

A reservoir of plasmas

THE RADIATION BELT AND MAGNETOSPHERE. By Wilmot N. Hess. 548 pp. Blaisdell, Waltham, Mass., 1968. \$16.50

by BRIAN J. O'BRIEN

Despite debatable opinions about the cost-effectiveness of space research, it remains true that the major scientific discovery of the post-Sputnik space era is that of the geomagnetically-trapped radiation and recognition of the magnetosphere of the earth. This book is the only comprehensive review of the topic. The author, distinguished in his personal contributions to the subject, presents a chatty and informal but accurate account of the status of research into the earth environment at high altitudes.

The importance of the book is not only that it illustrates man's evolution from a two-dimensional to a three-dimensional creature, but that it also serves more pragmatically as a reservoir of information for plasma physicists. This reservoir will be exploited when they come to recognize that the earth magnetosphere is a vast, natural and generally uncontrollable, and yet accessible, plasma laboratory with scaling factors impossible to reproduce on the ground.

The book progresses in an orderly manner from the relevant political confusion in the US before 1958 through the exciting discoveries by early Explorer and Sputnik satellites to the current understanding—and mysteries—of the magnetosphere. Hess does not attempt to hide the unknown factors, but instead takes the commendable approach of actually listing some of the problem areas. It is not often that one finds a scientific book that acknowledges so frankly that Mother Nature still has concealed many mysteries. Perhaps the reason is that the author has been confronted too often with the moment of truth when a scientific payload is destroyed catastrophically by an abortive rocket launch. To paraphrase Hilaire Belloc

There is no cure for this disease,

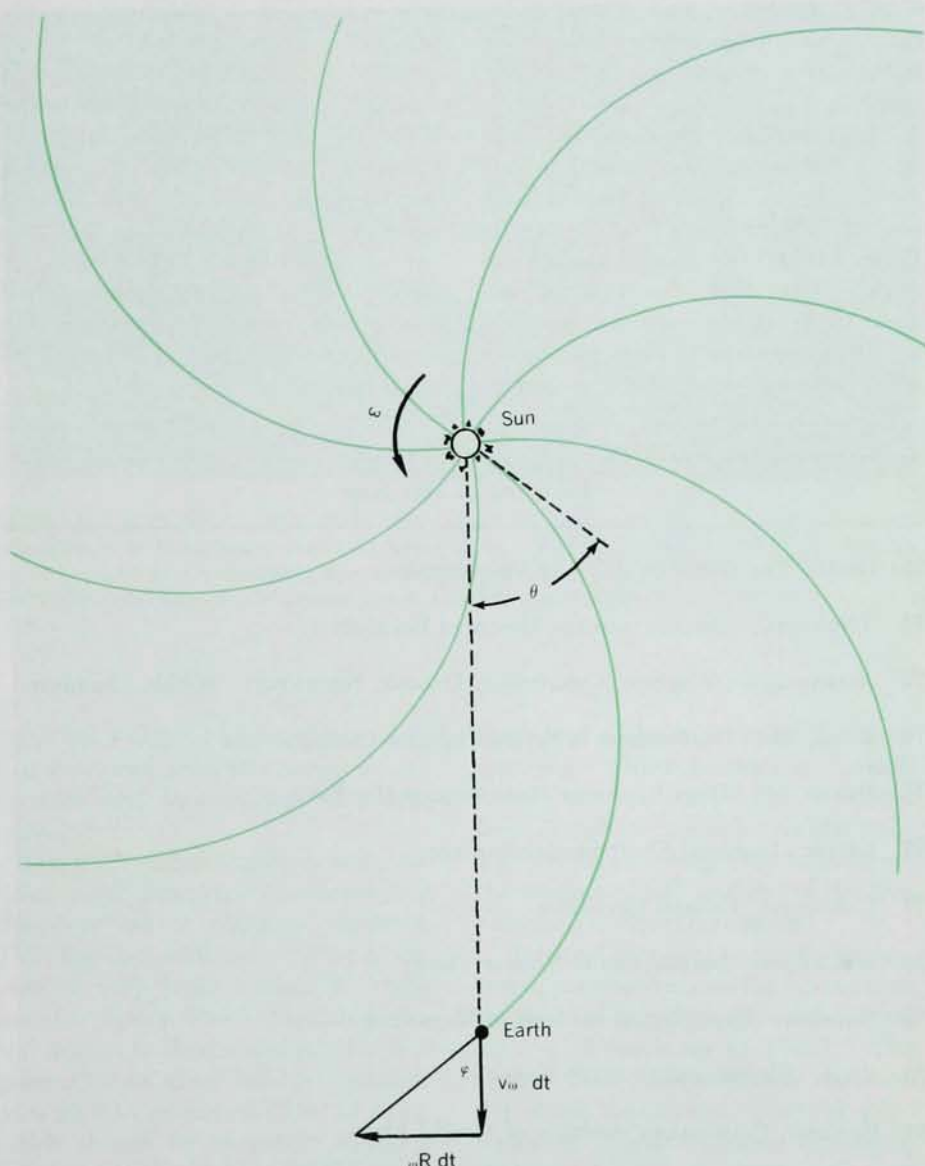
The doctors said as they took their fees.

After discussing the early satellite

launches, Hess methodically proceeds to treat the motion of charged particles in the geomagnetic field and the postulated sources and losses of trapped radiation. The subject matter is then extended outwards from the earth in discussions of the inner zone of trapped particles, the outer zone, the "edge" of the magnetosphere and beyond into interplanetary space. The very fact that man can adopt such

a large-scale and yet perceptive vision is clearly and accurately set forth by the scientific data collated and assessed by the author. The role of the mysterious auroras in magnetospheric phenomena is also examined.

These data are of interest, of course, to the research scientist. But because radiation damage can degrade satellite solar-cell power supplies and semiconductor devices, they are also important



INTERPLANETARY MAGNETIC FIELD. For a radially expanding solar wind and a rotating sun the field lines trace out an Archimedian spiral in this calculation. The angle ϕ between the local direction of the field and the earth-sun line is often called the "garden-hose angle" by analogy with the stream of water droplets from a rotating garden sprinkler. (From *The Radiation Belt and Magnetosphere* by Wilmot N. Hess.)

for engineers planning spacecraft of the future, as the Starfish bomb explosion dramatically showed.

In a book of such length and detail, it is probably inevitable that there be proofreading errors. These occur in some particularly important sections. The book, however, has several hundred original references and adequate internal-consistency checks so that the devoted reader can assure himself what is correct.

Significant facts are omitted from the text. For example no mention is given to the thousand-fold error in early estimates of the outer-zone electron flux, which so dramatically affected concepts of the radiation hazards awaiting astronauts. Significantly the book does not have a conclusion. This is a deliberate omission simply because it is not yet time to write a conclusion when Hess's questions remain unanswered. Indeed the last sentence of the book begins "For example, if . . ."

This is certainly the definitive book on magnetospheric explorations viewed by a scientist. Earth-bound plasma physicists must not ignore it. Politicians and the general public may neglect it, to their disadvantage, because of its all too lucid and detailed scientific discussion. Perhaps what is needed is a companion book, similar to

The Organization Man, that will place more emphasis on the human aspects of space research. There is something unique about a research field in which no second chances are given. Even though the author is a theorist, and therefore inevitably an optimist, he shows in his book an appreciation of

the realities that confront space experimentalists.

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Speculative and conventional special theory

PARADOXES IN THE THEORY OF RELATIVITY. By Yakov P. Terletskii. (Trans. from Russian) 120 pp. Plenum, New York, 1968. \$9.50

by DON B. LICHTENBERG

Paradox: 1. An assertion or sentiment seemingly contradictory, or opposed to common sense, but that may be true in fact. 2. A statement actually self-contradictory or false.

Yakov P. Terletskii uses the word in the first sense because he treats the theory of relativity as being fully self-consistent. It is clear from the context that he is concerned only with the special theory, although, in an unfortunate choice of words in chapter 1, he refers to the "complete equality of all conceivable frames of reference." He means, of course, the equality of all inertial frames.

One unusual aspect is Terletskii's attempt to derive the Lorentz transformation without assuming the constancy of the velocity of light c . Starting with the postulates of the isotropy of space, the uniformity of space-time and the equivalence of inertial frames, he gets quite far with the derivation. However, where c^2 appears in the usual Lorentz transformation, Terletskii obtains only an unknown constant.

To evaluate this constant, he appeals to the experimental fact that energy E of a particle moving with velocity u is equal to $m_0\gamma c^2$, where m_0 is the mass and $\gamma = 1/(1 + u^2/c^2)^{1/2}$. (The author puts this somewhat differently, stating that the moving mass is γ times the proper mass.) Of course, Einstein did not have at hand the knowledge that $E = m_0\gamma c^2$, but derived his famous formula using the assumption that the velocity of light is a constant. Terletskii also includes a conventional derivation of the Lorentz transformation.

A large part of the book is devoted to the usual problems connected with the contraction of moving rods, the slowing down of moving clocks and the nature of the variation of momentum and energy with velocity. The so called "clock paradox" is well treated.

By far the most intriguing features are contained in the final two chapters on the possibility of superluminal velocities and on imaginary and negative mass. Terletskii argues that the existence of imaginary and negative masses is compatible with special relativity. However, he fully recognizes that other principles of physics—causality and the second law of thermodynamics—can create difficulties. Particles of imaginary mass (if they exist) always travel faster than light. If these particles could be used to send classical signals, there would exist inertial frames in which the effect preceded the cause.

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