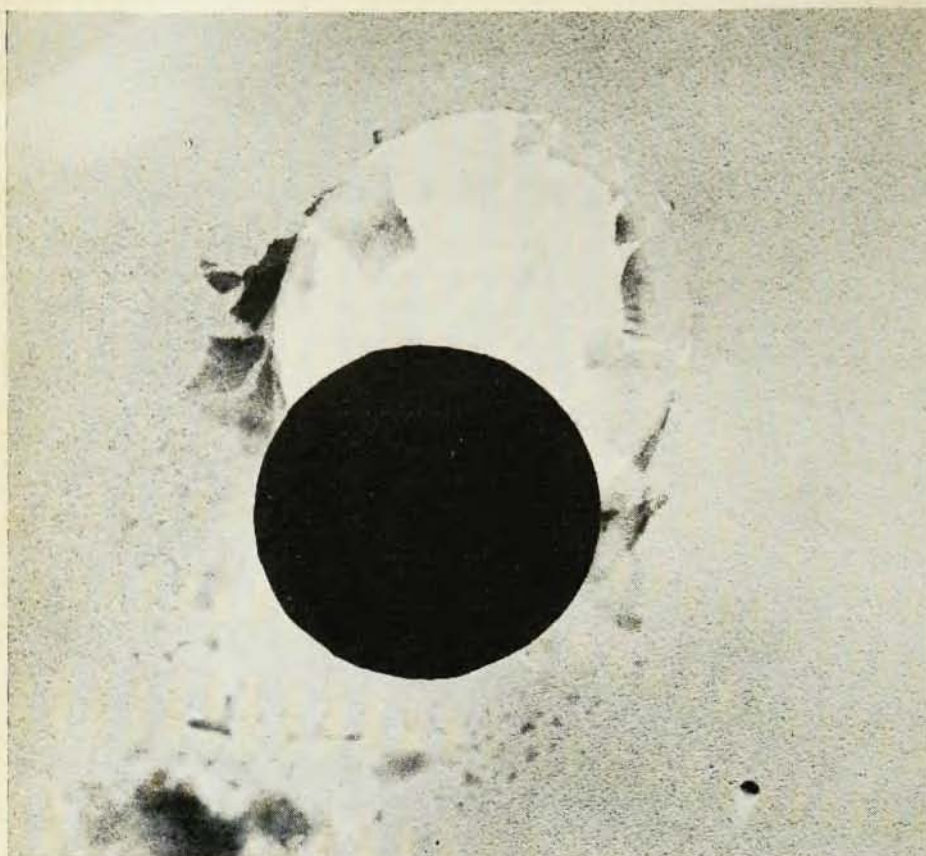




MICROMETEORITE SPHERULE shown on a sheet of collecting material. Diam-

COURTESY C. L. HEMENWAY, DUDLEY OBSERVATORY

eter of sphere is about one micron. From: *Meteors, Comets, and Meteorites*.

of which is ionic and to a small extent metallic (in all probability 2–3%), according to the investigations of this reviewer. Then follows chapter 5: "The new uncertain physics" (7 pages), so called because it explains the de Broglie relationship (light as wave and as particle) and Heisenberg's uncertainty principle. The explanation of the "wave-mechanical model" of elementary particles is given on the next 29 pages; no mathematics is used, only figures and diagrams. The largest chapter of the book (47 pages) is devoted to the "covalent bond." Then follow the chapters: Resonance and molecular orbital theory (30 pages); Complex compounds (31 pages); The metallic bond and semiconductors (34 pages); and "Weak forces—weak bonds" (33 pages). In this last chapter, forces, previously known as van der Waals forces, polarization phenomena (dipoles, HF, H₂O, ice), hydrogen bonding and clathrate compounds are discussed. The last consist of a host lattice, in the cavi-

ties of which other molecules are entrapped, for example, xenon in water under high pressure and below 0°C: Xe (H₂O)₆.

There are some inconsistencies in the text, for instance concerning electrical conductivity of metals on page 235, as compared with the second footnote on page 243. There are also some misprints, for example, in eq. (3.1) on page 50. In some places "bonds" is written instead of "bands" (pages 252, 256, 259).

Nearly all main bonding problems are covered by the book; they are well discussed in an elementary manner. Besides, at the end of each chapter (except 5) references for further studies are given. The book is recommended to all who are interested in an elementary presentation of bonding problems.

However, the reviewer doubts whether chemistry freshmen, especially those without secondary school courses in chemistry and physics (see preface) are sufficiently able to understand the book.

Solar system irregulars

THE PHYSICS AND ASTRONOMY OF METEORS, COMETS AND METEORITES. By Gerald S. Hawkins. 134 pp. McGraw Hill, New York, 1964. Paper \$2.50.

by E. J. Opik

Published in the series in Undergraduate Astronomy, of which the author is consulting editor, one would have expected to see a concise textbook, with clear definitions of the basic notions and precise explanations of how the more advanced knowledge has been arrived at. We are presented instead with an impressionistic sketch of modern developments, to which the author has solidly contributed himself, which may appeal to co-workers in the field but which may baffle the undergraduate who will need guidance, probably from the author himself.

The statements are usually correct and the material presented is of a wide scope for so short a monograph. However, misstatements and faults of presentation are also rather numerous, some of which are quoted or corrected below.

Radiation pressure is not the driving force in comet tails (page 2). A micrometeorite is not necessarily an object "that completely melts" during passage in the atmosphere (page 4). More meteors are not necessarily seen at lower altitudes (page 6); the author has overlooked that the greater volume covered is opposed by the greater distance and faintness of the objects. I in Öpik's equation (1.1, page 7) is not "ergs/sec" but *visual* ergs/sec involving luminous efficiency. Contrary to statements on pages 16–18, almost all the heating of the meteoroid is due to reflected air molecules. On page 17, the deceleration equations lack the *minus* sign, and on page 18, the dimensionless coefficient of efficiency, τ , is given the dimension of "ergs sec⁻¹". The rather sophisticated figure 2.2 is inadequately explained, and its promised "open circle" (page 20) is missing. On page

* * *

E. J. Öpik is a member of the department of physics and astronomy at the University of Maryland and the staff of the Armagh Observatory in Northern Ireland. Meteoritics is one of his specialties.



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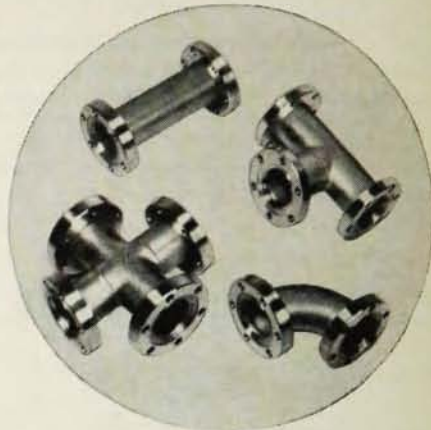
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GENERAL  ELECTRIC

268-16

23, the meteoroid is said to crumble "when it first encounters atmospheric resistance"; when is *first*? On the same page *m* stands for *n*. Atomic sputtering of a solid is not "smashing" (page 53). On Whipple's diagram of wind velocities, the wind has reversed its direction only once, not "5 times" (page 78) (there are five maxima and minima, without reversal). Velocities of separation for cometary fragments "of the order of a few kilometres per second" (page 115) are unthinkable. In the figure on page 126 the direction of motion of Jupiter is not indicated; if it is conventional (counterclockwise), the outcome will be a hyperbolic comet orbit, not an ellipse as shown; if it is clockwise, the most unusual (unrecorded) case of a retrograde short-period comet results as shown; also, "many successive perturbations" are *not* required—one could suffice.

There is an appendix containing "Review Questions and Problems" an average undergraduate would hardly master most of them on the evidence of this text alone; evidently, their difficulty has been recognized also by the author, who advises ignoring them "with impunity". There is no list of literature.

The reading of this, partly colloquial, exposition of meteor science definitely leaves the impression that the author has profound knowledge and experience in his subject. However, for the uninitiated it is a difficult kind of introduction to the maze of problems involved in the study of the stray bodies of the solar system.

Generations in transit

FLIGHT TO THE STARS. By James Strong. 178 pp. Hart, Hart, New York, 1965. \$4.95.

by *Herbert Malamud*

When the first automobiles made their appearance, some critics of the noisy monsters tried to convince people that riders would not survive a velocity greater than sixty miles an

* * *

A theoretician, Herbert Malamud is associated with the Radiation Research Corporation of Westbury, Long Island.



SPACE TRAVEL IN 1901. The vehicle was a ride at the Niagara Falls Pan-

American Exposition and gave customers a simulated trip to the moon.

hour. During the decade of the nineteen-thirties, science fiction stories treated in great detail the concept of space flight, ignoring those (including more than one otherwise competent scientist) who denounced space flight as impossible.

Now that we are perhaps five years from the moon, and it is clear that an extension to manned exploration of the planets is likely soon afterwards, we can still find those who circumscribe man's future. Doctor A will tell us that exploration is all very well, but clearly it is forever impossible for man to create permanent settlements on the inhospitable planets. Professor B will say that the planets are possible, but we can never reach the stars. Your reviewer is less dogmatic. I claim that it is impossible to light a safety match on a cake of wet soap. All else is possible.

Strong believes that it is possible to reach the stars, and he has written a book to proselytize his belief. In his words, "Only the madness of atomic war and total annihilation can bring the future to an end." His book, of necessity a mixture of science and science fiction, includes every argument he can muster to support his thesis, and destroys almost

trivially several arguments against it.

The first section of Strong's book begins by admitting that we do not have a propulsion unit at present capable of driving a ship to the nearer stars in anything like a reasonable time. It discusses, without finding a "best solution," several drive concepts, including chemical, electrical, nuclear and thermonuclear rockets. Unknown concepts such as space warps, gravitation drives and faster-than-light travel are dismissed with short comments, since the unknown cannot be discussed in any detail. Since speeds greater than presently achieved rocket speeds are unknown, Strong avoids discussing them in detail. Instead, he uses a "speed growth" curve, plotting the highest speeds achieved by man over the last two hundred years or so, and extrapolating the curve past the present. Far fetched as it is, this reviewer agrees that this is the only course open to him.

Thus, he calculates that in a century, speeds of one percent of light speed may be expected, and 80 years later, five percent. This, he concludes, is about as far as he would want to trust the extrapolation of the speed growth curve, and, on the