AIR FORCE

and SPACE DIGEST

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NASA SHOWS ITS SPACE AGE WARES

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UFOs remain a mystery, but their color, movement, and disappearances may be explained by a new theory that suggests "saucers" may be the remnants of space-born icebergs which many scientists now believe are the stuff of those eerie visitors from the void—comets . . .

A THEORY ABOUT FLYIN

DONALD H. ROBEY

IT IS widely known that in the year 1947 many people in many places began to report "flying saucers" and other strange objects in the sky. It is not so well known —only astronomers are, in fact, aware—that in the year 1947 earth's neighborhood of interplanetary space was visited by more comets than ever before.

I intend here to suggest a relationship between these two phenomena.

Comets are one of the great historical mysteries of the cosmos. In ancient times they were greeted as heralds of disaster: fire, flood, pestilence, war. The first question early astronomers asked about comets was whether these visitors came from within the solar system or originated among the stars beyond. Isaac Newton answered that one in his *Principia* by describing a method of delineating cometary orbits. Comets, he found, obey the same laws of motion that Johannes Kepler discovered were applicable to the travels of earth and other planets of the sun.

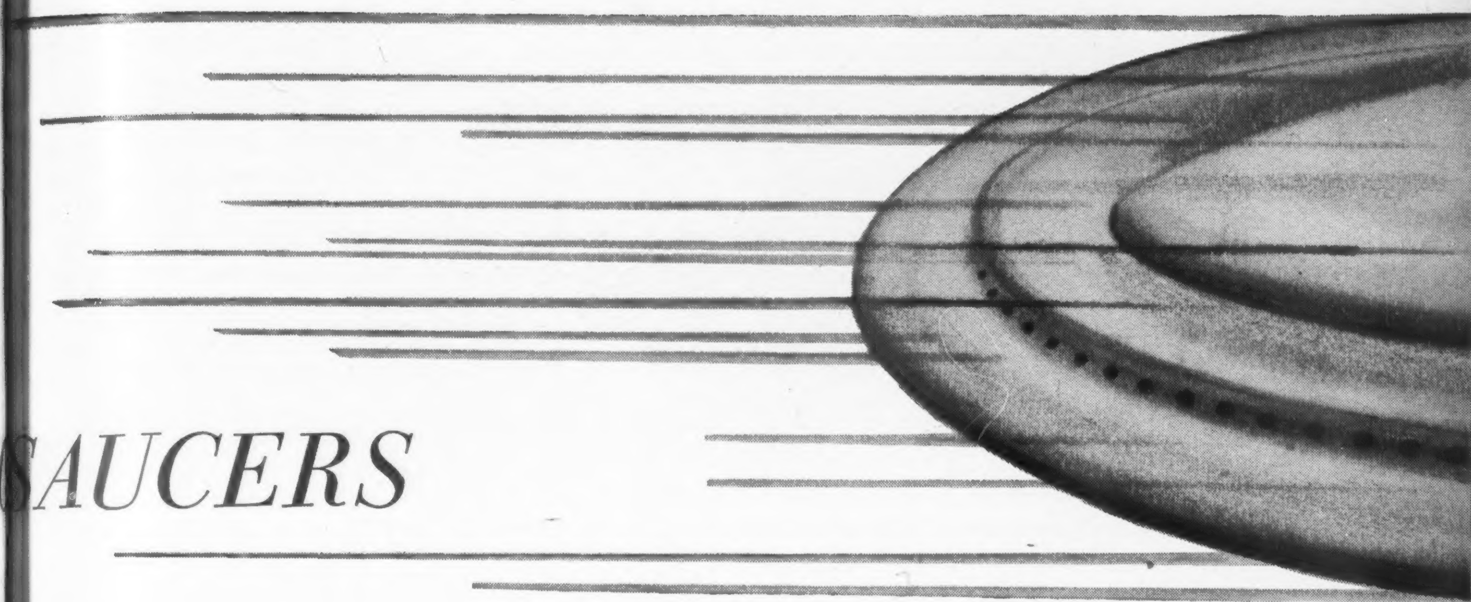
Edmund Halley followed up Newton's mathematical feat by tracking backward through time a brilliant comet he personally observed in 1682. Convinced by his calculations that this was the same comet that had appeared in 1305 and 1456 and 1531 and 1607, Halley accurately predicted its reappearance in 1758. Since Halley's day, the identical comet has been confirmed as a regular visitor to earth's vicinity since 240 B.C. Thus we know that some comets live for thousands of years.

Once comets were definitely established as members of the solar system, the next logical question was: What are they made of?

It was believed quite generally, until the last decade, that comets were flying gravel banks. However, if comets were flying gravel banks, many of them which have passed close to the sun or to Jupiter in the past (and have remained intact) would have fallen apart or been disrupted by the pull of gravitational tides. Also gases released during passages close to the sun would have tended to disperse the gravel.

Actually, all the strange characteristics of comets can be explained if the nuclei of comets are assumed to be gases frozen into icebergs adrift in space. This notion was first analyzed by Dr. Fred Whipple of the Harvard Observatory. The Whipple theory now commands widespread acceptance among astronomers. It is in harmony with the idea of a cloud of comets surrounding the solar system.

Professor J. H. Oort, Director of the Leyden Observatory in Holland, has adopted it as a foundation for further premises. He visions a hundred billion of these frozen monsters drifting around the sun in a sea shaped like a spherical shell 100,000 times as deep as the distance between the earth and the sun. The closer edge of this sea is 50,000 times farther from the sun than is the earth, and the last of the icebergs is three



SAUCERS

times farther out than that. The ice sea as a whole lies roughly halfway between the sun and the sun's nearest neighbor star. This neighbor star and other passing stars occasionally draw some of the comets out of the sea in much the same fashion that water currents southbound from the Arctic sweep terrestrial icebergs into the North Atlantic Ocean.

This disturbance of their accustomed motion throws some of the affected icebergs out among the stars while others race with ever-accelerating speed toward the sun. On their way in, a certain number sweep close enough to Jupiter, giant of the solar planets, to be caught by its gravitational attraction. Thereafter the icebergs travel a shorter orbit, with increased likelihood of breaking into fragments which brush past or into earth's atmosphere.

A few comets accessible to observations have been seen to disintegrate or break up when near the sun or after having passed close to Jupiter. A number of such disruptions, possibly a dozen per century, may occur near Jupiter.

I shall introduce the word "cometoid" at this point to give a name to what I believe is the next phase in a comet's decline. I define cometoid as a chunk of ice too small to be observed as a comet but too large to be entirely melted before it glides into the last few miles of air above earth.

There are no eye-witness accounts of a confirmed cometoid. But there is a thrilling report of an event whose description fits what might be expected to happen if a really large fragment of a spaceberg hit the earth. This event, which took place in Central Siberia in the morning of June 30, 1908 and wrought devastation far exceeding that of any other known heavenly visitor in recorded history, has often been called the most remarkable astronomical event of the twentieth century.

Earthquakes were registered at Irkutsk, Chita, and Kabansk in the USSR and in microbarograms in England. Sound similar to thunder was heard up to distances of 600 miles for several minutes. This was followed by noises similar to the firing of large cannon which shook buildings for two minutes. An immense dust cloud associated with the event passed over England on June 30 and July 1, 1908, reflecting enough light to enable harvesting throughout the night.

No iron or stony meteorite fragments of any size have ever been found at the site of the explosion. Yet when Professor Leonid A. Kulik, of the USSR Academy of Sciences, finally penetrated to the place to undertake a scientific examination nineteen years later, the area was still bare of trees, except for a few sheltered islands, over a radius of nineteen to twenty-two miles. In the midst of this barren circle was a shallow depression two miles wide, pocked with about 200 steep-sided, shallow craters, each from one to fifty yards across, most filled with mud, some with raised centers like the craters of the moon. After almost two decades of natural recuperation, mosses, bushes, and trees as far as six to ten miles out from the center bore signs of scorching by intensely hot gases.

A flying iceberg of the size indicated by the Siberian craters (a mass in the neighborhood of 100 to 10,000 tons) would have been vaporized upon impact, suddenly freeing the gases frozen inside it and heating them enormously to generate a violent but short-lived hurricane of carbon dioxide, water, methane, and ammonia in addition to deadly poisons such as hydrogen cyanide and cyanogen.

But is it possible for ice to survive the friction of passage into earth's lower atmosphere? This question has been answered conclusively in the computing laboratory of the Convair Astronautics Division of General Dynamics, at least so far as frozen water is concerned.

The calculations show that a solid sphere of frozen water, entering the atmosphere at speed of at least 6.9 miles per second, can survive and slow down to terminal velocities without completely ablating. If the sphere has a radius of one foot, and enters the atmosphere at an angle of six degrees above the horizon, it loses only half of its radius; by the time it descends to an altitude of 100,000 feet, the speed is only 1,700 miles per hour and the frictional heating is negligible. A sphere with a radius of five feet, under the same conditions, loses about 7.8 inches; the ablation stops at an altitude of roughly 50,000 feet, where the globe is still traveling 2,000 miles per hour.

Suppose a small faint comet with a nucleus a little over a mile wide were to disintegrate into small spheres, each having a radius of one meter (3.28 feet). There would be a billion spheres. A more realistic distribution might be obtained by assuming that the breakup would follow the distribution of meteoroids. Then the cometoids would range from one yard to more than half a mile across. The lifetimes of these ice chunks in short-period orbits would vary considerably. The billion smaller spheres would survive between six months and about five years. A hundred million cometoids with an initial diameter of 6.6 feet each would melt away to empty dust balls in one to ten years. The largest chunk of ice hypothecated here should last from 500 to 1,000 years. Thus, with the passage of time following disruption of a comet, larger cometoids would gradually become numerically predominant. After four and a half years, the most numerous would span at least thirty-five feet. But in the first year or two after the earth intersected a new stream of cometoids, the numerous small ice chunks, of the order of a few feet, would be combed out by the sun's heat.

Cometoids of these dimensions could explain the strange stories that are heard from time to time about cakes of ice falling from the sky through the roofs of houses, or found half-buried in open fields.

Now if comets are indeed icebergs vagrant from the deep-freeze surrounding the solar system, and if the fragments of them which I have called cometoids can enter the atmosphere intact, then the appearance of cometoids surely must have been observed at some time in the past.

I believe cometoids may have been seen. Such observations have been seriously questioned and generally omitted from scientific journals in recent years because the atmosphere was not deemed capable of slowing such large objects down to the speed reported—a few hundred miles per hour—without incinerating the objects. Many older sightings of unusual meteoric phenomena can be found in the scientific literature, however. For example, in *Monthly Notices* of the Royal Astronomical Society for December 1880, W. F. Denning describes a slow meteor which took at least fifteen seconds to cross the sky. A textbook written in 1869 and used in colleges for half a century still retained mention of a fireball observation in the eighth edition, printed in 1920. The sighting occurred during the great Leonid shower of November 12, 1833, when meteors fell like fiery snow. "Large fireballs with luminous trains were also seen," wrote the textbook authors White and Blackburn. "Some . . . remained visible for several minutes. Even stationary masses of luminous matter are said to have been seen. . . ."

This brings me back to the point of my beginning: the relationship between comets and the so-called flying saucers. Those familiar with unidentified flying objects will already have noted the resemblance between the hovering meteors just described and the slow-moving green fireballs seen above the deserts of the southwestern United States during recent years. There is a further small but perhaps significant link between the southwestern phenomena and the cometoids whose existence I have postulated. Drops of water have been observed falling from a clear sky coincidental with the passage of the fireballs.

Mathematical documentation for belief that spheres of frozen water could successfully enter earth's atmosphere from without and survive to reach earth's surface has already been given in this paper. Once the parent body is broken into numerous fragments, the heat affects each piece individually. Thus a homogenous spherical fragment with a radius of one inch decreases in radius ten times as fast as a body with a radius of 100 inches. It follows that if a large cometoid can stay in one piece while descending to low altitudes, its speed may drop to a few miles an hour or even to zero, and it may luminesce.

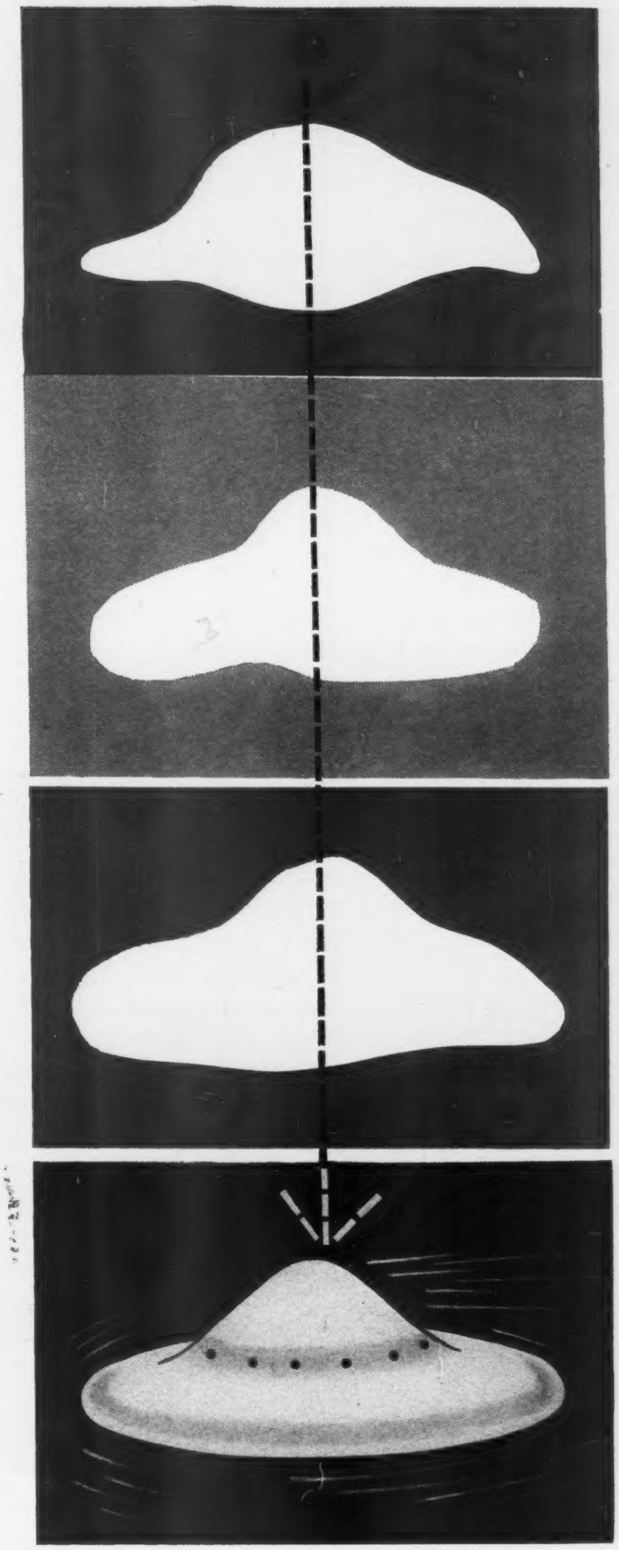
The entry of a cometoid into the atmosphere would be more complicated than the entry of a sphere of frozen water would be. However, as the object arrived within the atmosphere, the outer covering would consist only of dust and of ices which have low-vapor pressures, such as water and possibly materials of resinous or waxlike character. Within, the cometoid would contain a frozen mixture of terrestrial commonplaces like water and gases which would be very volatile in the earth's atmosphere, e.g., methane or ethylene. These vastly different components of the interior would have differing vapor pressures, hence would volatilize at different speeds. A gas that departed early in the course of the cometoid's flight would leave a hollow in other gases still in the frozen state.

Soon after entering the atmosphere, a cometoid would lose its protective dust cover. Erosion would then set in, due to break up and recombination in the surface of chemically active fragments of molecules called radicals.

During this period of its travel, when the pressure would be inadequate to produce melting, the cometoid would undergo a preliminary shaping by ablation processes. Corners would be removed, sharp edges dulled and rounded, and the surface pitted.

The inhomogenous nature of the internal ices would keep the entity turning. It would not matter whether the cometoid always turned in one direction or rocked back and forth; as long as it kept exposing different parts of the surface alternately, the rounding and forming would continue.

As the cometoid drifted into lower altitudes, the pressure would rise and cause melting. Substances like water, which expand on freezing, can melt under pressure and refreeze when the pressure is removed, provided the temperature is not too low. Liquids which ooze into the substrata would tend to sublimate the more volatile ma-



Evolution of a "flying saucer?" Cometoid travels along in space, top sketch. In second panel, ablation begins high in atmosphere. Third panel depicts melting stages, lower down in atmosphere, with concurrent shaping process due to spin. Bottom cometoid has attained saucerlike shape. (Drawings after sketches by Doug Anderson).

terials while freezing themselves. By this process a shell of low-vapor pressure ice would be expected to form around the cometoid. If it could be broken up and examined, it might have a shiny, glassy appearance like that reported for many "flying saucers." Grains of dust in the pitted surface might form bands around the sphere. A spinning disc could thus acquire concentric stripes, or a cigar-shaped object might have a series of bands.

In order to remain in existence, cometoids must be quite cold. During the disintegration period, they may have frigid shells filled with hot gases. These gases, being in a state of flux, will shoot out through the various openings in the shell to produce a miniature glowing cloud around it. The cometoids will then become more like hot-air balloons.

Also, because of recombinations of the radicals and melting of the foreward face of the shell, small jets tending to oppose the body's motion would occur. The reactions would not be instantaneous, so that a sphere, tumbling randomly, would have a slightly erratic path. A disc-shaped body, spinning clockwise about a vertical axis, would make a gradual counterclockwise turn. If a jet emerged from the interior through just one opening in the shell or if one of several jets predominated, a sphere or a disc would wobble in flight.

A sphere, per se, has no lift, but one that is spinning and blowing out gas jets can have a lift. If the sphere is spinning counterclockwise because of a tangential gas jet, then the jet will oppose the air stream underneath so as to build up an excess pressure relative to the jets on top. If the sphere was spinning in the opposite direction it would tend to dive.

Another lift mechanism might be present in a cometoid. If some of the internal ices were melting there would be a tendency for the liquid to extrude the bottom through any holes that were available. The instant the liquid touched the atmosphere (which would be relatively hot) it might expand to create a pressure underneath.

When cometoids descend to altitudes of a few miles their velocities fall to a few hundred miles per hour. Jet planes, which sometimes travel at higher speeds than that, are not luminous. Light emission must therefore result from changes of state within the cometoid. It is suggested that cometoids which are fresh from the very cold subsurface regions of comets may at times contain dormant atoms or combinations of atoms capable of emitting light when sufficiently warm. Since comets in general consist principally of unknown combinations of hydrogen, nitrogen, oxygen, and carbon, the light emitters would have to be of one or more of these elements. One element has been known for forty years for its exceptional phosphorescence on warm-up. This is frozen nitrogen, quite abundant in comets. It glows a brilliant green following excitation and can be seen in daylight.

If a cometoid were twenty feet in diameter, and aglow from the sudden warming of frozen nitrogen inside a thin, glasslike shell, the object would appear as bright as the sun at a distance of 105 feet or as bright as the moon at a distance of approximately 23,000 feet.

It might be pointed out, in this connection, that brightness of objects seen visually is associated with the wave length of light. That is, the eye is not equally sensitive to the different wave lengths in the visible spectrum. In dim light, the eye becomes more sensitive to green or blue-green light. It is not surprising, therefore, that many bright green fireballs have been seen. For the most favorable time for such objects to survive entry of the atmosphere is after sunset.

Although the explanations offered here cover most of the unknowns of "flying saucers," a few mysteries remain untouched. These include the apparent alternation of evasive and pursuit tactics by UFOs kept under simultaneous observation by experienced airplane pilots and by radar, reports of radiation accompanying the appearance of some UFOs, and alleged UFO effects on electrically controlled vehicles such as motor cars.

It has been noted by many scientists that electromagnetic bursts from the sun may influence comets in certain ways. The author is now refining mathematical formulae which could elucidate the transfer of these effects from comets to cometoids and thus explain yet unexplained enigma.—END

Donald H. Robey is a young physicist who is associated with the Convair-Astronautics Division of General Dynamics in San Diego, Calif. He has previously reported his cometoid theory to the American Meteorological Society. This article is condensed from the Saturday Review, Science and Humanity *section, September 5, 1959, and reprinted with permission of the* Saturday Review.