

after the other in the same nucleus) and spallation (evaporation processes from highly excited nuclei formed in high-energy collisions). The rest of the book contents (nuclear matter according to L. C. Gomes, John D. Walecka and Victor Weisskopf, general scattering theory, models of finite nuclei, compound-nucleus formation, the statistical model and direct reactions) may be found in Preston. Preston's book strikes me as more detailed (it is, after all, twice as long); one may compare figures 18.8 in Preston and 4.9 in Kikuchi and Kawai to confirm this impression.

Why doesn't someone start a loose-leaf *Physics of the Nucleus* (in several volumes perhaps)? If someone felt that he could add to the thing, he could suggest revisions here and there and maybe add a few pages. Every few years the thing would have to be edited anew. No doubt the *Encyclopedia of Physics* works something like that. But I am not thinking democratically—let 1000 *Physics of the Nucleus* bloom! Here you have another blossom—you judge whether or not it is prettier than the rest.

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The reviewer is a theoretical nuclear physicist at Los Alamos Scientific Laboratory.

Relativity insights

ASSUMPTION AND MYTH IN PHYSICAL THEORY. By H. Bondi. 88 pp. Cambridge Univ. Press, Cambridge, Mass., 1967. \$2.95

by LAWRENCE SKLAR

This slim volume contains the four Turner Lectures, delivered at Cambridge University in 1965, by the noted astrophysicist of the University of London, Hermann Bondi.

The first lecture, "The Limits of Theory Making," is a chatty, rather diffuse essay in philosophy. Here we learn that Bondi admires Karl Popper but, unless I misread Popper, Bondi somewhat misunderstands his views. Bondi believes that disproved theories can remain useful, and he doubts the usefulness of all-encompassing "unified field" theories (but sees, at least, something plausible suggested by Eddington's later work). Bondi further believes that theories have accreted unfortunate "myths" to themselves that distort

both our understanding of the theory and its influence on later science.

The second talk, "Relativity: Its Myths and Pre-suppositions," begins with a series of deep and insightful remarks on the nature of relativity in the special theory and the relation and indebtedness of this concept to the relativity of Galileo and Newton. Bondi points out the respects in which the Einsteinian theory is a return to, rather than a departure from, Newtonian theory. The essay continues with an elegant exposition of the fundamentals of the special theory by means of the k calculus. The lecture concludes with as lucid a brief treatment of the clock paradox, rightly styled by the author as the "so-called clock paradox," as I have seen in print. The treatment is a persuasive argument for the heuristic powers of the k calculus.

Lecture 3, "Gravitation," gives us a breathless, nonmathematical introduction to general relativity, but without the expository novelty of lecture 2. As if this were not enough to encompass in 15 pages, the section concludes with an attempted popular exposition of the recent work of Ezra T. Newman and Roger Penrose on gravitational waves. The author is dismayed that gravitational waves fail to have their energy concentrated on a thin shell of a wave front and even more disturbed that, according to this work, the present observed gravitational field of an object is a function of its past history as well as its present (or recent) state. What is worse, the influence of the remote past appears not to fade away, even asymptotically, in the remote future. One awaits a more detailed exposition of these curious results in a form suitable for nonspecialists.

Lecture 4, "The Origin of Inertia and the Universe," advances into the status of Mach's Principle in general relativistic theories. The author is perceptive and subtle, but, as in the third essay, the limitations of the lecture format make his treatment far too cursory. I suspect that most of what he says will be fully intelligible only to the already well initiated. Again our appetites for more are whetted by mention of the Hoyle-Narlikar attempt to formulate an action-at-a-distance version of general relativity.

In summary, this "ceremonial" lecture series is hardly the ideal format for presenting subtle ideas of physics



BONDI

and cosmology to a lay audience. Bondi does as well as one could possibly expect in these circumstances. One lecture is a model of popular science exposition. Two others, while too hasty and brief really to do the job they set for themselves, inform the sophisticated reader and at least tempt the layman to look further. Only the introductory lecture is, quite pardonably, too chatty to really serve any function at all, at least when it is removed from the intimacy of the lecture hall onto the cold printed page.

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Low-pressure techniques

VACUUM SYSTEM DESIGN. By N. T. M. Dennis, T. A. Heppell. 223 pp. Chapman & Hall, London (Barnes & Noble, New York), 1968. \$8.00

by J. H. SINGLETON

The uses of vacuum in industrial applications and in the laboratory are exceedingly diverse and require a wide variety of techniques. The intent of this book, as described on the jacket and in the preface, is to provide a guide to available vacuum equipment and to the design and operation of vacuum systems in the entire range, cov-

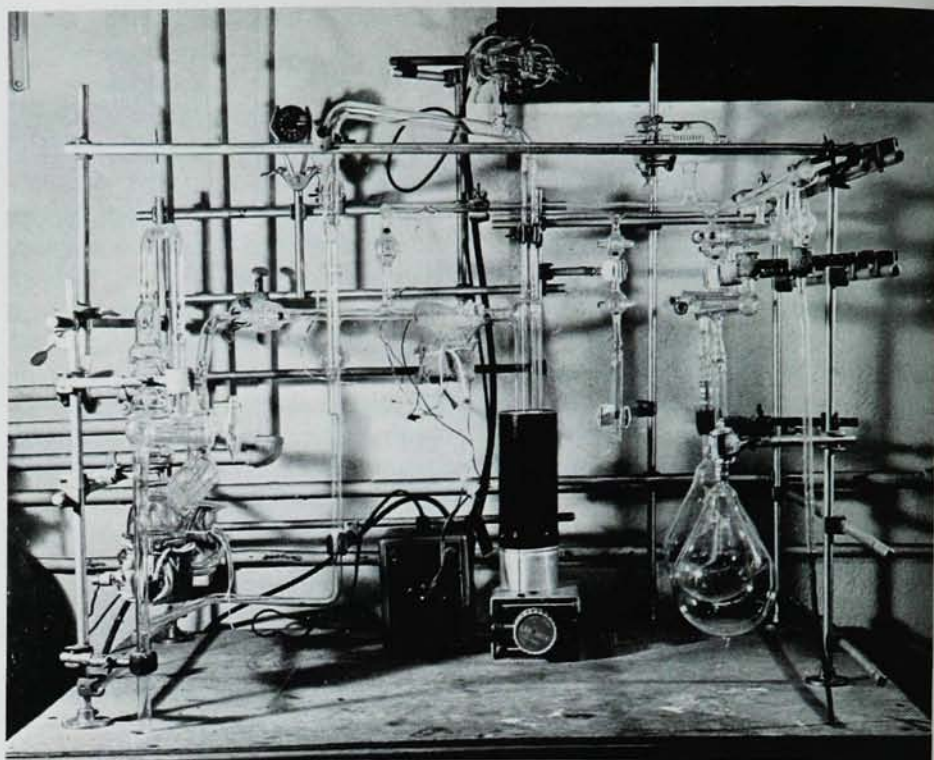
ering operating pressures from 10 to 10^{-11} torr. This is a formidable task, particularly in a relatively small book.

The authors have spent many years as consulting engineers in the vacuum field and are therefore acquainted with a wide variety of applications. Because of the range of topics many details are inevitably omitted and it is therefore regrettable that the book contains very few references. Thus one is constantly frustrated in attempting to trace sources of the information for either verification or amplification.

The introductory chapter is a very brief survey of some topics in gas kinetics and serves to define terms and concepts. The following three chapters describe and discuss the functions of vacuum pumps and accessories such as traps, valves and gauges. The descriptions of most of the pumps are completely covered by an earlier volume in this same series, written by B. D. Power, and could well have been omitted. In many sections the information is so brief as to be of no value, for example, a paragraph entitled "Choice of Pump Fluid" provides virtually no assistance, nor is any specific reference made to sources of further information. These chapters contain more extensive discussion of some newer developments, such as sputter-ion pumps. In this area a more critical discussion would have been desirable, with discussion of both problems and advantages. For example the life of many pumps has been limited by electrical leakage across insulators rather than erosion of the cathodes, and this same phenomena frequently invalidates pressure measurements using the pump ion current.

A wide range of vacuum gauges is also discussed but in many cases only a brief description is possible and adequate reference to further information is not provided. The emphasis on recent techniques such as modifications of the Bayard-Alpert gauge is commendable, but again, space limitations result in important omissions. For example electronic desorption of ions, a relatively common source of error in pressure measurement, should have been discussed.

Chapters 5 and 6 discuss characteristics of vacuum chambers and pumping systems, providing information necessary for system design. A number of the tables and curves illustrating characteristics of selected systems are of limited value and could well have been omitted in favor of more de-



VACUUM STATION, used for filling cells for studies of alkali metals and vapors, constructed at the Columbia Radiation Laboratory at Columbia University.

tailed design criteria. Figure 5.10, showing the outgassing curve for "... vessels containing a reasonable number of O-ring seals ..." is quite uninformative. On the other hand, the discussion of fabrication techniques and the selection of construction materials could have been substantially expanded, particularly in the area of inert-gas arc welding.

The text is not always carefully written and contains a substantial number of errors. However, the major drawback with this book is that

it has attempted to cover too wide a range of topics, and it cannot be recommended as a working guide in the design or operation of vacuum systems. For detailed guidance one must look elsewhere, although it is quite evident that no single source of information is available. The field is still open.

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Model building

ENGINEERING EXPERIMENTAL DESIGN FUNDAMENTALS. By Edwin M. Bartee. 399 pp. Prentice-Hall, New Jersey, 1968. \$9.50

by **ROBERT L. WEBER**

Edwin M. Bartee aims to present engineering experiment design in its total problem-solving context. Case histories of engineering experiments are used liberally and effectively to overcome the difficulty in teaching a methodology. No previous knowledge of statistics is assumed, but in the last two chapters statistical methods are developed for analysis of experimental data.

Model-building methods are presented in two primary steps. The first is the design of the experimental model (both structural and functional) and the second is the design of the analytical model. The methodology of experimental design is presented by formulating the experimental problem, analyzing the experiment, designing the experimental and analytical models, conducting the experiment and deriving a solution to the model.

In some preliminary discussion of engineering problems, introduction of mathematical notation in terms of