Abstract

The ratio of the photographic luminous efficiency τ_p to the square of the density ρ_m of about 400 Super-Schmidt meteors, precisely reduced by Jacchia, has been computed directly from the observational data. Fragmentation has been taken into account in the computation.

After critically reviewing previous papers on the subject, the author discusses his assumptions and the procedure he employed. The theory allows the evaluation of the quantity τ_p/ρ_m^2. It is possible to determine τ_p only in the few cases in which the meteors show positive evidence of being of asteroidal origin. The correct dependence of τ_p on v is found, after allowing for the different mean densities of meteors in short-period and long-period orbits, since the meteor density is independent of the velocity v. The author shows that a power law $\tau_p=\tau_{0p}\,v^n$ best represents τ_p as a function of v. The detailed behaviour of τ_p may actually be extremely complicated, since most of the meteor light comes from emission lines whose intensity may not vary uniformly or even smoothly with velocity. The exponent n turns out to be 1.0 ± 0.15 for both faint and bright meteors. The best small-camera meteors have been used for comparison. The value of τ_{0p} comes out to be about 1×10^{-19} 0 mag g^{-1} cm^{-3} s^4, which agrees very well with the value inferred by McCrosky and Soberman from the results of artificial meteors. The masses computed at Harvard on the basis of Öpik's original theory therefore appear to be about 6 times smaller than those obtained by using the value of the luminous efficiency derived in the present paper. At a velocity of 40 kms^{-1} the photographic luminous efficiency, expressed in physical units as the ratio of the energy radiated in the blue spectral range to the kinetic energy of the meteoroid, is about 2×10^{-3}. At the same velocity the mass of a zero visual magnitude meteoroid is roughly 0.8 g. The ionizing probability β of an ablated meteor atom can be estimated from τ_p and from some results of Davis and Hall (1963) on combined radio and photographic observations of meteors; at $v=32$ kms^{-1} β turns out to be 0.01.

The analysis shows no dependence of τ_p on mass or brightness and fails to detect any appreciable change of τ_p in the course of a meteor trajectory. Moreover, the results show that τ_p is independent of atmospheric density. Luminous efficiency does seem to depend on fragmentation in the sense that nonfragmenting meteors appear to produce light more efficiently than those that crumble easily. The results obtained for small-camera meteors are in general agreement with those obtained for Super-Schmidt meteors, but it appears that fireballs must have a density about twice that of fainter meteors. The mean relative density of meteors in the main recurrent showers has been also determined. Each shower appears to have its peculiar density. Jacchia obtained a similar result from an analysis of points near the beginning of meteor trajectories.

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