13. ATMOSPHERIC HEIGHTS OF TELESCOPIC METEORS

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The heights of sporadic telescopic meteors were observed from three stations, distant from each other 9·1, 6·0 and 3·2 km respectively, during the Piešťany meteor expedition in the summer of 1960 (Kohoutek, 1967). Three teams of four observers gathered individually data on 1187 meteors, together with 1864 drawings, during the period of 7 nights, August 15–27. Altogether, 189 pairs observed by at least two stations were identified from the complete material. The heights of the respective beginning (b), centre (c) or end (e) points of 159 pairs were determined by means of graphic-numerical analysis.

The parallactic shifts (π) at different points of the meteor trajectory, as recorded at the three bases, have been studied. For these statistics only meteors recorded by at least two observers at either station have been chosen. The dispersion of π is evidently caused by the real dispersion of meteor heights and by the errors of meteor plotting; the results are compared in Table 1.

Table 1

St	Point	π (°)	σ_{obs} (°)	σ_{err} (°)	σ (°)	H_π (km)	σ (km)	H (km)
12	b	3·92	0·64	0·58	±0·27	99·8	±6·8	89·0
	c	4·10	0·66	0·37	0·55	95·5	12·8	86·9
	e	4·76	0·78	0·71	0·32	82·3	5·4	80·1
13	c	2·68	0·70	0·68	±0·15	96·2	±5·2	–

Here π = the mean parallactic shift of the meteor group, H_π = the height above sea level corresponding to π, σ_{obs} = observed dispersion of π, σ_{err} = dispersion resulting from the mean error of one independent value of π, σ = the real dispersion in degrees and kilometers, respectively. The value of H represents the arithmetic mean of the meteor heights. Our summary contains results from St. 12 only, compared with that from St. 13 (c). The dispersion σ_{obs} determined for the meteors which were observed at St. 23 (base line 3·2 km only) was comparable with the observing errors and therefore these values have not been used.

The most probable mean heights were obtained as the arithmetic means of H_π and H, i.e. 94, 91 and 81 km for the beginning, centre and end points, respectively (the average corrected absolute magnitude was $M = 6{\cdot}3$).

The dependence of the heights of individual meteor points on the absolute magnitude

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was analysed in detail (Figure 1). It is concluded that there is negligible height variation with magnitude in the interval from 4·5 to 8 abs. mag.

The mean geocentric velocity, v_∞, of meteors of our material was estimated from the theoretical dependence $H(v_\infty)$, which was derived by Hawkins and Southworth (1958) and Jacchia *et al.* (1965). For the observed centre of the meteor trajectory the values 32·5 km/sec and 37·0 km/sec, respectively, were determined, with an arithmetic mean of 35 km/sec.

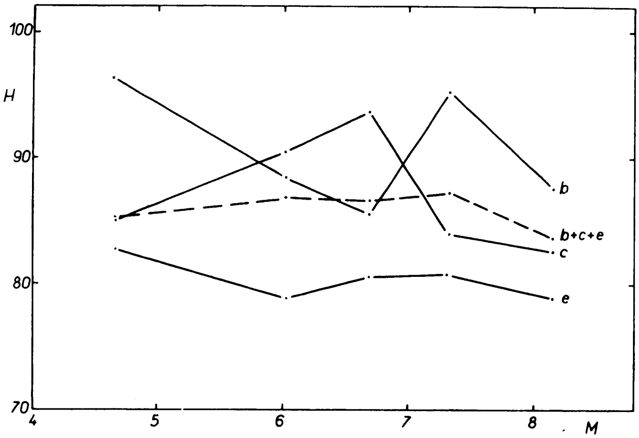

FIG. 1. *The dependence of meteor heights (in km) on the absolute magnitude for beginning (b), centre (c) and end (e) point.*

By making use of (1) the theoretically derived relation (Ceplecha and Padevět, 1961) between the magnitude of a meteoroid and the height at which intense evaporation begins (provided that the beginning of intense evaporation coincides with the height of appearance H_b), (2) the mean zenith distance of the radiants, $\cos z_R = 0{\cdot}66$ (Jacchia *et al.*, 1965), (3) the density of the meteoroids, and (4) the geocentric velocity, we determined the mean radius r_0 of the particles: $r_0 = 0{\cdot}50$ and 0·38 mm, for stony and iron meteoroids, respectively. The data mentioned above also permit us to determine approximately the value of the energy Q, needed for the heating and evaporating of 1 g of meteoric matter: $10{\cdot}5 \times 10^{10}$ erg/g and $4{\cdot}8 \times 10^{10}$ erg/g for stony and iron meteoroids, respectively. Öpik (1958) established for stony meteoroids $Q = 6{\cdot}05 \times 10^{10}$ erg/g, which is the value lying between our present value and that which was derived from our last observations in 1958, $Q = 3{\cdot}5 \times 10^{10}$ erg/g (Kohoutek and Grygar, 1962).

The diurnal variation of heights of telescopic meteors is shown in Figure 2. Whilst the H_e value remains practically constant with time (local sidereal time), the H_b value apparently increases. This increase of H_b might be explained from the increase of the mean geocentric velocity of meteors.

Recently Ceplecha (1966) introduced the k_b-parameter as a very good criterion for

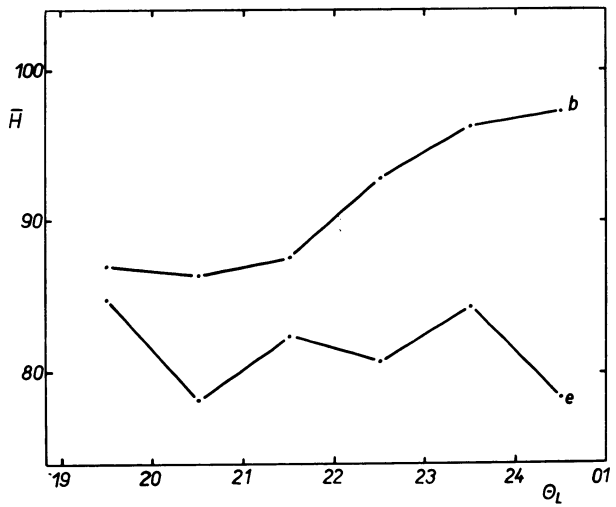

FIG. 2. *The course of the diurnal variation of meteor heights:* $\bar{H}$ *= height in km,* θ_L *= local sidereal time in hours.*

the estimation of the meteoroid composition. If we know the air density at the beginning of the meteor (adopted $\log \rho_b = -8{\cdot}86$) and mean $\cos z_R$, we can calculate, for the different values of the k_b-parameter, the geocentric velocity from the equation

$$\log v_\infty = \tfrac{2}{5}k_b - \tfrac{2}{5}\log \rho_b + \tfrac{1}{5}\log \cos z_R\,.$$

Results are given in Table 2.

Table 2

Group	k_b	v_∞ (km/sec)
	7·8	42·6
A		
	7·4	29·5
B		
	7·0	20·3
C		
	6·6	14·1

Unfortunately, we are not able to measure the geocentric velocity for individual meteors; our mean value, $v_\infty = 35$ km/sec, lies in the middle of the velocity interval corresponding to the group A. In this case, most of telescopic sporadic meteors would have the greatest meteoroid density, short-period orbits with small eccentricities and ecliptical concentration.

References

Ceplecha, Z. (1966) *Bull. astr. Inst. Csl.*, **17**, 347.
Ceplecha, Z., Padevět, V. (1961) *Bull. astr. Inst. Csl.*, **12**, 191.

Hawkins, G.S., Southworth, R.B. (1958) *Smithson. Contr. Astrophys.*, **2**, 349.
Jacchia, L.G., Verniani, F., Briggs, R.E. (1965) *Smithson. Contr. Astrophys.*, **10**, 1.
Kohoutek, L. (1967) *Bull. astr. Inst. Csl.*, **18**, 171.
Kohoutek, L., Grygar, J. (1962) *Bull. astr. Inst. Csl.*, **13**, 9.
Öpik, E.J. (1958) *Physics of Meteor Flight in the Atmosphere*, Interscience Publishers, New York, Appendix 1–2.

DISCUSSION

Ceplecha: Values of the k_b-parameter used by Kohoutek were derived from the McCrosky-Posen Super-Schmidt meteors with about $+5^m$ as the limit, while the telescopic meteors presented here have the limiting magnitude about $+10^m$. I do not believe that such a big extrapolation would be possible at all.

Kohoutek: It is, of course, true. It is very difficult to extrapolate the results from bright to faint meteors, but, unfortunately, I had no other possibility.