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MODELS OF SPORADIC METEOR BODY DISTRIBUTIONS

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The distributions of orbital elements and flux density over the celestial sphere are the most common forms of representation of the meteor body distribution in the vicinity of the earth's orbit.

The determination of flux density distribution of sporadic meteor bodies according to

$$QP(v, \varepsilon, \psi) = QP_{\varepsilon}(v)P(\varepsilon, \psi) \tag{1}$$

where ε is the elongation angle from the earth's apex and ψ is the angle measured from the ecliptic plane upward to its northern pole, has been worked out at the Engelhardt Observatory. The distributions P(v) (it was assumed that v and ψ are independent) are taken directly from meteor orbits catalogues corrected for selectivity of observational method while $QP(\varepsilon, \psi)$ is obtained by the PUPYSHEV (1965) method from radar observations with step-by-step rotating aerials. In this method, the number of recorded parameters is minimal as only events exceeding a threshold level are used and therefore the observational selectivity is minimal too, which makes processing easier. There is also no need to know the radiant distribution for determination of the velocity distribution. (The radiant distribution is usually obtained from catalogues of radar observations which for elongation angles over 100-110° are often unreliable). As a rule from observation one can obtain a meteor flux having some measured parameter (brightness, echo amplitude) greater than a certain threshold level. This process of changing an apparent sporadic meteor flux density to that of the real meteor body density taking selectivity into account is described in ANDREEV and BELKOVICH (1975).

Catalogues of meteor orbits compiled on the basis of radar observations over the equator (Catalogue of WDC B-2, 1975, 1977) and maps of the flux density distribution over the celestial sphere obtained by PUPYSHEV et al., (1980) have been used as observational data. The dependence of ionised meteor trail properties on meteor height and mass as obtained by TOKHTASJEVE (1975) has also been used.

The velocity distributions $P_{\varepsilon}(v_{\infty})$ reduced for selection and radiant density distribution $P(\varepsilon)$ were analyzed. The velocity distributions $P_{\varepsilon}(v_{\infty})$ given in ANDREEV et al. (1982) have been used as the first approximation for determination of radiant density distribution $P(\varepsilon)$ in order to take into account observational selectivity.

The transformation of geocentric velocity and radiant distributions of heliocentric ones have been carried out by the method described in ANDREEV, et al. (1982) and ANDREEV and BELKOVICH (1978). This transformation is required because of the influence of the earth's motion and gravitation on the apparent incident flux of sporadic meteor bodies.

Actual heliocentric velocity distributions $P_{\varepsilon}(v_h)$ and heliocentric radiant density distribution P(E) are plotted by solid lines in Figs. 1 and 2 respectively.

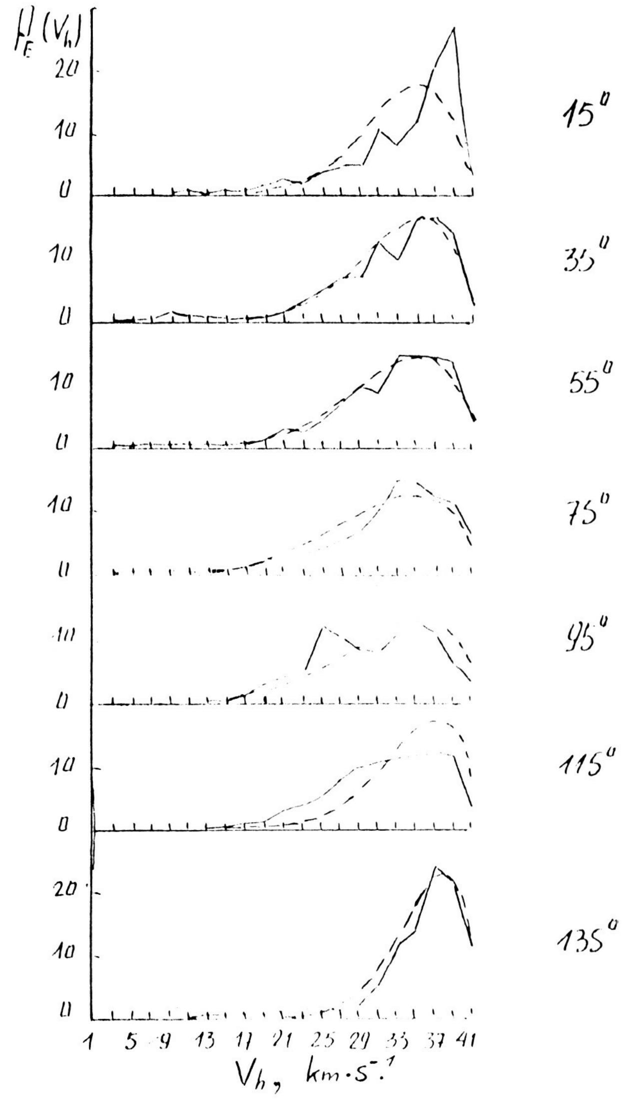

Fig. 1 Distributions of heliocentric velocities $P_E(v_h)$ of meteor bodies.

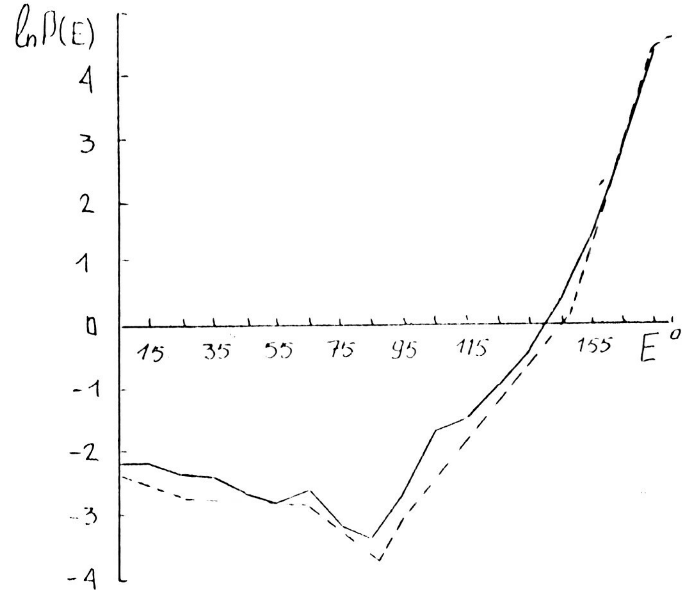

Fig. 2 Distributions of heliocentric radiants density P(E) of meteor bodies.

The theoretical distributions of heliocentric velocities were written as

$$P_E(v_h) = B^{-1}(p,q)\ (v_h/v_o)\ (1 - \alpha)^{p(E)}\ \alpha^{q(E)} \qquad (2)$$

where $v_o = 30$ km s^{-1} is the earth's orbital velocity,

$\alpha = 0{,}5(2 - (v_h/v_o)^2)$, $B(p,q) = \Gamma(p + 1)\ \Gamma(q + 1)/\Gamma(p + q + 2)$, $\Gamma(y)$

is the Gamma function, p(E) and q(E) are parameter derived by fitting the distribution equation (2) with observational data. The values p and q depend on heliocentric elongation angle E in complete interval as

$$p(E) = \begin{matrix} 4.17 - 1.95E, \\ -7.26 + 5.33E, \end{matrix} \quad \text{for} \quad \begin{matrix} 0° \leq E \leq 90° \\ 90° \leq E \leq 180° \end{matrix}$$

$$q(E) = \begin{matrix} 2.07 - 0.809E \\ -0.471 + 0.809E \end{matrix} \quad \text{for} \quad \begin{matrix} 0° \leq E \leq 90° \\ 90° \leq E \leq 180° \end{matrix} \qquad (3)$$

The heliocentric radiant density distribution P(E) was approximated as

$$P(E) = \exp \begin{matrix} -2.29 & -1.003E & \text{for} & 0° \leq E \leq 25° \\ -2.69 & -0.215E & & 25° \leq E \leq 65° \\ -0.0782 & -2.47E & & 65° \leq E \leq 87° \\ -12.54 & +5.73E & & 87° \leq E \leq 94° \\ -8.79 & +3.45E & & 94° \leq E \leq 148° \\ -23.18 & +9.02E & & 148° \leq E \leq 175° \\ -2.64 & +2.29E & & 175° \leq E \leq 180° \end{matrix} \qquad (4)$$

In the expressions (3), (4) E is in radians. The results using expressions (2), (4) are plotted by dashed lines in Figs. 1 & 2 respectively.

Distributions of the geocentric radiants and velocities calculated from the mathematical model equations (2) - (4) in order to verify its accuracy. The coincidence of observational distributions with modelled ones is quite good with an exception of cases where velocities were less than 20 km s^{-1}.

A somewhat modified method of modeling sporadic meteor body velocity and radiant distributions has been worked out to achieve a closer approximation of the observations.

It is generally believed that comets and asteroids are the main sources of meteoric matter, but some authors differ in estimation of relative contribution of both sources.

Division of meteor orbit data into three parts was taken as the basis for the modeling method. A similar division was made for photographic meteors in MCCROSKY and POSEN (1961).

The selectivity of the photographic method of observations was taken into account ANDREEV et al., (1983).

As classifying parameters those of the Tisserand criterion

$$T = a^{-1} + 2 \cdot A^{-3/2} \cdot a(1 - e^2) \cos i \qquad (5)$$

of the restricted circular three-body problem of Sun-Jupiter-particle were used. Here a, e, i are semi major axis, eccentricity, and orbit inclination refer to the meteor body and A is a semimajor axis of the disturbing planet. A value of T_o = 0.5767 corresponding to the Jovian orbit MCCROSKY and POSEN (1961) was taken as the dividing value of the Tisserand constant.

Meteor bodies with any i and $T < T_o$ were assigned to the first component. The orbits of these resemble those of long-period comets. Meteor bodies with $T \geq T_o$ were divided into two more components. The one contains meteor orbits with $i \leq 90°$ (these are asteroid-like orbits) and the other contains meteor orbits with $i > 90°$ representing a class of orbits not usually found among comets and asteroids.

Since the third group contained only 15 meteors from the catalogue (ANDREEV et al., 1983), this group was not subjected to further analysis. The preliminary result shows that the number of meteors of the third component increases with decreasing of masses of observed meteor bodies.

The heliocentric velocity distributions $P_E(v_h)$ of meteor bodies of the first and second components are plotted by solid and dashed lines in Fig. 3 respectively. They are completely different. One can see that the velocity distributions for each component do not depend on the elongation angle E.

Obviously, the observed dependence on elongation angle E of the heliocentric velocity distributions $P_E(v_h)$ of the total complex of meteor bodies and obtained from (3) and in ANDREEV et al. (1982) is really due to the superposition of the corresponding distributions of each of the three components.

The main advantage of this modified simulation method is the possibility of using traditional astronomical data for interpretation of observation and modeling results.

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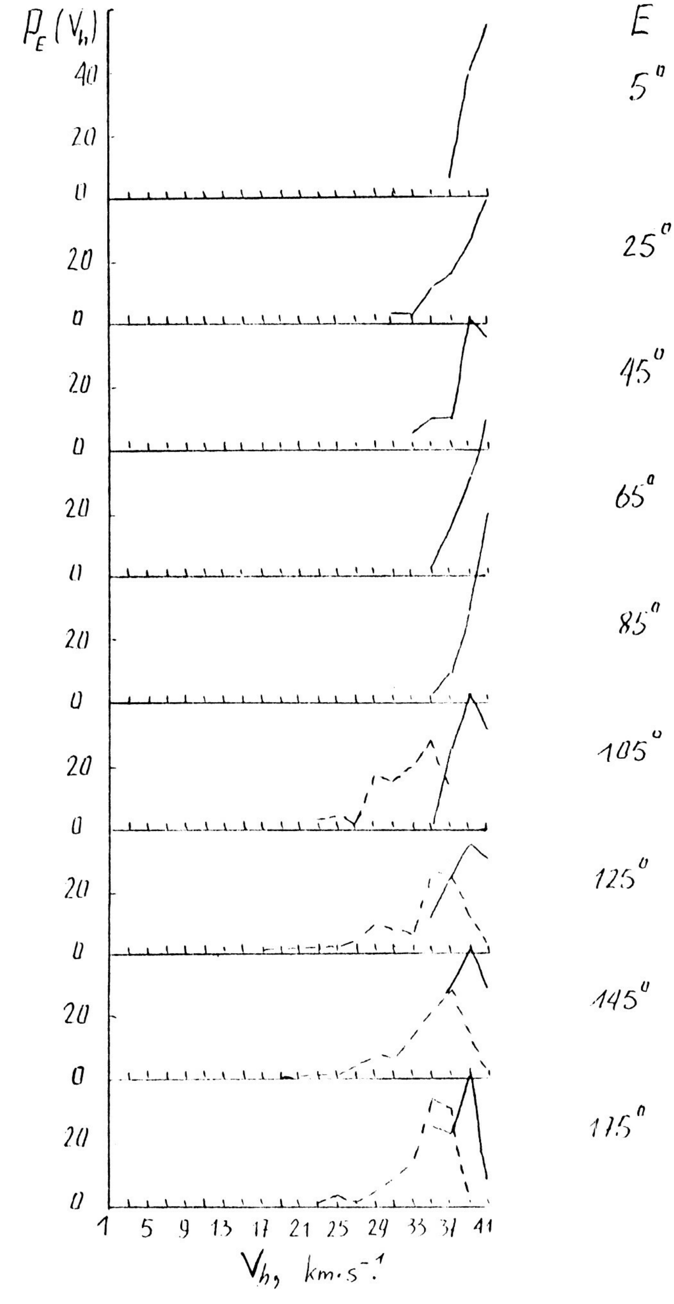

Fig. 3 Distributions of heliocentric velocities $P_E(v_h)$ of meteor bodies of the first and second components.

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