Thus if $\dot{M}$ g. are sublimated from the sphere per second, then the corresponding mass of reactive atoms in $\dot{M}$ is $n\dot{M}/(n+M)$ or $\dot{M}\, P_r/100$. This is equal to $\dot{M}\, P_r/100m$ atoms/sec., or if all the atoms recombine to form molecules, $\dot{M}\, P_r/200m$ ($=R_n$) recombinations/sec. This is an oversimplified picture, but it should lead to a suitable approximation.

Now, differentiating Equation (4) with respect to time yields

$$\dot{M} = 2(\dot{N} + \dot{n})m = 4\pi\rho a^2 \dot{a} \qquad .. \qquad (5)$$

If the radius of the sphere decreases at the rate $\dot{a}$, then the number of recombinations/sec., R_n, is

$$R_n = \frac{4\pi\rho a^2 \dot{a}\, P_r}{200\, m} \qquad .. \qquad .. \qquad (6)$$

$$= \frac{\rho S\, \dot{a}\, P_r}{200\, m}$$

where $S = 4\pi\, a^2$, the surface area.

The dissociation energy of molecular nitrogen is about 9·764 eV. or $1{\cdot}564 \times 10^{-18}$ joules, which is also the energy released by each recombination. Some unknown fraction, ζ, of this energy goes into radiated light. One estimate[29] was as high as 50%. The energy radiated as visible light P, is therefore approximately ($R_n\, E_r\, \zeta$)

$$P = \frac{\rho S\, \dot{a}\, P_r\, E_r\, \zeta}{200\, m} \qquad .. \qquad .. \qquad (7)$$

The intensity is given by

$$I = \frac{P}{S} = \frac{\rho\zeta\, \dot{a}\, P_r\, E_r}{200m} \qquad .. \qquad .. \qquad (8)$$

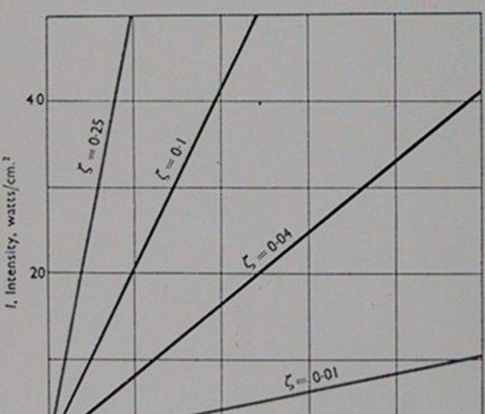

FIG. 2. Estimates of the light intensity at the surface of a sublimating sphere which contains a 3% concentration of nitrogen atoms. A sphere sublimating at the rate of 1 cm. per 10 sec. with 10% of the metastable atoms radiating when dropping to ground states has an intensity equal to a tungsten lamp filament at 1700° K. or about 10 W./cm². Most of the light would be centred around 5228·5 Å.

Now assuming that

$$m = 2{\cdot}33 \times 10^{-23}\ \text{g.}$$
$$\rho = 1{\cdot}026\ \text{g./cm}^3.\ (-252{\cdot}5^\circ\ \text{C.})$$
$$E_r = 1{\cdot}564 \times 10^{-18}\ \text{joules}$$

and

$$P_r = 3\ \text{(see Reference 30)},$$

the intensity becomes

$$I = 1035\, \dot{a}\zeta \qquad .. \qquad .. \qquad .. \qquad (9)$$

The intensity I is at the surface of the sphere, and is plotted in Fig. 2 for various ζ. The brightness of a 1700° K. tungsten filament is about equal to 10 W./cm². This is equivalent to a sublimation rate of approximately 0·1 cm./sec. if 10% of the atoms radiate when dropping to ground states and if 3% of the matrix contains metastable nitrogen. The intensity of sunlight is about 0·1 W./cm². on a clear day. If the aforementioned sphere, with an intensity equivalent to a 1700° K. tungsten filament had a radius of 10 ft., it would appear as bright as the Sun at a distance of 105 ft. or as bright as the Moon at a distance of approximately 23,000 ft. Also most of the light would be concentrated in the green, where the eye is sensitive.

VIII. SUMMARY

The basic differences between the unusual fireballs treated here and the common varieties were outlined. A discussion of the different debris responsible for known meteors was also included. It was noted that this material could not be responsible for stationary or very slow meteors.

A chunk of a comet's nucleus, consisting of an ice-dust conglomerate, was then considered as a possible source of bright meteors. The name "cometoid" was introduced to distinguish these objects from meteoroids. Reference was made to a previous paper[2] which showed quantitatively that solid spheres of frozen water could easily absorb the heat influx when entering the atmosphere at speeds of 36,400 ft./sec. Spheres having radii of 1, 5 and 10 ft. were considered. Also, it was observed that many of these objects slowed down to terminal speed (≈500 ft./sec.) while still at altitudes of several miles depending on the angle of entry with the local horizontal.

Cometary ices are believed to be less dense than water and may contain frozen radicals and atoms. However, it was assumed that these objects could also survive re-entry.

The existence of transient cometoid streams was predicted and estimates of the lifetimes of cometoids in space were made.

The large object which impacted in central Siberia in 1908 is believed to have been a rare, retrograde cometoid. The incident is discussed in Appendix B.

The ablation characteristics of inhomogeneous ice mixtures which contain internal energy sources, *e.g.* molecular fragments, was studied. The following deductions were made: