AN HYPOTHESIS ON THE SLOW MOVING GREEN FIREBALLS*

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(Communication from the Convair-Astronautics Division of General Dynamics Corporation)

ABSTRACT

The slow green fireballs are distinguished from ordinary meteors and their characteristics are described. The theory is advanced that they are cometoids, composed of matter in a physical state between those of meteoroids and comets, namely chunks of frozen substances ("ices") at very low temperatures. The matter is probably in an unstable state and contains a source of thermal and luminous energy; evidence is presented in support of the suggestion that this is solid nitrogen.

The large object which impacted in central Siberia in 1908 is believed to have been a rare retrograde cometoid; the available data on this incident are reviewed.

I. INTRODUCTION

In what follows, a theory is presented which offers an explanation for the actions of certain bizarre fireballs. By a process of analytic continuation, the results can be applied to other forms or shapes of unidentified aerial phenomena. In particular, the theory applies to sizable objects (orders of inches or feet) which slow down to speeds of a few hundred miles/hr. or less at altitudes of a few miles. Certain characteristics such as wobbling in flight, fuzziness at low altitudes or a shiny, metallic appearance at high altitudes, light emissions, short life-times, lack of remains, and spheroidal shapes, etc., can be predicted and explained qualitatively.

Actions of this type cannot be attributed to objects which produce the common variety of meteors and fireballs, *i.e.*, to stone or iron meteorites or dustballs (meteoroids).

The unusual meteors discussed here are believed to be caused by pieces of comets (cometoids), *i.e.*, chunks of frozen matter (ices) which are at very low temperatures. Furthermore, from what is known about comets this matter may be in an unstable physical state, containing a source of thermal and luminous energy. The thermal energy is expected to come from recombinations of frozen radicals and metastable atoms, and the light emission from atoms which radiate when dropping back to ground states, *e.g.*, metastable nitrogen.

It is suggested that a short-period cometoid stream may originate when a member of Jupiter's comet family comes too close to Jupiter. The combination of tidal actions and internal explosions could completely shatter the comet to produce myriads of small bodies ranging in diameter from inches to hundreds of feet.

Furthermore, a near-encounter with Jupiter could deflect the trajectories of the particles nearer the Sun to a point where, at one astronomical unit, the Earth would be in a position to intercept them.

The lifetime of a cometoid stream will be very short. Over 99% of it is likely to sublimate from solar radiation in a decade. The remaining large objects will be scarce and mixed in with the dust remnants. In other words, the cometoid stream will be a transient phenomenon and within a few years it will become a meteor stream. A few large cometoids may be present for a century or so. There is evidence for the presence of cometoids in the great Leonid shower of 1833.

The object which struck in Central Siberia in 1908, wiping out an estimated 80 million trees, was probably a sporadic cometoid. Although several expeditions were made to this area, meteorites were not found. Only dust, which probably constitutes 3%, or less, of the volume of cometoids, may have been found.

Because of the radial nature of a cometoid explosion, it is suggested that some of the lunar craters may have been formed by cometoid impact. For example, the Moon may have intercepted a cometoid stream on several occasions.

Impacts of small cometoids on the Moon could dislodge debris from the surface to produce a special type of stone meteorite. Urey has recently found evidence to suggest that some meteorites may have originated from the Moon.[1] It is possible that cometoids could have played a part in this. Such processes may still be going on.

A discussion of comets is presented, although very little is actually known about the comet's nucleus. However, a knowledge of the physical stage of comet nuclei is necessary in order to understand the actions of cometoids in the atmosphere.

It has been established quantitatively that a solid sphere of frozen water, entering the atmosphere at a speed of 6·9 miles/sec., can survive and slow down to terminal speeds without completely ablating.[2] The steeper the angle of entry (with the local horizontal), the greater the drag stresses but the smaller the net heat influx. A sphere of frozen water, having a radius of 1 ft., which enters the atmosphere at an angle of $-6°$ with the horizontal (84° with the vertical), loses only

* Manuscript received 7 September, 1959.

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