

## EXPANDING UNIVERSES

by Erwin Schrodinger

Professor Schrodinger explains in a way which can be visualized, and with the help of a series of carefully constructed scale-drawings, some of the puzzling properties of expanding flat and spherically closed world-models. There are chapters on *The de Sitter Universe*, *The Theory of Geodesics*, *Waves in General Riemannian Space-time*, and *Waves in an Expanding Universe*. The exposition requires the knowledge of calculus and of analytic geometry, but it does not presuppose a thorough previous acquaintance with Einstein's theory of gravitation. Bibliography.

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subject at least secrecy had long outlived its usefulness. After the session, the minor questions of absolute normalization were dealt with, temporarily at least, by the adoption of "International Values" for the thermal cross sections of  $U^{233}$ ,  $U^{235}$ , and  $Pu^{239}$ —a step that can forestall confusion in the comparisons of future results, but which can be modified with understanding when future refinements in the absolute values of certain basic cross sections become available.

The subject matter of other sessions ranged into survey papers on delayed neutrons, several papers on the number of neutrons emitted during fission for a variety of nuclides, an important experiment on the measurement of the cross section of the king of reactor poisons, radioactive  $Xe^{135}$ , and discussions of methods of analysis of experimental data and of the significance of the work in theories of nuclear structure. In all, forty-one papers are reproduced. The records of the questions and answers that followed the sessions lends a welcome note of "liveness" to the printed proceedings, and the excellent quality of the record, the promptitude of its publication, and the modest price of all of the volumes are tributes to the very efficient editorial job that has gone into the publication of the complete conference record.

**High-Temperature Technology.** Edited by I. E. Campbell. 526 pp. John Wiley & Sons, Inc., New York, 1956. \$15.00. Reviewed by Norman H. Nachtrieb, *Institute for the Study of Metals*.

Thirty five contributors have pooled their special knowledge to produce this monograph on the technology of high temperatures. It is an essentially practical book, concerned with three broad aspects of the subject: the varieties and properties of refractory materials, methods for the production of high temperatures, and techniques for the measurement of high temperatures and physical properties. For the purposes of the monograph, "high temperatures" are considered to be those which are terrestrially attainable in the range  $1500^{\circ}\text{C}$  to about  $3200^{\circ}\text{C}$ . Approximately half of the volume is devoted to various classes of refractory substances and their thermal, mechanical, and electrical properties. Metals are generally unsatisfactory as structural materials for one or more of a number of reasons: poor oxidation resistance, excessive volatility, low strength, or cost (in the case of noble metals). More suitable materials are to be found in the oxides, silicides, nitrides, borides, sulfides, and carbides of certain metals. Several dozen simple oxides and a comparable number of complex oxides are listed with melting points ranging to  $3300^{\circ}\text{C}$ . Considerations other than high melting point enter in the selection of refractories, however. Some oxides (e.g.,  $\text{CeO}_2$ ) form volatile lower oxides in reducing atmospheres; others (e.g.,  $\text{V}_2\text{O}_5$ ) cannot withstand oxidizing conditions. Still others (e.g.,  $\text{La}_2\text{O}_3$  and  $\text{CaO}$ ) hydrate readily, undergoing dimensional changes or complete disintegration. Certain transition metal carbides show promise up to  $2500^{\circ}\text{C}$  in inert

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atmospheres (NbC and TiC), as do some borides ( $ZrB_2$ ) and sulfides (CeS). The numerous tables of physical properties of these materials which appear in the first nine chapters are especially valuable.

Furnace designs, principles of operation, and their range of usefulness are discussed in several chapters. Methods of producing high temperatures based upon resistance heating, arc furnaces, induction heating, and solar furnaces are well summarized. A brief description of an electronic torch suggests the possibilities offered by the energy released on recombination of dissociated polyatomic gases. No reference appears to the tremendous temperatures achieved in nuclear fission or fusion reactions.

The concluding third of the book deals with the measurement of temperature and of such mechanical and physical properties as high-temperature plastic flow, hardness, melting point, vapor pressure, thermal conductivity, linear expansion, thermal shock, and electrical conductivity.

For a book whose authorship is as manifold as this, there is a gratifying uniformity of style and over-all sense of organization. References are numerous and up-to-date, and the indexing (author and subject) appears to be well done. This should be a useful reference book both to scientists and engineers interested in the technical aspects of high temperatures.

**Methods of Mathematical Physics** (Third Edition). By Sir Harold Jeffreys and Bertha Swirles. 714 pp. Cambridge U. Press, New York, 1956. \$15.00. Reviewed by Philip M. Morse, Massachusetts Institute of Technology.

The development of theoretical physics has been intimately related to the development of the branch of mathematics called analysis, from its beginnings in the era of Newton and Euler, to the present. It is thus not surprising that courses and texts purporting to show the physicist how to use mathematics, if they get beyond the cookbook stage, spend most of their time on analysis. The book under review is no exception, though it is far from being a collection of recipes. Since the appearance of its first edition, ten years ago, it has become one of the five or six standard reference works on the use of analysis for the solution of problems in physics.

The pedagogic problem of showing how mathematics is used in physics may be solved by developing the mathematics logically, bringing in the various applications to physics as illustrative examples, or by sticking more closely to the physics and working out the mathematics as needed. Probably both methods have to be applied before the treatment is successful. At any rate the book of the Jeffreys is of the first type, with the exposition following the logical development of the mathematics as far as possible. In this it can be compared with the two-volume treatise of the same title by Courant and Hilbert. The fact that the two volumes supplement, rather than duplicate, each other may