

Walton in achieving close packing, but this is offered without explanation or hypothesis. Again, the permeability apparatus sketched in Fig. 5.12 is essentially similar to streaming potential cells for electrokinetic studies. The validity of using bulk fluid viscosity when the fluid is in narrow channels has been doubted in electrokinetics and could be questionable in permeametry. Packing of solid particles in liquids receives scant attention; CPVC studies in paints are not mentioned. This is surprising when one might postulate that paint films approximated to two-dimensional packings and were worthy of mention for this alone.

The gaps between theory, experiment and practice are wide and an opinion on present and future lines of investigation which might narrow these gaps would bring the book to a more definite conclusion.

Despite these minor shortcomings, W. A. Gray has produced an eminently readable book on a complex subject, and he is to be congratulated. D. P. BRYANT

## RADIATION BELTS

### The Radiation Belt and Magnetosphere

By Wilmot N. Hess. Pp. xii + 548. (Blaisdell, a Division of Ginn: Waltham, Mass., and London, 1968.) \$16.50.

PROBABLY the greatest scientific achievement of space research has been the discovery of the radiation belt and the advance in knowledge of the magnetosphere; incidentally this has been almost entirely American work. In the past decade the subject has advanced from very indirect observations, coupled with rather speculative theory, to an established branch of science. This is not to say that the magnetosphere is fully understood and, of course, further advance requires further observations with satellites. The general layout of the magnetosphere is known, however, and the now numerous workers in the field need a book of the sort reviewed here. There have been several conference reports covering the subject, but Hess has been so energetic as to cover the whole field, while his book has the advantages of a single author, particularly in the interrelating of the chapters. He also writes in a readable, informal style, and keeps theory and observations well balanced.

The short but interesting introduction includes a summary and list of problems for the future. Basic theory is given in the second chapter, including a thorough account of particle motion in a magnetic field with all three adiabatic invariants and some plasma theory. The chapter ends with a painstaking and clear description of the various coordinate systems used, and explanations of how particle observations are expressed and related to coordinates. The third chapter concerns the physical mechanisms which have been proposed for the sources and loss of trapped particles, though some of these mechanisms are not now believed to be important.

The fourth chapter concerns the inner zone, particularly such questions as spectrum, time decay and solar cycle changes, and includes theoretical discussion. Chapter five concerns radiation belts produced by bombs, which are scientifically useful because the source is known. The sixth chapter, on the outer belt, contains some of the most interesting physics developed in this subject, which is very close to the plasma theory developed in connexion with fusion research. Hess gives extensive accounts of the theory of the "pumping" mechanism and of the interaction of the trapped particles with VLF and ELF waves. These are believed to be important, the former as an energy source and the latter in controlling the loss rate. Chapter seven on the magnetopause includes considerable theoretical discussion of instabilities and the eighth chapter on aurorae also includes recent theoretical studies. The short ninth chapter on synchrotron radiation discusses radiation from the belt produced by the large Starfish

explosion and radio noise from Jupiter. Chapter ten on low energy particles discusses magnetic storms and whistlers and other VLF phenomena. Finally, there are three useful appendixes tabulating basic information.

This book is attractive particularly because of the wealth of high quality diagrams, about as many as there are pages. Hess also uses the colourful jargon of the subject, such as the leaky bucket and the windshield wiper. The very first diagram is open to criticism; it shows the 1950s view of the geomagnetic field as a dipole in vacuum, which is unfair to theorists. This is recognizable as the influence of Brian O'Brien, which also appears at one or two other points. As a whole, however, the book is pleasing and timely and should be warmly welcomed.

J. W. DUNGEY

## Correspondence

### Is Botany Dead?

THESE correspondents refer to two articles which appeared in the November 9 issue of *Nature*, one on page 521 and one on page 541.

SIR,—You ask if botany is dead. You may be interested to hear, therefore, that the British Association has recently set up a committee, of which I am chairman, to consider the "Future of Botany".

Yours faithfully,

P. W. BRIAN

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SIR,—Your editorial in *Nature* referring to the article by Sir Frank Engledow on botanical studies in this country explains the situation as it exists, but hardly suggests how it might be improved.

Unfortunately, the popular derisive image of botany originates at VI Form level, but we feel that this image would quickly change if the whole scope of botany could be presented to the potential university student. Too much emphasis is placed on systematics, especially by concentrating study on the detailed life histories of selected representative plants at A-level. Are all fern prothalli heart shaped?

If teachers would digress from these A-level species and inject some enthusiasm into the lessons of their chosen subject, the situation might change. The Nuffield scheme, through its scientific approach by investigating problems experimentally, should help to introduce some vitality into the subject. Botany could also be brought into perspective by emphasizing the ecological, physiological and economic aspects and in particular the importance of these subjects to man.

If this fails, then we think that the pundits will have a dubious pleasure in being correct.

Yours faithfully,

A. MACKIE

C. SCARD

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University of Southampton.

SIR,—As long as there are people on Earth to feed and an environment fit for plants and humans to grow in, the service of botanists will continue to be needed. Curiosity and love of nature will ensure that many young men and women are attracted into this field. But the teaching they