New meteor shower in Bootes

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A new meteor shower on a LPC-type orbit has been detected in 2022 by the Global Meteor Network during the time interval 282.41° < $\lambda_\odot$ < 282.83° (2022, January 2–3) from a radiant at R.A. = 219° and Decl.= +28° with a geocentric velocity of 58.9 km/s. The new meteor shower has been listed in the Working List of Meteor Showers under the temporary identification M2023-D1.

1 Introduction

Verification of older radiant plots of the Global Meteor Network revealed a radiant concentration south of the Quadrantid radiant, active for as little as 10 hours during the night of 2–3 January 2022 (*Figure 1*).

2 Meteor shower search methodology

The method has been described in Šegon et al. (2023), but for this specific case we choose not to use the Southworth and Hawkins (1963) *D*-criterion, but the criterion defined by Valsecci et al. (1999). The idea to use another discrimination criterion is to show that this method works regardless the kind of criterion which is applied. The resulting distribution of *D*-criteria plotted as a histogram (*Figure 2*) allows us to select the histogram bin containing most meteors.

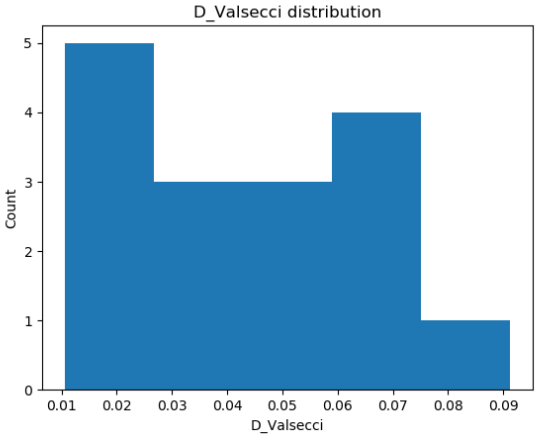

Figure 2 – Histogram of the distribution of the values of the D_V criterion valid for the first mean orbit estimate.

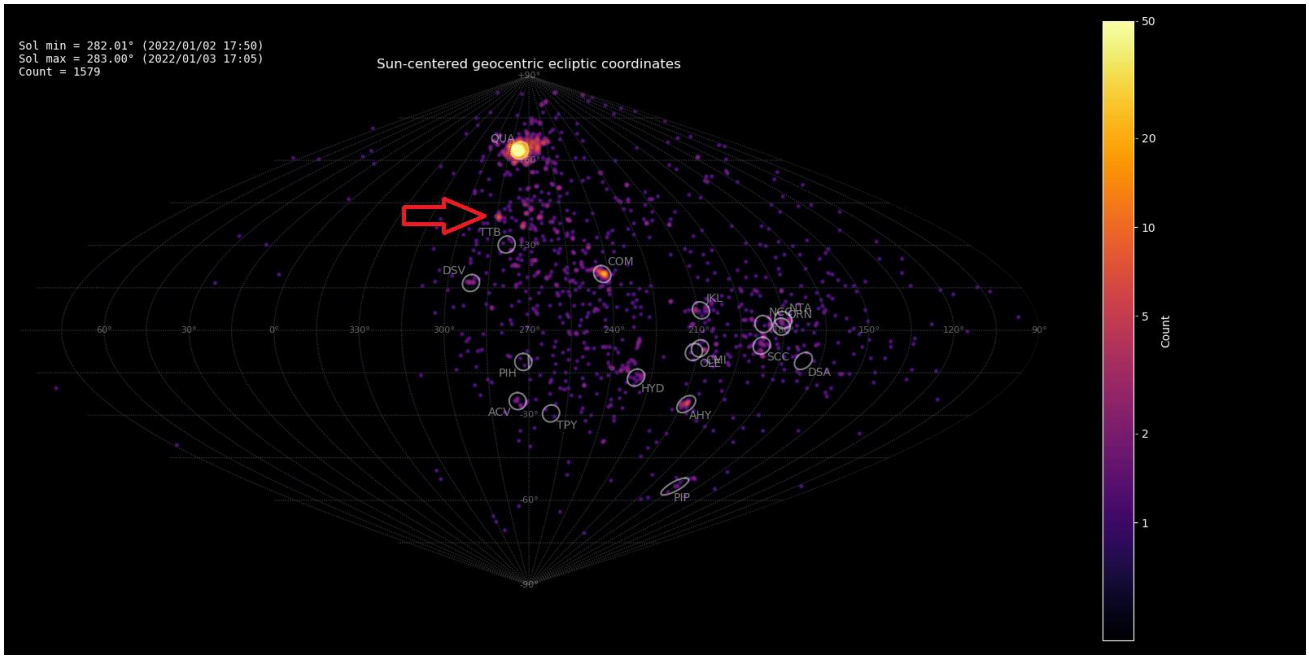

Figure 1 – Radiant plot of the Global Meteor Network data for 2022 January 2–3 in Sun-centered geocentric ecliptic coordinates. The new radiant is visible south of the QUA radiant and is marked by a red arrow.

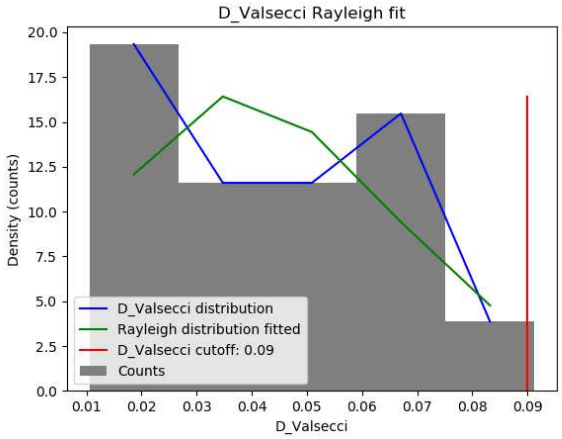

Figure 3 – Rayleigh distribution fit and D_V cutoff.

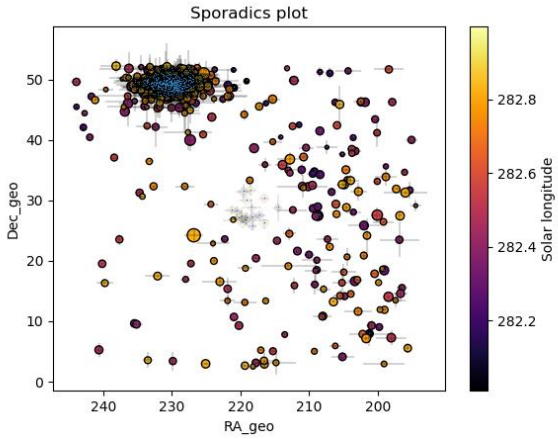

Figure 4 – All radiants in geocentric equatorial coordinates during the shower activity. The gray crosses are the new shower radiants, you can see the QUA radiants in the upper left.

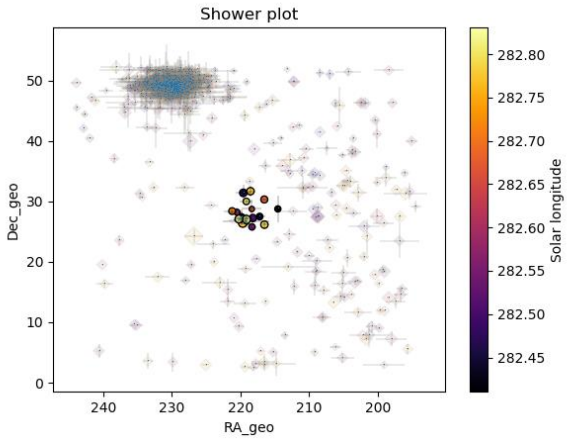

Figure 5 – The reverse of *Figure 4* where the background radiants are now grayed out, all radiants in geocentric equatorial coordinates. The QUA shower radiants may be clearly seen as a separate group of orbits at their expected radiant positions (up and left from the new shower).

The Rayleigh distribution fit results in D_V = 0.09. The resulting mean orbit calculated with the method of Jopek et al. (2006) is listed in *Table 1*. The radiant plot in equatorial coordinates is shown in *Figures 4 and 5*. The activity period appears to be very short, about 10 hours within the interval 282.41° < $\lambda_\odot$ < 282.83° (*Figure 6*).

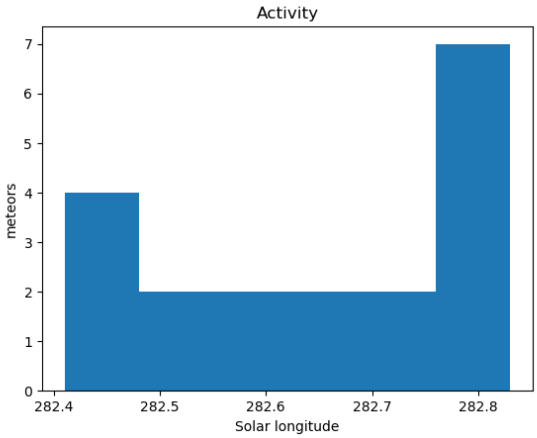

Figure 6 – The activity period with the number of orbits identified as new shower members.

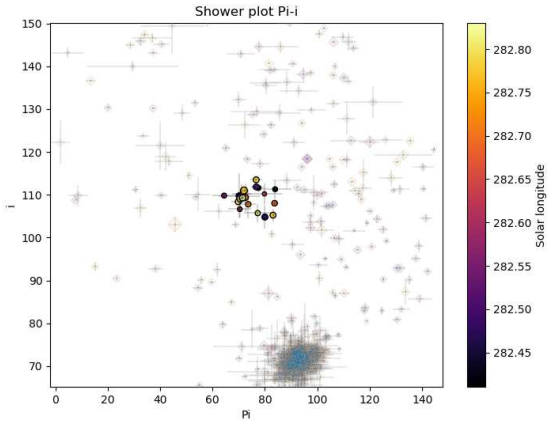

Figure 7 – The diagram of the inclination i against longitude of perihelion Π. The QUA shower radiants may be clearly seen as a separate group of orbits (down and right from the new shower).

3 New shower or existing shower?

Verification of the IAU MDC Working List of Meteor Showers (Jenniskens et al., 2020; Jopek and Kaňuchová, 2014; 2017; Jopek and Jenniskens, 2011; Neslušan et al., 2020) reveals two meteoroid streams with the same type of orbits. One shower is active the same date, the other one more than 10 days later in time with slightly different radiant positions, in equatorial and in Sun-centered ecliptic coordinates.

Both the Southworth and Hawkins as well as the Drummond *D*-criteria exceed the upper limits to suggest any similarity. All three orbits in *Table 1* are Long Period-type comet (LPC) retrograde orbits, but differ mainly in longitude of perihelion. Nevertheless, the occurrence within a period of weeks with radiants not too far apart may suggest some common origin for these same orbit type meteoroid streams. The ten-hour duration activity observed in 2022 could not be associated with any existing shower and therefore has been suggested as a new meteor shower.

Table 1 – Known neighboring showers, Canum Venaticids-Bootids (TCV#0579) and Serpentids-Coronae Borealids (RSE#0594), both (Gural et al., 2014) and the new meteor shower.

	TCV	RSE	New
$\lambda_\odot$ (°)	282	298	282.66
$\lambda_{\odot b}$ (°)	275	293	282.4
$\lambda_{\odot e}$ (°)	288	303	282.85
α_g (°)	210.1	234.9	218.8
δ_g (°)	+29.4	+25.1	+28.2
$\Delta\alpha_g$ (°)	0.69	0.71	–
$\Delta\delta_g$ (°)	–0.17	–0.20	–
v_g (km/s)	59.9	56.6	58.9
λ (°)	195.3	224.5	204.9
$\lambda_g - \lambda_\odot$ (°)	273.3	286.5	282.2
β_g (°)	+38.6	+43.2	+40.8
a (A.U.)	7.0	10.9	14.9
q (A.U.)	0.977	0.902	0.9296
e	0.861	0.917	0.9375
i (°)	113.7	103.7	109.1
ω (°)	171.6	145.9	153.1
Ω (°)	281.8	298.4	282.7
Π (°)	93.4	84.3	75.7
T_j	0.27	0.21	-0.04
N	21	17	18

4 Another search method

Another method has been applied to search for this new meteor shower combining three different discrimination criteria (Roggemans et al., 2019).

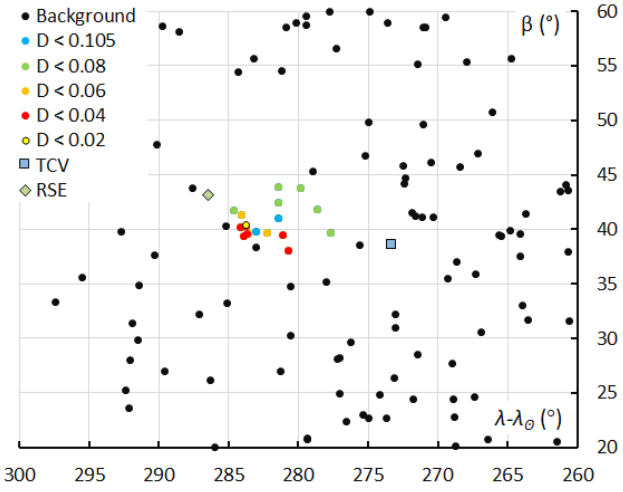

Figure 8 – Close up of the Sun-centered ecliptic geocentric coordinates for the possible new shower and the two known showers TCV and RSE.

This stream search detects 18 similar orbits in the 2022 data but with a large dispersion. Only 6 of these orbits fit with $D_{SH} < 0.1$ and $D_D < 0.04$. The large spread is very well visible in the Sun-centered ecliptic coordinates (*Figure 8*). The positions of the Canum Venaticids-Bootids (TCV#0579) and Serpentids-Coronae Borealids (RSE#0594) are also marked in this plot to show the offset relative to the radiants of the new shower. The diagram of inclination i against the longitude of perihelion Π (*Figure 9*) shows the large dispersion in longitude of perihelion.

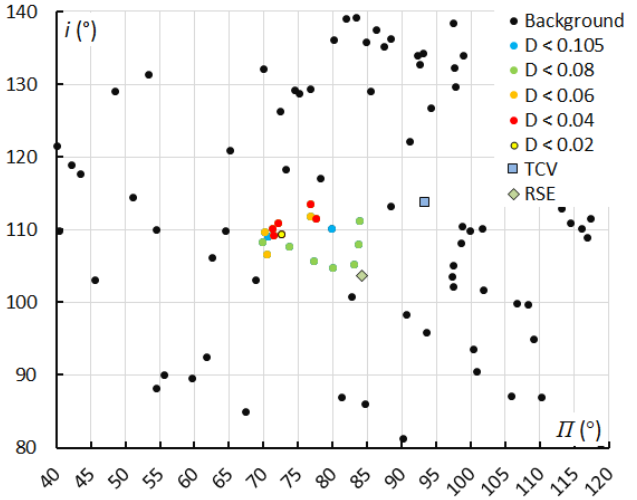

Figure 9 – Diagram of the inclination i against the longitude of perihelion Π for the new shower and the two known showers TCV and RSE.

The 6 best fitting orbits within the interval $282.43° < \lambda_\odot < 282.85°$, according to this method yield a mean orbit which is in good agreement with the results presented in *Table 1*.

- $a = 17.9$ AU
- $q = 0.926$ AU
- $e = 0.948$
- $i = 110.9°$
- $\Omega = 283.1°$
- $\omega = 151.9°$
- $\Pi = 75.0$
- $Tj = –0.12$

5 Comparing older data and other datasets

Looking up past years orbit data for Global Meteor Network, we find only 4 similar orbits with $D_{SH} < 0.1$ and $D_D < 0.04$ for 2023. Checking the CAMS data for 2011–2016 we find 13 similar orbits with $D_{SH} < 0.1$ and $D_D < 0.04$, one or few each year, spread in time. The SonotaCo data for 2007–2022 yield 4 orbits with $D_{SH} < 0.1$ and $D_D < 0.04$, only one for 2022 at $\lambda_\odot = 284.0°$ but nothing during the activity interval according to GMN although SonotaCo had 47 orbits collected in 2022 during this interval. And EDMOND data for 2006–2016 had only 4 similar orbits with $D_{SH} < 0.1$ and $D_D < 0.04$.

The new shower appears also as a group of unidentified radiants on the CAMS map for 2022, January 2–3 (*Figure 10*). However, this data includes GMN data and it is not possible to select only CAMS data in this display. As

CAMS data has not been released publicly since 2016, no comparison is possible.

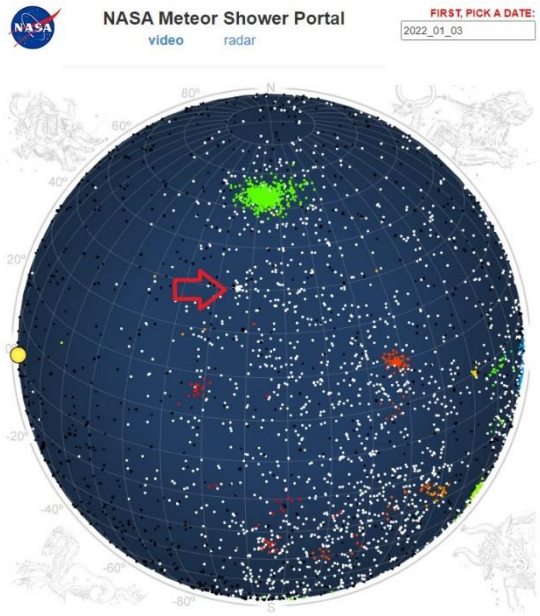

Figure 10 – Radiant plot for CAMS on 2022 January 3. The radiant concentration is indicated with a red arrow.

6 Conclusion

A new meteor shower radiant has been discovered in Global Meteor Network data around 2022 January 2–3 at R.A. = 218.7° and Decl. = +28.0°. A mean orbit could be established based on 19 orbits. The new shower may be related to two nearby meteoroid streams, Canum Venaticids-Bootids (TCV#0579) and Serpentids-Coronae Borealids (RSE#0594) which have the same type of orbit.

The new meteor shower has been reported to the IAU and has been listed in the Working List of Meteor Showers[3] under the temporary identification M2023-D1.

Acknowledgment

The authors thank all people who support the Global Meteor Network by contributing meteor camera data or in any other way to help monitoring meteor activity around the clock worldwide. For the list of GMN contributors we refer to Šegon et al. (2023).

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[3] https://www.ta3.sk/IAUC22DB/MDC2022/Roje/pojedynczy_obiekt.php?lporz=01594

