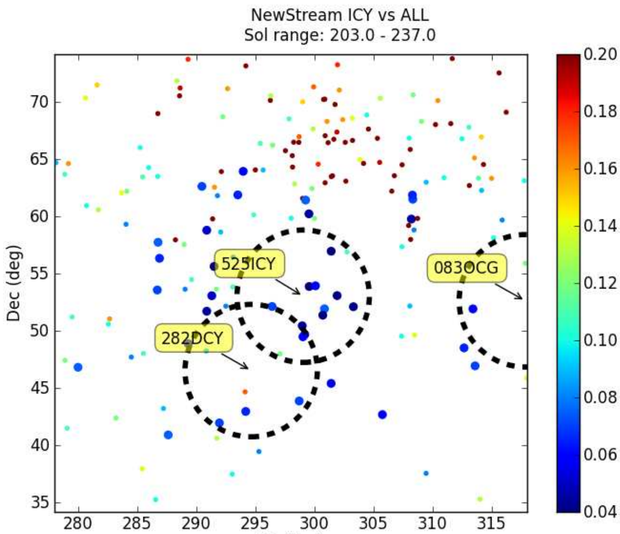

Figure 7 – Search plot of the ι-Cygnids on which the positions of the radiants of the ι-Cygnids, δ-Cygnids, and October Cygnids are indicated.

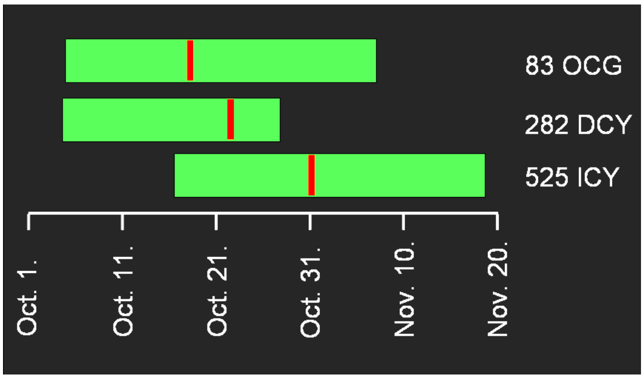

Figure 8 – A rough overview of activity data for 525 ICY, 83 OCG and 282 DCY.

found its way into the IAU MDC, but clue may be in the radiant coordinates of the Sekanina shower α-Cygnids, whose radiant is exactly at coordinates that IAU MDC provides for 83 OCG. This shower is not mentioned by the IAU MDC, and, from Sekanina's orbital elements, we found D_{SH} between 0.19 and 0.22 between it and showers 525 ICY, 83 OCG, and 282 DCY.

4 Conclusions

Putting it all together, 282 DCY is a rediscovery of 83 OCG. Also, 525 ICY is identical to 83 OCG, but is much better defined, as we now have 40 orbits available, against 12 from the past (7 + 5, if we put the 83 OCG and 282 DCY orbits together). This fact was not recognized before, most probably due to inaccurate data for the 83 OCG radiant in the IAU MDC database, together with the fact that the IAU MDC does not provide any information about the period of activity of showers in the database. The moment of the "maximum" alone is not sufficient anymore. Again, the IAU MDC will have to solve this problem officially.

To refine these conclusions, orbit evolution studies of all the showers involved, together with the potential parent bodies are needed.

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