Book Reviews

Stars and Stellar Systems

The study of the internal structure of the stars would seem, at first thought, to be a singularly futile and unrewarding field of endeavor; it is difficult to imagine a more inaccessible spot than the interior of a star. This subject, however, is one of the classical topics in astrophysics, and it has attracted a continuous succession of outstanding astronomers and physicists. Although much of the theory of stellar structure is necessarily highly speculative, there have been some truly solid achievements. Only a short time after Walter Adams obtained the necessarily poor spectroscopic observations of the companion of Sirius, which suggested an average density of the order of 50,000 for this white dwarf, the theory of a degenerate gas was worked out and successfully applied to (of all things) the behavior of electrons in metals at room temperatures. A short time later, studies of the structures of stars of various masses and luminosities strongly suggested that some kind of atomic-energy generation was taking place in these deep interiors, and thus made it almost inevitable that such processes would first be recognized, then evaluated in detail, and finally controlled and used.

This volume, **Stellar Structure** (University of Chicago Press, Chicago, 1965. 668 pp., $17.50), edited by Lawrence H. Aller and Dean B. McLaughlin, is the fifth to appear in a nine-volume compendium of astronomy and astrophysics, *Stars and Stellar Systems*, which is being published under the general editorship of Gerard P. Kuiper and Barbara M. Middlehurst. In this volume, 11 experts discuss, in 11 long chapters, the problems of internal structure, the sources of stellar energy, the origin of the chemical elements, observational and theoretical aspects of supernovae, the nature of magnetic stars, stellar stability, and stellar evolution and age determinations. Three of the 11 authors are products of the Indiana University school of astrophysics. The book should stimulate the increasingly large numbers of nuclear physicists and astronomers specializing in this field, and should serve as a basic reference source for the many more astronomers who are now active in problems associated with stellar evolution.

A few clarifying graphs or figures would have improved some of the almost completely mathematical chapters. I could find no graph of the march of temperature or pressure with the radius for any stellar model, nor a graph of the premain sequence evolution of any star. It would have been useful to have included the H-R diagram of white dwarfs and a graph comparing their masses and radii with theory. No color-magnitude diagram of a globular cluster is given. The only chapter illustrated with photographs is an outstanding one on supernovae observations; this chapter, by Fritz Zwicky and written in his highly personalized style, might more appropriately have been included in another volume of the series. The chapter on stellar opacities, by Arthur N. Cox, combined with the lengthy and detailed opacity tables that Cox and his associates calculated at Los Alamos, should alleviate a serious stumbling block caused by a previous lack of reliable information of this sort.

The study of stellar structure has been strongly stimulated by the development of electronic computers, by the mounting physical data on nuclear cross-sections and opacities (stimulated in turn by the need to thoroughly understand nuclear explosions), and by the observations of the color-magnitude diagrams of globular and galactic clusters. In one sense the theoretical astrophysicists are far behind the observations; it has taken them about 50 years to "find" the main sequence, and most of the rest of the H-R diagram, so important in a wide variety of astronomical investigations, is largely unexplained.

Some of the theoretical knowledge of stellar interiors that is accepted today and seems "safe" may well not be. Four years ago, for example, C. Hayashi published a classical paper which indicated that the premain sequence evolution of stars was quite different from that previously envisioned, and that gravitational contraction times needed to be drastically reduced. One may well wonder just how close to the truth even this new concept may be. Unfortunately, crucial observational data are not being accumulated sufficiently rapidly; there is an appalling shortage of telescopes. The detailed study of globular clusters to the faintest possible limit and the study of the spectra of supernovae and of white dwarfs, for example, have been, of necessity, limited to a very few observers with the Palomar 200-inch telescope.

In this connection it is worth quoting the editors: "From the standpoint of stellar evolution studies, two of the most valuable objects known are the Magellanic clouds. In either of these, one may observe large stellar populations—all at essentially the same distance from us. The most luminous and easily observed stars are those that are evolving the most rapidly. Whereas one may compare only a handful of bright, rapidly evolving stars in any single cluster in our own Galaxy, in the Magellanic clouds one may compare multitudes of stars at almost any given epoch in their evolution. Unfortunately, there does not yet exist a single fully modern adequate telescope in the southern hemisphere! It is fervently to be hoped that these deficiencies in astronomical instrumentation will be remedied soon."

JOHN B. IRWIN
Carnegie Institution of Washington, Casilla 61-D, La Serena, Chile

Geological Sciences

Solutions, Minerals, and Equilibria (Harper and Row, New York, ed. 2, 1965. 465 pp., $14.25), by Robert M. Garrels and Charles L. Christ, deserves a wider audience than its title may attract; any chemist who is striving to understand the behavior of solutions should be intrigued and inspired by the research of Garrels, Christ, and their co-workers in the chemistry of natural waters. Although much insight has been provided, the failure of presently used laws to fully explain such complex systems points