STRUCTURAL PECULIARITIES OF THE QUADRANTID METEOR SHOWER

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Systematic radio observations to investigate the Quadrantid meteor shower structure are regularly carried out in Tajikstan. They have now been conducted annually in the period of its maximum activity (January 1-6) by the Gissar Observatory since 1966.

The paper provides the latest results of these investigations on the basis of 1981-1984 data obtained using new equipment with a limiting sensitivity of $+7.7^m$ which make it possible to draw some conclusions on the Quadrantids shower structure both for transverse and lengthwise directions.

Since 1981, meteor radar observations in Dushanbe have been carried out by using the MIR-3 radar whose principal parameters are: wavelength 8m, repetition frequency 500 pps, pulse duration 40 µs, passband of receivers 50 kcs, peak pulse power in each of two directions 15-20 kW, and minimal detection level 4µv.

Identical transceiving antennas - five-element arrays oriented simultaneously westward and southward with a maximum gain coefficient of G_r = G_T = 13 at an elevation angle of 45° are used.

As on-line M-6000 computer records average hourly rates of radiometeors as well as their durations and range distributions along with the individual levels of each parameter in each direction.

Fig. 1 shows the variations of the number of radiometeors on the nights from January 1 to 2, 3 to 4 and 5 to 6, 1984. Considering radiometeors recorded on the nights of January 1 to 2 and 5 to 6 as a purely sporadic background, the activity of the Quadrantids on January 4 is clearly marked within the period of 20:00-03:00 UT in the westward direction while for the southward direction it is in the intervals are obtained by simple subtraction of the extrapolated rate of sporadic meteors from the total meteor number.

Fig. 2 gives the 1966-1984 curves of the hourly rate variation of all Quadrantid radiometeors with a reflection duration $\tau \geq 0.01s$ and of meteors with $\tau > 1$ sec as a function of solar longitude.

A rather symmetric shape of the curves and discrepancy between the maximum of the combined meteor rates (λ_0 = 282°, 62) and that of radiometeors with $\tau > 1$ sec (λ = 282°, 76) is of great interest. The latter, just as with the Geminids occurs a little later than the total rate maximum does.

To study the cross-structure of the Quadrantid meteor shower, solar longitudes corresponding to the maximum density of meteor flux of a certain radio magnitude were determined for those years when a sharp peak of activity occurred within the middle of a radio observation interval. The
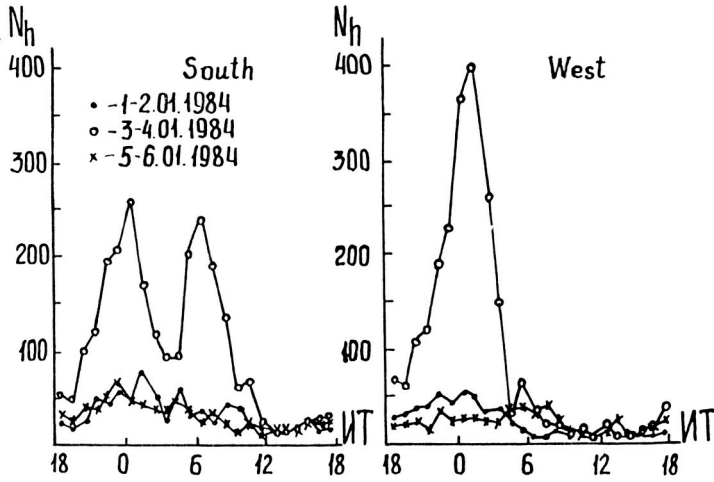
Fig. 1 The radiometer rate variation at the epoch of the
        Quadrantid shower activity on January 1-2, 3-4, 5-6,
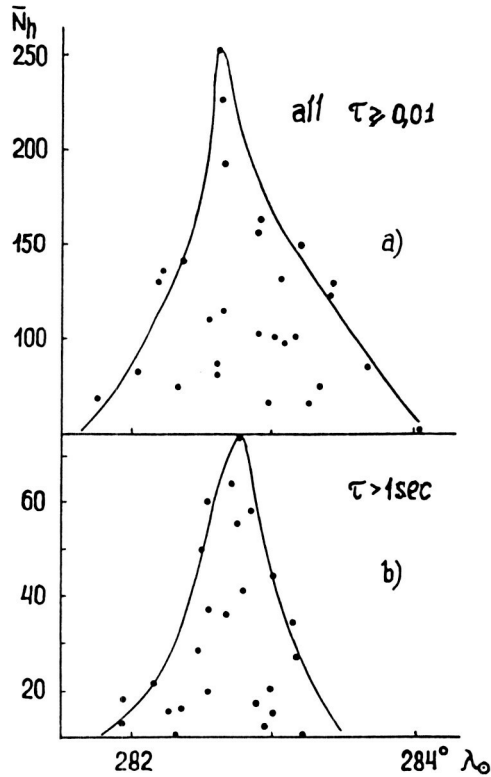   1984.

Fig. 2 The curves of the Quadrantid maximum activity for
        1966-1984 (minus sporadic background).

resulting dependence is presented in Fig. 3 and correlates well with a similar finding by ISAMUTDINOV (1983). In the linear approximation, this dependence can be expressed as

$$L_o = 282°,71 - (0°,02 \pm 0,01) M_r$$

where L_o is the solar longitude and M_r the radiometeor magnitude.

Two more dependences characterizing the shower's cross-structure are given in Fig. 4. It represents the dependence of the average over a number of years of the flux density of particles Q km^{-2}h^{-1} (with a mass over 10^{-3} g) and the parameter "s" (index of mass flux) on solar longitude. The dependences were derived by taking into account known ionic quenching processes. The derived values Q (> 10^{-3} g) = 0.1 particle km^{-2}h^{-1} exceed by about one order of magnitude similar values obtained from radar observations in LEBEDINETS (1970), HUGHES and TAYLOR, (1977), and ANDREEV, et al., (1982) but within 10 per cent of the value obtained by BELKOVICH, et al., (1982). The maximum flux density of the particles falls at solar longitude λ_o = 282°,62 and the parameter "s" minimum - occurs at λ_o = 282°,76, which is in good agreement also with the results of Hughes and Taylor, (1977).

A considerable variety of values Q and "s" for the same solar longitude proved to be caused by the annual variations i.e., by the length-wise inhomogeneity of the stream. Therefore, based on the analysis by HUGHES and TAYLOR (1977), we assumed that the Quadrantides stream revolution period is 4.4 years. This was done in order to estimate the stream structure along its axis and investigated the variations of parameters Q and "s" on the basis of our 18-year observations. The interval of solar longitudes covered was from 282°0 to 283°3.

Fig. 5 (where 360° = 4.4 years) gives the changes of the averaged values of Q̄ and "s̄" along the orbit stream. The averaging was performed for areas of 20°x0.06 for Q and 20°x0.4 for "s" parameter. It is worth noting that each area had 3 or 4 values of both Q and "s", and the deviations from the average value did not exceed ±0.02 to ±0.13 along the ordinate and ±10° along the abscissa. It is clearly seen that the variation of stream parameters along the orbit occurs with periods of about 4.4 years and 1 year. The maximum deviation from the average value is ±50% for Q and ±7% for "s". Although measurement errors are possible, inhomogeneous particle distribution along the stream orbit may also be the cause. This is all the more so, since the increase of particle flux density in 7 out of 9 cases corresponds to the parameter "s" decrease (usually observed in streams). Besides, it is necessary to note that since the stream orbit is close to that of Jupiter, a deflection of orbit stream with a period of 1,077 years is possible. Probably this is just the phenomenon that we seem to observe.

References

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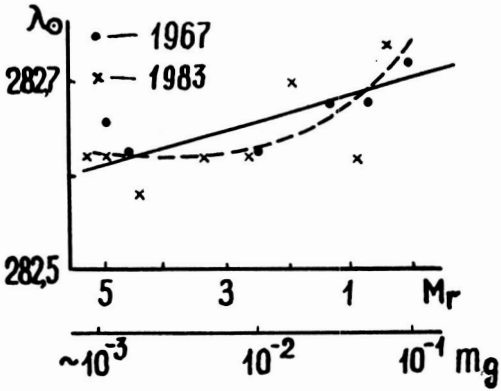
Fig. 3 The dependence of the particle
flux density maximum of Quadrantides
on solar longitude and radio-
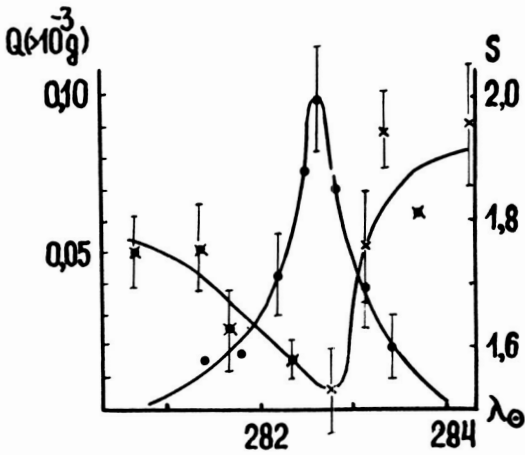magnitude. • ---- 1967, x ---- 1983.

Fig. 4 The dependence of the Quadrantid
flux density of particles over
10^3g and the "s" parameter of mass
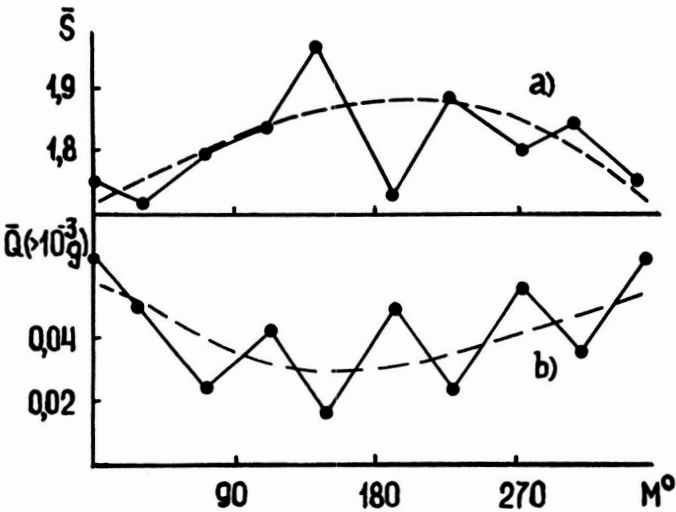distribution of meteor bodies on
solar longitude.

Fig. 5 The observed length-wise
structure of the Quadrantid
shower. a) parameters "$\bar{s}$",
b) particle flux density
$\bar{Q}(m>10^{-3}g)$.

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