CLUSTERING OF PARTICLES WITHIN METEOR STREAMS

V. PORUBČAN

Astronomical Institute of the Slovak Academy of Sciences,
Bratislava, Czechoslovakia

Abstract. A number of visual and radar data analyses dealing with the time distribution of meteor particles within the meteor population is presented and checked. A verification of those claiming a non-random distribution of meteors showed that there is no real grouping of meteors within the permanent meteor streams or within the sporadic background over a random level. On the other hand, analyses of young streams, the Giacobinids 1946 and the Leonids 1969 showed that meteors within these streams tend to cluster into pairs or larger groups more frequently than one can infer for a random distribution.

1. Introduction

The micrometeoroid impact experiment on the HEOS 2 satellite (Hoffmann et al., 1975) showed the possibility of a clustering of dust particles into larger groups. As for the larger particles such as meteors, there is a strong conviction maintained by many observers that meteors within the streams are observed to be clustered in pairs or larger groups more frequently than one could expect from chance distributions. Attempts to verify the reality of this impression using exact statistical tests have already been made by several authors. Nevertheless, it appears that there is still no general consensus on the interpretation of the results.

According to the place of fragmentation, two kinds of meteor complexes can be distinguished:

(a) Groups of meteors generated outside the atmosphere, somewhere in interplanetary space or in the Earth—Moon system (lunar ejecta) before the interaction with the atmosphere.

(b) Groups generated within the atmosphere as a result of an interaction with it.

The meteor phenomenon itself betrays frequent progressive fragmentation of the meteoroids in the atmosphere. This source of small and dense meteor groups or clusters seems to be a common feature for larger bodies. For smaller bodies it is less pronounced, and for faint radio meteors one can infer that only about 2% of echoes are produced by particle clusters in the atmosphere (Novoselova, 1971). Meteors fainter than magnitude +5 are produced by single solid grains, according to Poole and Kaiser (1967).

In this paper only groupings of type (a), produced by fragmentation of meteoroids outside the atmosphere will be discussed.

2. Analyses Based on Visual Observations

The first analyses dealing with this problem were based on visual observations of the major meteor showers, which only have frequencies sufficient for statistics. The Andromedids were examined by Kleiber (1888). After an analysis of 164 events he concluded that about 14% of them appeared in pairs. However, further analysis of his data with different sampling intervals revealed contradictory results (Kresák and Vozárová, 1953). A comparison of Kleiber's observational data with those expected from the Poisson distribution, evaluated by the chi-squared test gives the probability of 0.14 which exceeds the 5% rejection level.

The Leonids were studied by Millman (1936) who, by comparing the observed and theoretical distributions of time intervals between successive meteors, obtained negative results for this stream.

Most analyses of visual observations have been devoted to the Perseids. Subbotin analysed the 1928 apparition (2920 meteors) and in a plot of one-minute rates the Perseids appeared as a series of groups extending over a few minutes each (Astapovich, 1958). This phenomenon has been reported by other observers as well, and was attributed to the non-random distribution of the Perseids. Interesting simultaneous observations of this shower on a long base-line of about 4000 km were organized in 1950 and 1951 at the observatories of Stalinabad, Ashkhabad, Abastumani and Odessa.

According to the analysis of these data by Savrukhin (1951), the Perseids were composed of separate meteor clouds of different size. Some of them were spread over ten seconds, i.e. a few hundred kilometres, but the larger ones had dimensions of several thousand kilometres at least. There were no strong accumulations, however, as most of the clusters were within the margins of expected random fluctuations.

Results slightly in favour of a non-random grouping of the Perseids were obtained by Millman (1936), by a study of the distribution of time intervals. Agazdanova (1951), using observations of 421 Perseids obtained during 382 minutes of observation in 1950, found that the distribution of one-minute counts of meteors largely differed from the theoretical Poisson distribution. However, during such a long period of observation there should appear an appreciable progressive change of meteor rates, simulating departures from randomness. Moreover, a probability of 0.07 resulting from a comparison of observation and theory is still over the 5% rejection level. On the other hand, a thorough analysis of the 1952 Perseids (1037 meteors recorded during 21 hours of observation) by Kresák and Vozárová (1953) showed that the distribution of meteors within this stream was random.

An unusual distribution of the Perseids from the photographic data appeared on August 12, 1972 (Russell, 1973). Of the nine spectra photographed during 7-hour period, in a continuous succession of 10-minute exposures, seven were recorded within one hour, and the other two spectra 4 hours earlier 20 minutes apart. Russell found the probability of seven events in one hour being random, 0.0003.

But, it is not possible to consider these as a close group of meteoroids, for a mean distance among them at the velocity of Perseids exceeds 2.5 times the Earth's diameter.

3. Analyses Based on Radio Observations

Relevant results based on radio measurements are much more conclusive, since the statistical samples are generally more extensive and the instant of apparition can be determined with a higher accuracy.

A number of analyses of radar echo records, obtained at different stations with different instrumental equipment, have already been devoted to this problem. Although most of them were primarily concerned with the major meteor streams, some included sporadic meteors as well. A list of these analyses is presented in Table 1. A common feature of all these analyses, except of Nos 8 and 9, is that there was no non-random grouping of meteors within the streams and sporadic meteors over a random level. The only positive results are those of McCrosky (1957) and Wylie and Castillo (1956),

Table 1. List of radar data analyses searching for non-random grouping of meteors

Authors	Freq. (Mc/s)	Date	Shower	Total time (min)	Meteors	D	Accur. (s)
Bowden, Davies (1957)	72	Sept.—Nov., 48	—	2400	537	~270	30
Briggs (1956)	50	June 8—9, 55	—	120	421	17.1	0.05
		July 27, 55	—	60	280	12.9	0.05
Porubčan (1968)	37.5	Dec. 11—13, 59	Gem	1140	7406	9.2	1
		Dec. 14, 61					
Bowden, Davies (1957)	36	Aug. 9—10, 54	Per	480	2598	11.1	0.1
		Aug. 16—18, 56	—				
Porubčan (1968)	20	Apr. 22, 64	Lyr	141	5329	1.6	1
		Sept. 3, 65	α—β Per	139	8534	1.0	1
		Sept. 17, 65	L Aur	52	4325	0.7	1
		Oct. 21, 65	Ori	113	5855	1.2	1
		Oct. 28, 65	—	20	1175	1.0	0.1
Shain, Kerr (1955)	18.3	Apr.—May, 47	—	—	—	—	0.1
Poole (1965)	17	Aug. 10—12, 62	Per	—	~2500	—	1
McCrosky (1957)	32.8	Aug. 12.48	Per	120	2413	3.0	1
		Dec. 12, 48	Gem	120	3001	2.4	1
		May 27, 49	—	150	1566	5.7	1
Wylie, Castillo (1956)	20	—	—	—	—	—	—

(see Bowden and Davies, 1957). The last columns of the table contain particular probability characteristics, obtained by the individual authors for the three relevant methods of analysis: the Poisson distribution of meteor rates, the exponential distribution of time intervals, and a serial correlation of time intervals. The table lists the resulting probabilities p of the irregularities in the observed distribution being at random. With no clustering, an average value of $p = 0.5$ would have to be expected; a conservative rejection level, mostly used in statistical tests, is $p = 0.05$, i.e. one case out of 20. The Poisson distributions have been searched by different authors, for five sampling intervals: 0.1, 1, 5, 10 and 30 seconds. The estimates obtained by the chi-squared test for the data analysed by Briggs (time distribution) and Poole (Poisson distribution) are approximate estimates from the figures in their original papers, as the numerical data have not been published. The figures given in italics represent median values from a set of distributions. For two analyses (Shain and Kerr, 1955 and Wylie and Castillo, 1956) quantitative values of the estimates of the observed distributions are missing entirely.

Results of the first seven analyses show that in all cases the departures of the observed distributions from the theoretical ones were no greater than expected from statistical fluctuations. As for the Poissons distributions, in all cases of sampling intervals between 30 and 0.1 seconds the probability of the distribution being random is greater than 0.20. For the time distributions the probability is everywhere greater than 0.10 except for the two distributions obtained by Poole (1965), one of $p = 0.03$ and the other of $p < 0.01$. This is possibly caused by the timing accuracy being inconsistent with the high frequency of meteors. Corrections of this effect may be quite considerable in similar cases (Porubčan, 1968).

Of the two inferences claiming the reality of grouping, the first one reported by Wylie and Castillo is lacking accurate quantitative data. These authors have found a significant excess of 30-second sampling intervals, containing five or more echoes, over the number expected from the Poisson distribution (Bowden and Davies, 1957). But, Bowden and Davies believe that the equipment of Wylie and Castillo was not capable of distinguishing satisfactorily between fluctuating echoes and close groups, and that this has led to an excess of apparent groups in their results.

The second possible evidence of grouping has been put forward by McCrosky (1957), who analysed the data published by McKinley (1951). These observations are from three nights in 1948—1949; two of them are from the maxima of the Perseids and Geminids and the third one is a sporadic night. The data include a total of 6980 meteors, and the number of one-second and half-minute intervals was compared with the expected one, determined by the Poisson distribution.

Poisson distr., sampling intervals (s)					Time distr.	Correlation
0.1	1	5	10	30		
—	—	—	—	0.3	0.8	−0.044 ± 0.045
—	—	—	—	—	—	0.130 ± 0.060
—	—	—	—	—	0.23	0.110 ± 0.060
—	—	—	0.42	0.77	0.60	0.028 ± 0.020
0.4	—	—	—	—	0.4	−0.036 ± 0.038
—	—	0.32	—	—	0.78	−0.089 ± 0.028
—	0.75	0.48	—	—	0.37	−0.131 ± 0.026
—	—	0.44	—	—	0.30	−0.134 ± 0.015
—	—	0.75	—	—	0.35	−0.100 ± 0.021
—	0.50	—	—	—	0.64	—
—	—	—	—	—	no grouping	—
—	—	0.33	0.33	—	>0.1	0.004 ± 0.036
—	0.0013	—	—	0.54	—	—
—	—	—	—	excess	—	—

(Figures in italics represent median values; D is a characteristic distance among meteors, given in seconds.)

A very low value of $p = 0.0013$ was obtained for the entire data at one-second sampling intervals which suggests that the departures are such that there is a definite excess of observed pairs and triplets.

If the excess of pairs and triplets does really exist, it should appear in the three samples treated separately, too. An examination of the sets of data divided into 30-minute periods reveals that the departures from randomness essentially vanish under these conditions. The median values of the probabilities p obtained for McCrosky's data on the Perseids, Geminids and a sporadic night are 0.47, 0.38 and 0.41, respectively. Therefrom it can be concluded that the positive result was only due to an inadequate combination of data from periods with different levels of average activity, and that the evidence of grouping was a spurious one.

All the preceding analyses, except for the early work of Kleiber on the Andromedids, refer to the observations of permanent meteor showers, i.e. to stream structures in their middle and late evolutionary stages. For all these streams of considerable dispersion (high age), and also for the sporadic meteors, the results seem to be definitely negative. Therefore, an application of a similar analysis to showers of recent origin, the Giacobinids 1946 and the Leonids 1969, where the conditions of the dispersion processes in the earliest evolutionary phases may be different, was desirable.

4. The Giacobinids 1946

The relevant data on the 1946 Giacobinid shower were obtained by a team of visual observers at the Skalnaté Pleso Observatory on the morning of October 10. In spite of poor weather conditions at the time of observation, interfering twilight and full Moon, and a very low altitude of the radiant at the maximum, this meteor display ranks among the strongest ones ever observed, with a peak meteor rate of 6800 per hour (Kresák and Slančíková, 1975). The analysis by these authors showed that the Giacobinid stream consisted of separate layers of enhaced meteoroid densities, and this evidence may indicate a non-random distribution of the particles within this stream.

In spite of the adverse observing conditions the Giacobinids were so numerous that even for the team of experienced observers at the Skalnaté Pleso Observatory it was not possible to keep on exact timing (to the nearest second) for all individual events. This was the case especially around the shower maximum when one-minute counts of meteors were recorded. At the peak of activity, additional meteors seen by individual observers approximately in five-minute intervals were recorded. For this reason a search for non-random groups within this shower had to be constrained to a partial analysis of two intervals of about 20 minutes each, from the increasing and decreasing branch of activity.

The results obtained are summarized in Tables 2 and 3. Since even during the period of increasing activity some meteors with very rough timing were included, an adequate analysis was only possible for counts by individual observers.

Table 2 lists the results for one-minute sampling intervals, where the probability p of observing any group of $i_{\max}$ or more meteors in one minute during the period of observation is given. In the last two columns n_i — number of observed groups of $i_{\max}$ meteors and n — expected number of groups with $i_{\max}$ and more meteors following from the Poisson distribution are listed. A similar analysis for a finer division to one-second samling intervals was possible only for the first period considered (Table 3).

Very low values of probabilities p and the resulting differences among observed and expected numbers of groups in individual cases which are in favour of those observed, indicate a non-random distribution.

It may be conjectured that the deviations from randomness are primarily due to the general trend of activity rather than to clustering effects. However, this is not the case, because the values of $i_{\max}$ tend to appear at considerable distances from the shower maximum. For example, a one-minute interval of $i = 6$ (observers A, C), and of $i = 7$ (observer B) occurs just at 3:20—3:21 UT.

Thus substantional deviations from a random distribution are indicated. Unfortunately, the data available do not allow to judge about the size of the clusters and their relation to the layers detected by Kresák and Slančíková.

5. The Leonids 1969

The Leonid data of the 1969 used in the present analysis were obtained by the Springhill Meteor Observatory high-power radar around the shower maximum on November 17. The radar was operating on 32.8 Mc/s. The maximum in 1969 was not as high as that in 1966, but there was a higher proportion of short-duration echoes (according to the low-power radar data by McIntosh, 1971).

The data analysed completed for the whole curve

Table 2

One-minute intervals						
Observer	Time (UT)	Meteors	$i_{\max}$	p	n_i	n
A	3:18—3:41	50	7	0.70×10^{-2}	1	0.16
B	3:18—3:44	71	8	0.71×10^{-2}	2	0.18
C	3:18—3:44	84	7	0.47×10^{-1}	1	1.22
A	4:00—4:20	36	8	0.56×10^{-3}	1	0.01
B	4:00—4:20	40	6	0.17×10^{-1}	1	0.34
C	4:00—4:20	24	4	0.34×10^{-1}	1	0.68
D	4:00—4:20	23	6	0.12×10^{-2}	1	0.02

Table 3

One-second intervals						
Observer	Time (UT)	Meteors	$i_{\max}$	p	n_i	n
A	3:18:00—3:41:00	50	2	0.64×10^{-3}	2	0.88
B	3:18:00—3:44:05	74	3	0.17×10^{-4}	1	0.03

of activity around the maximum included 14,160 echoes (November 17, 8:30—9:55 UT). The relative echo rates in successive one-minute intervals, uncorrected for the sporadic background, are plotted in Figure 1. The maximum is really a very narrow one, lasting only a few minutes.

Three methods of analysis were used (Porubčan, 1974). In the first the time intervals between

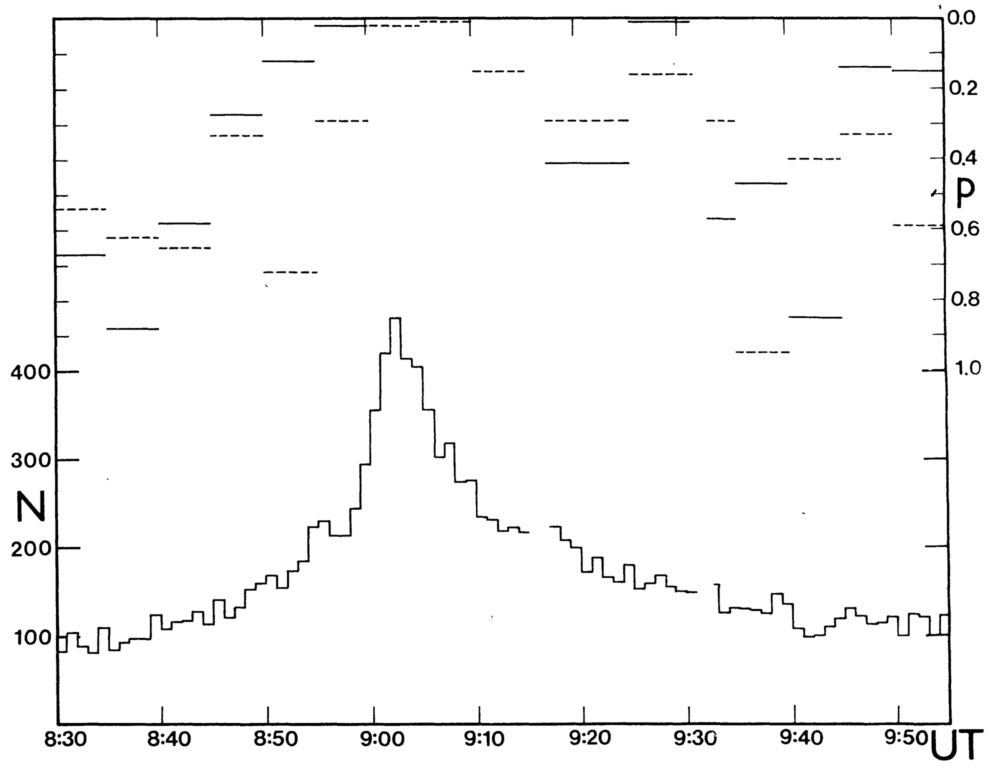

Fig. 1. Changes of echo rates (below) and probabilities resulting from the chi-squared test applied to the time distribution of the echoes (above) in the great Leonid display of November 17, 1969. Dashed lines refer to an exponential distribution of time intervals between successive echoes, full lines to the distribution of echo rates in 0.1-second intervals. The total number of echoes was 14,160 but only those of $R \leq 200$ km were taken into account in computing the probabilities.

successive echoes were noted, and the frequency distribution of these intervals was compared with that expected for randomly appearing echoes, represented by an exponential law. In the second method the data were divided into 0.1-second intervals, and the number of echoes in each interval was noted. The number of intervals containing n echoes ($n = 0, 1, 2, 3, \ldots$) was compared with that expected from the Poisson distribution. The third method is based on the distribution of the slant-range differences between pairs of successive echoes.

To eliminate the steep changes of meteor rates during the observations, the data were divided into successive five-minute sets and those around the maximum were combined into sets of approximately equal one-minute frequencies. As the antenna of the high-power radar at the Springhill Meteor Observatory is omnidirectional, the observed region was confined to a narrower zone by a slant range limitation of the echoes ($R \leqslant 200$ km).

An aplication of the chi-squared test on individual 5-minute sets of echoes of $R \leqslant 200$ km, is shown in the upper part of the figure where the probabilities p are plotted (dashed lines — p from the distributions of the time intervals; full lines — p from the Poisson distributions). Median values of the probabilities p for all the distributions formed are summarized in Table 4. The samples of the first and last line are outside the sharp shower maximum. In the second and third line 5-minute sets and combined sets with approximately equal one-minute frequencies around the shower maximum are given.

Table 4. Median values of probabilities from the chi-squared test

UT	Sets	Time distr.		Poisson distr.		
		All echoes	Echoes of $R \leqslant$ $\leqslant 200$	1.0 s all echoes	0.1 s all echoes	0.1 s of $R \leqslant$ $\leqslant 200$
8:30—8:55	5	0.20	0.62	0.51	0.38	0.58
8:55—9:15	4	0.00	0.08	0.25	0.00	0.00
8:55—9:15	5	0.00	0.27	0.34	0.00	0.01
9:15—9:55	7	0.58	0.33	0.50	0.18	0.41

The third method used, draws on the fact that the mutual proximity of meteors means that they will appear not only within a short time interval, but also within a narrow range of slant ranges. The effect of grouping can be verified by deriving the differences ΔR of the distances between each pair of successive echoes, separately for those which appear within a very short time interval and those for which this limit was exceeded. The reality of grouping should be reflected by an excess in the relative number of small values of ΔR for the short time intervals.

An analysis of this kind, based on all data is summarized in Table 5. The table lists the relative numbers of pairs for different time intervals Δt between successive echoes, distributed according to ΔR. The second column contains the closest pairs and the sixth those with the longest time delays between successive echoes (a random sampling in ΔR). In the last four columns, the relative numbers of different ΔR for $\Delta t = 0$ are compared with those of $\Delta t \geqslant 0.5$ seconds from the whole period (8:30—9:55 UT), and from the data around the shower maximum (8:55—9:15 UT).

It was shown that there is definite evidence against any non-random accumulations of meteors within permanent meteor streams of considerable dispersion. On the other hand, the Springhill observations of the unique Leonid display in 1969 suggest some degree of clustering, which is confined to the core of this young stream.

The deviations of the observed distributions from both the exponential distribution of time intervals and the Poisson distribution of meteor rates are entirely consistent with chance deviations for the ascending and descending branch of the shower activity. However, there is a definite excess in the period around the maximum (8:55—9:15 UT), both for the total of data and for a sample of $R \leqslant 200$ km. The effect is less pronounced for the time distribution with echoes of $R \leqslant 200$ km, we must take into account the effect of blending smaller echoes with larger ones which according to a rough estimate, amounted to about 20% at the maximum.

As the Poisson distributions for the one-second sampling intervals gave negative results, the dimensions of the non-random groups are small; according to the distributions of $\Delta t/\Delta R$ they may be 40 km (last two columns of Table 5). In Table 5, the values for $\Delta t = 0$ and $\Delta R \sim 0$—20 km should be actually even higher because of the blending effect.

An analysis of the Poisson distributions for 0.1 second sampling intervals around the shower maximum (Table 4, third line) shows that a least 10% of the population is associated in close pairs or groups. The width of the region of non-random clustering is comparable with the diameter of the Earth.

This finding may be indicative of a fragmentation

Table 5. Relative occurrences of different values of ΔR for different Δt constructed for all the data (8:30—9:55 UT) and around the maximum (8:55—9:15)

ΔR (km)	Δt for 8:30—9:55 UT							Δt for 8:55—9:15	
	0.0—0.1	0.2—0.3	0.4—0.5	0.6—0.7	>1.0	0.0	⩾0.5	0.0	⩾0.5
0—20	26.2	24.7	22.3	21.8	21.7	23.9	21.0	26.4	23.2
20—40	18.0	17.2	15.7	15.5	15.5	18.6	15.5	19.7	16.8
40—60	15.3	15.2	13.2	15.6	11.6	14.9	13.3	15.4	15.4
60—80	10.4	11.3	12.3	11.8	10.8	11.0	11.0	10.9	10.4
80—100	7.1	8.4	9.4	8.2	9.6	7.9	9.7	7.2	9.4
100—120	6.5	5.9	7.3	6.2	6.0	7.3	7.4	6.0	7.0
120—160	8.9	9.1	10.0	11.1	10.2	9.5	11.3	8.7	9.9
160—200	4.8	5.2	5.4	6.0	8.8	4.8	6.8	4.0	4.8
200—250	2.4	2.5	3.9	3.1	4.6	1.9	3.4	1.6	2.8
250—300	0.4	0.5	0.5	0.7	1.2	0.2	0.6	0.1	0.3
echoes	5665	3671	1924	1105	877	2758	3655	1713	734

process occurring, after the release of meteoroids from their parent comets, in the central region of the stream which is most densely populated.

References

AGAZDANOVA, A. S. (1951): Izv. Turkm. Fil. Akad. Nauk, *1*, 95.

ASTAPOVICH, I. S. (1958): Meteornye yavleniya v atmosfere Zemli. Moskva, 360.

BOWDEN, K. K. R. and DAVIES, J. G. (1957): J. Atmosph. Terr. Phys., *11*, 62.

BRIGGS, B. H. (1956): J. Atmosph. Terr. Phys., *8*, 171.

HOFFMANN, H. J., FECHTIG, H., GRÜN, E. and KISSEL, J. (1975): Planet. Space Sci., *23*, 215.

KLEIBER, J. (1888): Astron. Nachr., *118*, 345.

KRESÁK, Ľ. and SLANČÍKOVÁ, J. (1975): Bull. Astron. Inst. Czech., *26*, 327.

KRESÁK, Ľ. and VOZÁROVÁ, M. (1953): Bull. Astron. Inst. Czech., *4*, 128.

McCROSKY, R. E. (1957): Bull. Astron. Inst. Czech., *8*, 1.

McINTOSH, B. A. (1971): IAU Colloquium 13 (Evolutionary and Physical Properties of Meteoroids, Ed. C. L. Hemenway, P. M. Millman and A. F. Cook). NASA SP-319, 193.

McKINLEY, D. W. R. (1951): Astrophys. J., *113*, 225.

MILLMAN, P. M. (1936): J. Roy. Astron. Soc. Can., *30*, 338.

NOVOSELOVA, N. V. (1971): Astron. Ves., *2*, 112.

POOLE, L. M. G. and KAISER, T. R. (1967): Planet. Space Sci., *15*, 1131.

POOLE, L. M. G. (1965): Bull. Astron. Inst. Czech., *16*, 364.

PORUBČAN, V. (1968): Bull. Astron. Inst. Czech., *19*, 316.

PORUBČAN, V. (1974): Bull. Astron. Inst. Czech., *25*, 353.

RUSSELL, J. A. (1973): Astrophys. J., *184*, 1017.

SAVRUKHIN, A. P. (1951): Astron. Tsirk., Kazan, *121*, 9.

SHAIN, C. A. and KERR, F. J. (1955): J. Atmosph. Terr. Phys., *6*, 280.

GRUPOVANIE ČASTÍC V METEORICKÝCH ROJOCH

V. PORUBČAN

Astronomický ústav Slovenskej akadémie vied, Bratislava,
Československo

Súhrn

V práci sa analyzujú vizuálne a radarové pozorovania meteorov a výsledky získané rôznymi autormi týkajúce sa časového rozloženia častíc v meteorických rojoch. Overenie tých pozorovaní, ktoré poukazujú na nenáhodné rozloženie meteorov v čase ukazuje, že nie je reálne grupovanie častíc do tesných skupín (dve a viac častíc) vo vnútri stálych a vývojove starších meteorických rojov a v sporadickom pozadí, nad hladinu náhodnosti. Z tohto hľadiska nenáhodné grupovanie možno hľadať jedine pri mladých meteorických rojoch, čo by pri jeho reálnosti mohlo poukazovať na postupný rozpad meteorických častíc po opustení materskej kométy.

Na overenie tejto možnosti v práci sa analyzujú dva mladé roje: Giacobinidy 1946 (vizuálne pozorovania zo Skalnatého Plesa) a Leonidy 1969 (radarové pozorovania zo Springhillu). Pretože pre vysokú frekvenciu v maxime Giacobiníd nebolo možné zachytiť presný časový záznam meteorov, spracované sú dva 20-minútové úseky z obdobia pred maximom a po maxime. Zistené pravdepodobnosti výskytu najvyššieho počtu pozorovaných meteorov v minútových a sekundových intervaloch pre jednotlivých pozorovateľov poukazujú na grupovanie častíc v tomto roji nad náhodnú hladinu (tabuľky 2 a 3). Analýza Leoníd 1969 rozšírených oproti predchádzajúcej práci (Porubčan, 1974) o celú zostupnú časť aktivity (45 minút, 5129 meteorických ozvien), potvrdzuje výskyt nenáhodných dvojíc a viacnásobných skupín meteorov iba v úzkom centrálnom pásme aktivity tohto roja (obr. 1, tab. 4 a 5).

ГРУППИРОВКА ЧАСТИЦ В МЕТЕОРНЫХ ПОТОКАХ

В. ПОРУБЧАН

Астрономический институт Словацкой Академии Наук, Братислава,
Чехословакия

Резюме

Приводится и проверяется ряд анализов визуальных и радиолокационных данных разных авторов, относящихся к временному распределению частиц в метеорных потоках. Проверка тех, которые свидетельствуют о неслучайном распределении метеоров показывает, что реальная группировка метеоров до близких групп (две и больше частиц) в регулярных метеорных потоках и в спорадическом фоне над уровнем случайности, не существует. С этой стороны, неслучайную группировку можно искать только в молодых метеорных потоках, что при её реальности бы могло показывать на постепенный распад метеорных тел по опускании кометы родоначальницы.

Для проверки этой возможности приводится анализ двух молодых потоков: Джакобинид 1946 (визуальные наблюдения из обсерватории Скалнате Плесо) и Леонид 1969 (радиолокационные наблюдения из метеорного обсерватория Спринггилл). Вследствие высокой численности во время максимума Джакобинид не было возможно получить точную временную регистрацию метеоров, для того обработанны два 20 минутные записы из периода перед о после максимума. Вероятности наличия самого большого числа наблюдаемых метеоров в минутных и секундовых интервалах для каждого наблюдателя показывают на неслючайную группировку частиц в этом потоке (таблицы 2, 3). Анализ Леонид 1969 (Порубчан, 1974) разширенный о целую область падения активности (45 минут, 5129 метеоров), потверждает наличие неслучайных пар и больших групп метеоров только в самой центральной области активности потока (рис. 1, табл. 4, 5).