II.

Radiants of Meteors observed in August, 1920 and 1921, at Tashkent.

Discussed by **E. Öpik.**

Simultaneously with the Double-Count observations (see *T.P.* 25_1 and the preceding paper) meteors were traced on the map. From the maps the following radiants were deduced. A *computed* radiant means the centre of gravity of the intersection-points, computed as the mean of their coordinates (only meteors making an angle greater than 30^0 being used); an *estimated* radiant is the estimated centre of the area of radiation.

a) In 1920 the observations were made by Mr. P. J. Davidovitsch, at Tashkent ($\varphi = 41^0.3$; $\lambda = 4^h37^m E$) and by Mr. G. P. Zacharov at Iskander (46 kilom. towards *NE* from Tashkent). The observations were made during 3 hours, with the mean moment at $13^h.5$ Tashkent mean time on each night. The computations were made chiefly by Mr. J. E. Gorshenin. For each night only one mean radiant was determined, and only *Perseids* were considered. The results were:

Table 1.

Radiants of Perseids in 1920.

By Mr. Davidovitsch				By Mr. Zacharov.			
Date 1920.	Mean Radiant Computed. α 1855	δ	n	Date 1920.	Mean Radiant Computed. α 1855	δ	n
Aug. 7 and 8	$38^0.6$	$53^0.2$	12	Aug. 7 and 8	$37^0.6$	$57^0.9$	10
„ 9	46.3	56.5	16	„ 9	37.5	53.8	12
„ 10	40.7	55.3	18	„ 10	42.6	55.6	15
„ 11	42.2	56.2	33	„ 11	43.1	55.0	27
„ 12	44.6	56.0	17	„ 12	42.0	55.2	20
„ 13 „ 14	43.6	56.4	15	13	39.7	55.5	13

The number of meteors used in the derivation of the radiant is denoted by n. The average deviation of the single meteors from the mean radiant was about $\pm 1^{0},5$. The mean radiant from all days, $\overline{\alpha} = 44^{0}$; $\delta = 56^{0}$ (1920) was used in the computation of the Normal Horary Numbers of the Perseids in $T.P.25_{1}$.

b) In 1921 the observations were made by Mr. Davido-

Table 2.

Radiants of Perseids in 1921.

Chart and №		Mean Date (Gr.M.T.) Aug. 1921	Tash-kent M. T.	Radiant computed α 1855.	δ	Number of Meteors Used	Rejected	Mean Zen. Magn.	
I	1	7.85	$13^{h}.0$	$41^{0}.0$	$52^{0}.9$	10	1	2.3	Aug. 7 and 8 combined
	2	8.00	13 .6	35 .7	57 .5	16		2.6	
II	3	9.35	12 .9	44 .5	53 .7	7	2	2.2	
	4	9.34	12 .8	36 .5	58 .1	9		2.5	
III	5	10.36	13 .3	40 .6	56 .2	15	3	2.3	Separate Radiants not distinct enough.
IV	6	11.30	11 .8	42 .4	54 .8	10	4	1.6	
	7	11.30	11 .8	42 .4	58 .6	13		1.6	
V	8	11.32	12 .3	38 .1	55 .7	21	5	1.9	
	9	11.32	12 .3	31 .6	59 .5	6		1.7	
VI	10	11.34	12 .9	37 .1	56 .1	23	6	2.1	Separate Radiants not distinct enough.
VII	11	11.36	13 .3	36 .7	54 .9	12	7	2.0	
	12	11.36	13 .3	32 .8	59 .9	11		1.7	
VIII	13	11.39	13 .8	40 .4	56 .6	14	8	2.4	
	14	11.39	13 .8	34 .6	55 .2	14		2.4	
IX	15	11.40	14 .2	40 .7	57 .5	7	9	2.0	
	16	11.40	14 .2	34 .7	56 .9	15		2.7	
	17	11.40	14 .2	30 .4	53 .1	6		2.8	
X	18	12.37	13 .5	41 .4	56 .5	9	10	2.6	
	19	12.37	13 .5	36 .8	56 .0	25		2.3	
	20	12.36	13 .3	34 .3	58 .2	9		1.9	
XI	21	13.37	13 .4	43 .0	55 .9	14	2	1.9	
	22	13.39	13 .9	39 .7	61 .0	5		2.3	
				Radiant Estimated					
XIII	*23	11.68	13 .5	46 .5	52 .5	13	—	2.1	Aug. 11, 12 and 13 combined.
	*24	11.92	13 .1	54 .0	57 .0	7	—	1.8	
	*25	12.58	12 .6	34 .5	52 .0	4	—	3.0	

vitsch at Tashkent. *All* meteors seen were traced on the map, for the observations should meet the needs of the *Double-Count*; in this way about 460 meteors were traced on the days from the 7th to the 13th August. The computations and other reductions were made by Mr. R. Livländer and Mr. A. Pohla, at Tartu.

The results are contained in Table 2.

The 1st column of table 2 gives the number of the chart in gnomonic projection on which the radiant was determined, and the number of the radiant; the 2nd — the mean date (from Greenwich noon); the 3d — the mean local time; the 4th and 5th — the coordinates of the radiant; the 6th — the number of meteors used in the derivation of the radiant, the 7th — the number of meteors which appeared to be Perseids, but which were rejected because they did not agree well enough with the mean radiant. The 8th column contains the mean *Zenithal Magnitude* of the meteors used in the determination of the radiant.

The great number of observations on August 11 allowed of the independent determination of the radiants for every $\frac{1}{2}$ hour of the observations.

The radiant presented generally an area with two, sometimes three distinct and very pronounced condensations; so it seemed advisable to determine the radiant separately for each condensation; the radiant being the result of computation (except for № 23, 24, 25), a subjective error could enter only through the choice of the meteors, not through the estimate of the centre. The choice of the meteors belonging to each radiant was made independently for each chart after a thorough discussion, with the purpose in view of excluding *apparent* intersection-points and false radiants.

The radiants № 23, 24, 25 resulted from meteors rejected on August 11, 12 and 13 because they did not agree with the principal radiants of the day; the first two indicate real centres of radiation with a relatively small number of meteors, whereas № 25 is, probably, illusory.

The subdivision of the radiants found must be real; sometimes a striking anology exists between them, as in the pairs of radiants № 1 and 2 (Aug. 7, 8); № 3 and 4 (Aug. 9); № 21 and 22 (Aug. 13). On the day of maximum a very complicated character of the area of radiation is indicated, and the a comes

out rather too low, if compared with the average value for the Perseids found by other observers.

For comparison in table 3 the *estimated* centres of the entire area of radiation for each chart are given, without any subdivision into the separate radiants. The mean radiant $\alpha = 40^0$, $\delta = 57^0$ (1921) was adopted in the reduction of the Double-Count observations.

Table 3.

Mean Radiants of Perseids, August 1921.

	Chart	I	II	III	IV	V	VI	VII	VIII	IX	X	XI
Centre of Area	α 1855.	38⁰	41	40	42	37	38	36	37	35	38	40
	δ	56⁰	56	56	57	57	56	58	56	56	56	57
Date		Aug.7,8	Aug. 9	Aug.10	Aug. 11						Aug.12	Aug.13

Mean Radiant Aug. 7—13 . . . $\alpha = 38^0.4$; $\delta = 56^0.5$ (1855) or $\alpha = 39^0.5$; $\delta = 56^0.8$ (1921).

The Non-Perseids and the rejected Perseids were treated together, the observations of Aug. 7—10 and 11—13 being traced on two gnomonic charts; for about $\frac{2}{3}$ of the meteors centres of radiation were found. The results are contained in table 4.

Table 4.

Radiants of Non-Perseids and rejected Perseids.

№	MeanDate (G.M.T.) Aug. 1921	Tash-kent M.T.	Chart XII Radiant Estimated 1855 α	δ	$\Delta\alpha$	$\Delta\delta$	Number of Meteors used August 7	8	9	10	Total	Mean Zen. Magn.	Zenithal Magn. of single Meteors
26	8.42	12h.6	352⁰.5	28⁰.5	4⁰.5	3⁰.5	3	5	2	1	11	3.3	3.0; 2.4; 3.1; 3.8; 3.4; 3.7; 4.0; 3.8; 2.6; 3.6, 3.2.
27[1]	8.79	12 .9	339 .5	40 .0	3 .0	4 .5	1	4	3	1	9	3.4	2.9; 3.4; 4.7; 3.3; 2.0; 4.4; 2.7; 3.4; 3.4.
28	9.36	13 .2	22 .5	38 .5	4 .5	3 .0	0	3	1	3	7	2.8	3.3; 2.3; 2.4; 1.9; 3.6; 3.0; 3.3.
29	9.35	13 .1	8 .0	45 .0	5 .0	4 .0	0	1	2	1	4	2.9	2.6; 3.4; 3.9; 1.6.
30	9.48	13 .2	45 .5	45 .5	6 .0	4 .5	0	2	3	3	8	2.0	2.8; 3.2; -0.2; 2.6; 4.4; 3.1; -0.9; 0.6.
31	9.09	12 .8	53 .0	76 .0	15.	3 .0	1	1	5	1	8	1.4	1.2; 0.1; 0.9; 1.8; 1.8; 1.6; 1.2; 2.8.
32	9.79	13 .2	2 .0	57 .5	4. 0	3 .0	0	0	4	3	7	3.6	3.8; 3.8; 3.0; 3.4; 3.3, 4.1; 3.6.
33	8.38	13 .6	62 .5	54 .5	5 .0	3 .0	1	3	1	0	5	1.3	0.5; 1.7; 1.5; 1.3; 1.7.

1) Very short meteors.

Table 4. Continued.

№	Mean Date (G.M.T.) Aug. 1921	Tash-kent M.T.	Chart XIII Radiant Estimated α	δ	Δα	Δδ	Number of Meteors used August 11	12	13	Total	Mean Zen. Magn.	Zenithal Magn. of single Meteors
34	12.37	13h.4	350°.0	+32°.0	4°.0	3°.0	2	4	2	8	3.1	2.4; 3.3; 3.0; 3.6; 3.0; 3.3; 2.8; 3.2.
35	12.71	13 .2	348 .5	17 .0	3 .0	3 .0	1	1	2	4	2.7	0.4; 3.3; 3.9; 3.3.
36	12.11	13 .3	25 .5	57 .5	5 .0	3 .0	2	0	1	3	1.7	-0.3; 3.6; 1.9.
37	12.33	12 .6	17 .5	46 .0	4 .0	2 .0	1	2	1	4	2.9	3.6; 2.6; 2.0; 3.5.
38[1])	12.06	12 .9	341 .5	47 .5	8 .0	5 .0	4	1	2	7	3.1	3.0; 3.5; 3.0; 3.5; 2.2; 3.1; 3.1.
39	12.63	13 .8	9 .5	18 .5	1 .5	1 .5	0	3	1	4	3.5	4.0; 3.7; 3.6; 2.8.

Radiants 23, 24 and 25, given in table 2, were determined from the same chart.

The table is self-explanatory; $\Delta\alpha$ and $\Delta\delta$ mean the diameter of the area of radiation, the $\Delta\alpha$ being *not* converted into degrees of the great circle. In the derivation of the radiants only the *direction* was taken into account, and in several doubtful cases the apparent length of path was considered, to decide the probability of a meteor belonging to a certain radiant. It is surprising to note, that the radiants obtained in this way generally contain meteors of a very limited range of Zenithal Magnitude, and that the *mean* Zenithal Magnitude of the meteors traced upon the chart is thus a definite characteristic of the radiant. As striking examples of this phenomenon radiants № 31 and 33 (bright meteors) and № 26 and 32 (faint meteors) of table 4 may serve. The phenomenon is the same as noted by *Denning* and other observers that each radiant has its own characteristic most frequent magnitude (as well as the length of path, colour etc): the only difference is that the Zenithal Magnitudes will probably agree more closely than the apparent magnitudes. Thus the mean Zenithal Magnitude and its uniformity can serve as a valuable criterion of the reality of the radiant found. If the meteors classified to some radiant show Zenithal Magnitudes varying within restricted limits, the radiant can be assumed as real, especially if the average brightness is

1) Short meteors.

high: in this case such a small number as only 4 meteors can indicate a radiant with certainty.

Taking into account this circumstance, we may conclude, that the majority of the radiants of table 4 are real. Radiant № 36 is probably illusory; № 35 is somewhat doubtful. The following radiants seem to be related with one another: № 27 and 38; 26 and 34; 29 and 37.