impossible to make a definitive statement concerning the distance to the source at this time.

- Hagen, J. P. and McClain, E. F. 1954, *Ap. J.* **120**, 364.
 —, Lilley, A. E. and McClain, E. F. 1954, *Naval Research Lab. Rep.* 4448, Oct. 18.
 Lilley, A. E. 1955, *A. J.* **60**, 167.
 Williams, D. R. W. and Davies, R. D. 1954, *Nature* **173**, 1182.

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McCrosky, Richard E. Fragmentation of faint meteors.

By the use of a new graphical method of reduction, a large fraction of the 4000 meteors doubly-photographed by the Baker Super-Schmidt cameras of the Harvard Meteor Project can be rapidly reduced for approximate values of velocity, height and radiant. Mean errors are about 5 per cent in velocity and 3 per cent in heights. Results for about 500 meteors are included in this discussion. In general, these meteors represent a homogeneous group in terms of apparent maximum magnitude. Consequently, all meteors of a given velocity group are represented by the same mass. It is to be expected, on the basis of the present meteor theory, that such a group of meteors of the same velocity and mass should appear at the same height. It is found that the beginning heights for meteors with normal light curves can be well represented by the relationship $\rho v^3 = \text{constant}$, where ρ is the atmospheric density and v is the meteor velocity.

Among the meteors studied, a group of low-velocity meteors comprising 15 per cent of the total are peculiar in the sense that they display an abrupt rise of light at the beginning of the trail. A typical meteor of this group will rise from below the plate limit to 1 magnitude above in less than 1/60 sec. The shutter breaks often become invisible at the end of the trajectory (terminal blending). Both of these phenomena can be explained by a sudden increase of the effective surface area of the meteoroid by fragmentation into a number of smaller pieces. The differential deceleration of fragments of different sizes cause the meteoroid to spread along the trail and obscure the shutter breaks.

Meteors of this group do not obey the $\rho v^3 = \text{constant}$ law for beginning points. However, the point at which the burst takes place can be described in terms of a constant value of the dynamic pressure, $\rho v^2 = 2.5 \times 10^4$ dynes cm^{-2} (0.02 atmosphere). Quite likely we have here a measure of the weak crushing strength of meteor-

itic material. Such a value is in qualitative agreement with our present conception of cometary meteoric material as derived from Whipple's comet model and from the densities of meteoroids as determined by Whipple and others.

The height corresponding to the observed value of ρv^3 is greater, at all meteor velocities, than the height corresponding to the observed ρv^2 value. Consequently, if the above hypothesis is correct we should expect to find occasionally a high velocity meteor that first appears normally at the proper value of ρv^3 and then shows a fragmentation after its trajectory has carried it into the range where crushing may take place. In 1949, Jacchia reported 7 examples of high velocity meteors that displayed an abrupt increase in luminosity some time after their appearance. The average value of ρv^2 at the point of discontinuity of the light curve agrees with the value obtained for those low velocity meteors of this study which obey the ρv^2 law.

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McKellar, A., Welsh, H. L. and Stephenson, F. C. The spectrum of solid oxygen a few degrees above absolute zero.

The rather rough agreement in wave length between the two strongest unidentified diffuse interstellar lines ($\lambda\lambda 6284$ and 5780) and absorption bands of high-pressure gaseous, liquid and solid oxygen prompted us to investigate the absorption spectrum of solid oxygen down to the temperature of liquid helium (4.2°K). The spectral region $\lambda 4000$ to $\lambda 6700$ was covered. With absorbing paths of the order of millimeters, bands and diffuse lines were photographed, characteristic of the three modifications of solid oxygen (α -oxygen up to 24°K , β -oxygen between 24° and 43°K , and γ -oxygen from 43°K to the melting point, 55°K). Spectra of the three modifications differed in diffuseness and slightly in wave length, as reported in 1935 by Prikhotko, Ruhemann and Federitenko. The strongest absorption was in a violet-degraded sequence of bands with heads near $\lambda\lambda 6300$, 5780 , 5330 , and 4940 . Several line-like absorptions occurred between $\lambda 4459$ and $\lambda 4806$.

Three of the seven diffuse interstellar lines ($\lambda\lambda 6284$, 5780 , and 4760) occur in regions of absorption by solid oxygen. Our knowledge of the role played by the structure of the modifications