Hutchinson (Kan.) Naval Air Station.' City Editor Brian Coyne of the *Arkansas City Daily Traveler* said 'a brilliantly-lighted, tear shaped object with prongs or streams of light spraying downward was sighted shortly after midnight. The prongs were observed first as directed towards the Earth and then extending from the sides of the object.' He also described the head of the object as being green in color or 'bluish green'."

Why the bright blue-green light? It cannot be from incandescence or excitation of the air. For 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 sub-surface 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 for as long as five minutes 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, glass-like 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.

TO SUMMARIZE, we have argued that comets are the astronomer's equivalent of the mariner's iceberg, that comets disintegrate into express trains of ice fragments, that ice fragments of considerable size can survive Earth's atmosphere within a few miles of Earth's surface, that such fragments are mixtures of frozen gases which melt during atmopheric entry and so create thin-shelled spheroids filled with the hot gases of rapidly recombining radicals, that these ice balloons are shaped by their passage into saucer-like, disc-like, and cigar-like forms lighted eerily from within.

Under certain circumstances, the cometoids could appear to be swiftly approaching Suns or Moons. Peculiar maneuvers are not only possible but almost inevitable, given the irregular burning and ejection of jets of the very same gaseous radicals which provide the power for most of our conventional explosives. The illusion of very large machines, operating under intelligent direction, is hardly a wild imagining to anyone who recalls the enormous force released by collision of one of the "machines" with the Earth in the swamps of Siberia.

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 of this paper is now refining mathematical formulae which could elucidate the transfer of these effects from comets to cometoids and thus explain the yet unexplained enigmas of the UFOs. It is hoped that this work may be the subject of another contribution to SR/Research in the not-too-distant future.

For the present, it is enough to have conveyed some sense of the historical role that comets have played in the development of human thinking, and perhaps to have suggested the extent to which all of us are subject to wonders far beyond the range of comprehension of man's most elaborate tools.

SCIENCE IN BOOKS

A BRIEF COMETARY

THE origin of comets, like the origin of the rest of the solar system, is still very much open to debate. The fact that such a large percentage of the orbits are nearly parabolic except when they have been altered by a close approach to one of the planets would indicate that comets come from far out in our solar system. . . . There may be a vast reservoir [of them] circling the Sun at distances of between 50,000 and 150,000 astronomical units. This far out the comets would be moving so slowly that speeds as low as 250 to 450 feet per second, and periods of revolution of the order of 10 to 50 million years would seem to be in order. The Sun's gravitational hold on these comets would be very weak. The nearest star, Alpha Centauri, is only about 270,000 astronomical units from the Sun, and, together with its binary companion, has a mass about twice that of our Sun. Thus the perturbing forces on the comets in the reservoir that would be exerted by the Alpha Centauri system and other near stars would be comparable in strength to the Sun's hold on them. When these forces combine in such a way as to reduce the velocity of a comet in its orbit, it could be drawn in toward the Sun. . . .

As a comet moves into the region of the planets it seems to be a loosely-knit swarm of chunks of frozen gases in which there may be imbedded small particles of solid material of a stony or metallic nature. This nucleus is probably somewhere between a few miles and a few hundred miles in diameter. The mass can hardly exceed one ten-thousandth the mass of the earth, and it may be much less. Though the precise mass of a comet has never been accurately measured, an upper limit can be obtained by noting that comets passing very close to the Earth-Moon system, and even through the satellite system of Jupiter, have not been massive enough to produce any detectable change in the periods of any of the planets or satellites involved. The head of the comet may be anywhere from 30,000 to 150,000 miles in diameter, but of an average density far lower than our best laboratory vacuum. Stars seen through the head of a comet are not dimmed by any detectable amount.

The tails of comets frequently attain lengths of from five to fifty million miles, and thus they are clearly the largest members of our solar system, with the possible exception of the Sun's corona. They are so rarefield, however, that . . . an ounce of comet tail would cover the entire United States to a depth of half a mile.

—THEODORE G. MEHLIN,
in "Astronomy,"
(Wiley, $7.95)

THE RESEARCH FRONTIER

—Univ. of Michigan.

WHERE IS SCIENCE TAKING US? *Ask that question of a scientist, and he'll say he doesn't know. Often as not, he'll tell you to ask the statesman, the legislators, the politicians. Science can inform the culture to which it belongs, can contribute tools to enhance understanding, can constantly remind of the universal nature of knowledge and knowledge's refusal to be fettered. But it cannot take over contral of a democracy without destroying the democratic spirit. The rules and regulations have to be worked out in the main by students and practitioners of the law.*

The University of Michigan Law School is more aware of this reality than most American institutions of learning, and one of the agencies it has created as a consequence is the Atomic Energy Research Project. The Project combines basic research in relationships between science and the law with applied

By WILLIAM BERMAN
(University of Michigan)

LIKE the Russians, we have used little imagination in recognizing the explosive power of hydrogen as a potential force for peace. To date our most impressive act has been assignment of the code name Plowshare to a few preliminary and somewhat tardy explorations of possible constructive uses of explosive nuclear fusion.

One reason for our delinquency has been our blind faith in President Eisenhower's Atoms-for-Peace plan of 1953. We have proceeded on the assumption that peaceful applications of atomic energy could transform the world into a Garden of Eden without considering the real needs of the underdeveloped lands whose friendship we seek. We have been thinking in terms of nuclear power generating stations for countries which have few, if any, electric light bulbs. We have been talking about radioisotope laboratories for nations which have no sewer systems. We have been expecting complex industrial techniques of people with little or no experience in skilled work.

Apart from increased literacy and adequate public health facilities, the first steps in industrialization of any nation must be directed toward exploitation of natural resources, including the preparation of land for farming and extraction of mineral deposits. Roads and inland waterways must be developed for the facilitation of commerce. Extensive electrification and adequate housing will come later, but they can have no realistic place where half the population must exist on less than ten cents a day.

Hydrogen explosions can open the way for irrigation of now barren acres, for development of transportation systems, for mining of buried riches.

Why do we limit this discussion to fusion explosions? Why do we not also include the atom bomb, or, for that matter, older forms of explosives?

Where the release of large amounts of energy is involved, conventional high explosives are much more bulky than nuclear explosives and more dangerous to handle. Ordinary atomic explosives (such as the fission bombs) have a practical potential for much greater energy releases than conventional explosives. But they raise two major problems which impose very finite limits upon their peaceful use. First, the fissionable material from which all of their energy derives is prohibitively expensive. Second, the fissioning process creates large quantities of extremely dangerous radioactive substances.

Hydrogen is plentiful and comparatively inexpensive. It releases energy through a fusion reaction which frees some neutrons but no other radioactive debris. While a fission explosion is still necessary to trigger the fusion of the hydrogen, present estimates are that the trigger's proportion of the total released energy can be reduced well below 5 per cent. Some scientists familiar with fusion techniques say that where the size and weight of a nuclear explosive device is unimportant, as would be true in many peaceful applications, it is reasonable to believe that the trigger can be eliminated altogether.

To a very limited number of individuals, the idea of employing nuclear explosives in such a manner was not entirely new when Admiral Lewis L. Strauss, then Chairman of the Atomic Energy Commission, announced on June 9, 1958 that the AEC was "initiating . . . studies to ascertain the feasibility . . . of nuclear explosives for peaceful purposes." Among those perceptive enough to envision the far-fetched was Camille Rougeron, a retired French military officer, who in 1952 (the year of the first successful American H-bomb test) made the heady prediction that constructive uses of fusion explosions would increase rapidly during the ensuing twenty years.

During the first five of those twenty years, the United States held fourteen series of tests of nuclear weapons, involving the detonation of more than seventy nuclear devices. But not one experiment was made with the specific purpose of exploring nuclear explosions for peace.

THE first test that developed valuable information directly related to nonmilitary use of nuclear detonations resulted from public indignation about the hazards of bomb fallout. There was a continuing need to test new weapons, the AEC said, and it began to examine the practicability of conducting tests underground.

The first underground shot, code named "Rainier," was fired on September 19, 1957, at the AEC's Nevada Test Site. A nuclear device containing a charge equivalent to 1,700 tons of TNT was installed some 900 feet below the surface of a volcanic rock mesa at the end of a horizontal tunnel dug for the purpose. The results were more favorable than anticipated. There was no blast wave, no fireball, no significant seismic ground shocks, and no escape of radiation.

After the "Rainier" results were evaluated, the AEC released a number of technical papers prepared or edited by scientists of the University of California's Lawrence Radiation Laboratory. Described in these in considerable detail were various possible peaceful applications of nuclear explosives. The reports also analyzed economic practicability, which quickened commercial interest. During the fall of 1958, and literally up to the moment when the United States' unilateral one-year moratorium on weapons testing became effective at the end of the year, four more underground shots were detonated in Nevada. These varied in power from the equivalent of sixty-five to 23,000 tons of TNT. Their results encouraged the AEC to announce the likelihood of several early experiments