Tau Herculids in 2017 observed by CAMS

Carl Johannink, Jaap van 't Leven and Koen Miskotte

Dutch Meteor Society, the Netherlands
c.johannink@t-online.de
jvtleven@gmail.com
k.miskotte@upcmail.nl

During routine CAMS observations in the night of May 30-31 CAMS BeNeLux collected five meteors in just more than one hour, which are associated with comet 73P/Schwassmann-Wachmann. These five meteors appeared from a very narrow radiant, near RA = 210 degrees and Dec. = +29 degrees, geocentric velocity (v_g) ~12 km/s, with very similar orbits.
Further searches on the nights around this peak resulted in another twelve candidates.
The first five meteors very likely belong to the 1941-dusttrail of this comet, which was predicted to produce meteors with a geocentric velocity of 12.4 km/s, radiating from RA = 212.6 degrees and Dec. = +29.7 degrees, on May 31.136 this year (Lüthen et al., 2001). A short summary of historical visual observations is also given.

1 The observations

While processing all the data obtained during the night 30–31 May, we noticed immediately five meteors with virtually identical radiant positions, geocentric speed and orbital elements. Each single one of these meteors appeared within the time span of little more than one hour, to be more precise between 23^h39^m UT and 00^h45^m UT (*Table 1*). Almost instantly the comet 73P/Schwassmann-Wachmann emerged as being the possible source, according to predictions given for the year 2017 with likely meteor activity and considering the comet has an orbital period of 5 years. In this case the passage of this comet in 1941 can be considered to be the source of the meteors observed (Lüthen et al., 2001).

What was striking was that the radiant position of aforementioned meteors originating from the passage of this comet perfectly coincide with the predicted radiant position at RA = 212.6 degrees and Dec. = 29.7 degrees, as shown in *Figure 1*.

The question arose if, around this date, more orbits could be linked to this comet. Hence the decision to look for a possible match between the orbit of the comet 73P/Schwassmann-Wachmann, and the 1627 orbits that we could record with CAMS in the month of May 2017, as well as the 380 orbits recorded up to and including June 10 2017. For the comparison of all the orbits recorded with respect to similarities with the comet's orbit, the Drummond criterion was implemented (Drummond, 1981). In 2017 the orbital elements of 73P/Schwassmann-Wachmann are as follows[5]:

Orbital elements valid for 2017-03-28,0 TT = JDT 2457840.5 (based on 1040 observations between 28 November 2010 and 2 June 2017):

perihelion date	2017-03-16.84173TT
argument of perihelion ω (°)	199.38777
ascending node Ω (°)	69.66219
inclination i (°)	11.23692
eccentricity e	0.6855140
perihelion distance q (AU)	0.9721785

Next, meteors were selected from all those observed in the period of 20 May up to and including 10 June which fulfilled the Drummond criterion of $D_d \leq 0.06$.

Table 1 shows these meteors with their corresponding time of appearance and the stations that recorded them. The numbers in red concern the TAHs belonging to the dust from 1941.

Table 1 – Overview of the stations having recorded the τ Herculids with corresponding time of appearance and the D-criterion value (in red the five τ Herculids belonging to the dust trail of 1941).

Date	Time (UT)	Stations:	D_d
20.05.2017	22:39:45.37	_354_318	0,0543
22.05.2017	23:58:52.60	_395_365	0,0507
30.05.2017	23:39:49.72	_383_347	0,0095
30.05.2017	23:58:53.42	_802_322	0,0220
31.05.2017	00:19:35.57	_381_384	0,0134
31.05.2017	00:23:47.28	395_399_383	0,0566
31.05.2017	00:35:20.56	_321_347	0,0344
31.05.2017	00:45:21.36	384_381_324	0,0343
31.05.2017	01:39:12.08	_324_345_365_384_381_345	0,0347
31.05.2017	21:52:30.42	_351_801_361	0,0333
31.05.2017	23:20:29.75	_372_364_347_315	0,0438
01.06.2017	22:33:31.31	_000354_000326_000311_000314	0,0472
08.06.2017	22:50:56.35	_000323_000802	0,0368
09.06.2017	22:17:19.12	_000368_000342	0,0583
09.06.2017	22:59:31.00	_000367_000344_000388_000367	0,0376
10.06.2017	23:25:00.49	_000323_000349	0,0598
10.06.2017	23:25:44.89	_000345_000365_000395	0,0336

[5] MPEC 2017-L52

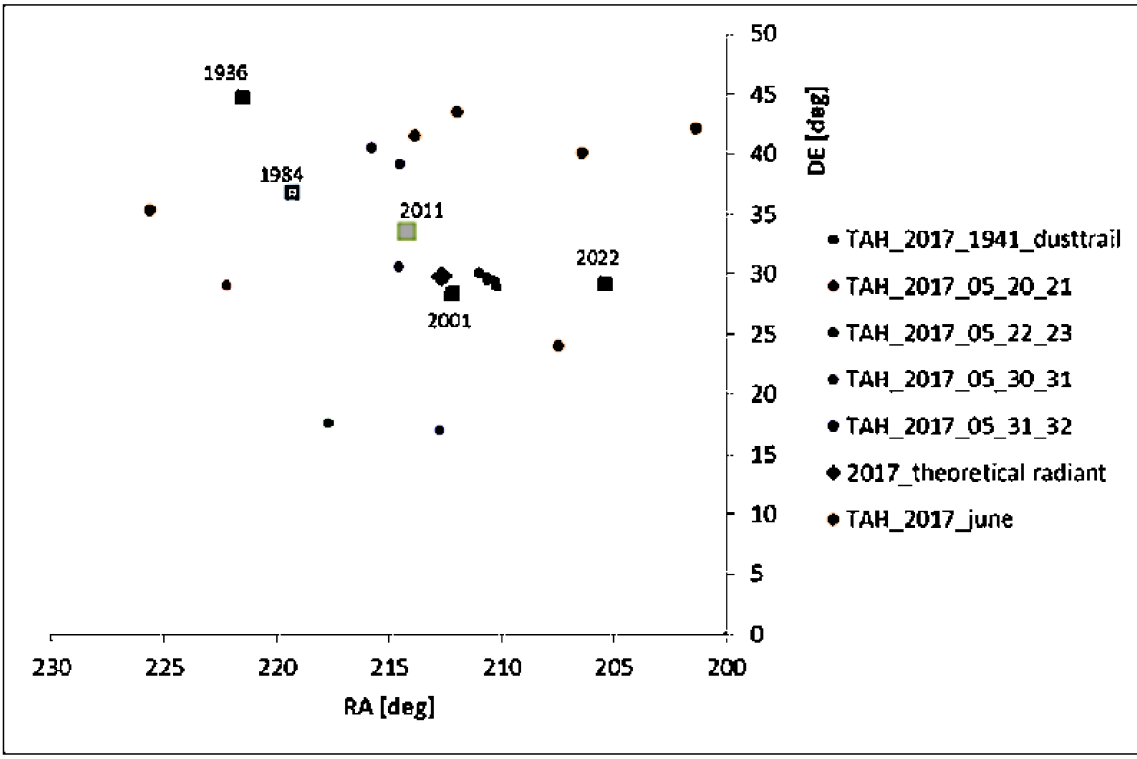

Figure 1 – Plot of the radiants of the 5 tau Herculids (TAH) of the 1941 dusttrail, the remaining tau Herculids, and the predicted radiant of the years with significant meteor activity.

Figure 1 shows the radiant of these meteors (shown as dots). Also presented, the predicted radiant positions of years in which TAH activity could be expected, as well as years in which some activity was recorded according to Lüthen, Arlt and Jäger (2001).

Table 2 – Maximum and minimum, mean and median values for radiant, geocentric speed and a number of orbital elements of the five tau Herculids (of the 1941 dust trail) recorded in the night of May 30–31 2017.

	2017 May 30–31			
	Min.	Med.	Mean	Max.
RA	210.19	210.56	210.53	210.95
Dec.	+28.89	+29.46	+29.51	+30.02
V_g	11.69	11.87	11.97	12.34
q	0.9893	0.9896	0.9898	0.9904
e	0.6415	0.6585	0.6606	0.6883
i	11.24	11.39	11.51	11.87
Π	269.34	269.46	269.43	269.51
H_{begin}	90.14	90.65	90.66	91.08
H_{max}	85.4	87.6	87.2	88.3
H_{end}	79.83	82.23	82.88	86.35

The concentration of the five tau Herculids originating from the 1941 dust trail and their proximity to the theoretical radiant predicted by Lüthen et al. (2001) is significant. The fact that the comet had several close passages to Jupiter in the past explains the rather large spread on the radiant positions in the separate years included in the plot. Besides that, the radiant is situated near the antapex in Hercules, therefore any small changes in the orbit result directly in large changes in the radiant position.

The similarities between the five tau Herculids of the 1941 dust trail are represented in *Table 2*, including the minimum, maximum, mean and median value for several orbital elements.

This result is the second successful confirmation of tau Herculids activity by CAMS. In 2011, when CAMS California was being started up, it recorded in total 12 meteors, among which 3 tau Herculids, on 2 June between 4^h00^m and 12^h13^m UT. These three meteors had a radiant position RA = 215.5 ± 0.4 degrees and Dec. = 34.0 ± 0.6 degrees[6].

Also in that year prediction and observation coincide to a large extent with less than 1 degree deviation of the radiant position in the prediction of possible activity on 2 June at around 5^h45^m UT (*Figure 1*) (Lüthen et al., 2001). The same article refers to the year 2022 too. According to, amongst others, Vaubaillon and Brown (Wiegert et al., 2005) a sort of 'diluting' effect on the density of the older dust trails can be observed, as these will probably be rather extended by then.

With the necessary premises based on the past (among others about the ZHR in 1930) they come to a ZHR score

[6] CBET 2817

of maximum 10 for the dust trails of 1892 and 1897. However, according to Lüthen, Arlt and Jäger (2001) the rather recent dust trail of 1995 is the one being closest to Earth. There is a good chance that this is a dust trail with a higher dust density as a result of the fragmentation of the comet into at least four pieces in 1995.

Besides that, the calculated distance between the 1995 dust trail and the Earth is, in that year, a lot smaller than in all the previous cases. In Maslov[7] we see, because of this reason, two peak moments for 2022.

The first peak, with a ZHR of some dozens, on 31 May 2022 at around 3^h11^m UT, caused by older dust trails, and a more substantial peak with regard to the 1995 dust trail at around 5^h15^m UT with a ZHR score of 600–700, possibly rising into the thousands. To conclude, *Figure 2* shows a plot of the orbital elements Π versus i for the complete dataset of tau Herculids.

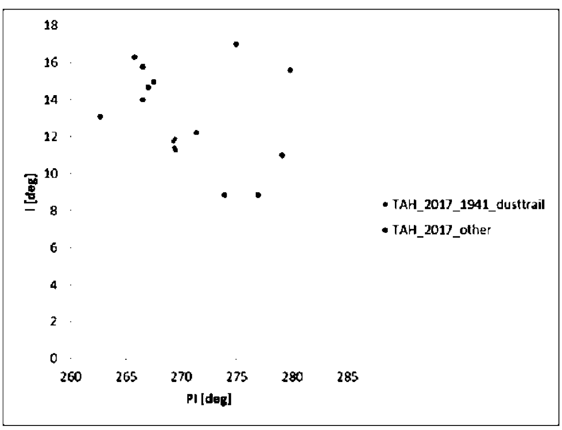

Figure 2 – Plot of Π versus i for the meteors discussed.

2 Conclusion

In the last decade of May 2017 and the first decade of June, 17 tau Herculids could be recorded. The close coincidence between the radiant position and the predicted value for activity of the 1941 dust trail in 2017 (Lüthen et al., 2001) is significant for five tau Herculids recorded in the night of 30–31 May.

Moreover, the remaining orbital elements and the light curves show a very similar picture. After 2011, 2017 is the second year in which activity of tau Herculids could be recorded, conform the predictions.

The predictions for 2022 currently vary between a ZHR score of ~10 and several thousands, depending on which dust trail is being considered. Hopefully, over the next few years, the model makers will be able to make a more reliable prediction about the activity in that year, especially for the dust trail of 1995.

In the period of 2000 up to and including 2014, only few tau Herculids were observed visually each year by Dutch observers.

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[7] http://feraj.ru/Radiants/Predictions/73p-ids2017eng.html