Book Reviews

Effects of the Sun

The New Solar Physics. Papers from an AAAS symposium, Denver, Feb. 1977. JOHN A. EDDY, Ed. Published for the American Association for the Advancement of Science by Westview Press, Boulder, Colo., 1979. xxiv, 214 pp., illus. $17.50. AAAS Selected Symposia Series, 17.

This slim symposium volume presents the current status of research in several areas of solar physics. The book begins with a delightful introductory essay by Eugene Parker on the importance of solar physics to astronomy. This contribution alone is worth the price of the book and should be required reading for all astronomers—solar and nocturnal.

The remaining four review papers, although uneven in style and depth of coverage, will give the serious advanced student a solid overview of the inconstancy of the sun as evidenced by tree rings, solar neutrinos (or rather the lack of them), the solar origin of the solar wind and interplanetary magnetic fields, and solar oscillations of various sorts and frequencies.

The solar oscillation review, by Henry A. Hill, to pick an example, gives a thorough look at a new and exciting subject. Oscillations of the solar diameter with periods longer than five minutes, which have been found by Hill and his co-workers in studying the solar oblateness, represent global effects that promise to give us fundamental data about the interior structure of the sun. Some investigators are skeptical about the reality of these oscillations, and the observational discrepancies that lead to such skepticism are examined in detail by Hill. The five-minute oscillations, for which there is solid observational evidence, are now viewed as global nonradial acoustic waves trapped below the photosphere. Both sets of oscillations allow for the first time a "seismic" probing of the deep solar convective envelope. This is a truly exciting prospect; solar physicists now have a tool that will allow them to probe below the solar surface to determine, for example, the depth of the convection zone and the rotation rates of subsurface layers. The first results are only now beginning to come from this important research, and the possibilities for the future seem enormous.

In another of the reviews John A. Eddy discusses evidence for a changing sun. This evidence—most of it arboreal—supports earlier conclusions about long-term solar activity. These conclusions are based on historical records of sunspots, auroras, and the corona seen at eclipse and on radiocarbon data. The evidence discussed by Eddy confirms the existence of the Maunder minimum, the quiet period in solar activity from about 1645 to 1715, along with other maxima and minima extending back to about 5000 B.C. This valuable information is available from tree rings because of the happy coincidence that the amount of ^{14}C that is produced in the upper atmosphere of the earth and makes its way into organic materials such as tree rings is modulated by the level of solar activity. This happens because the high-energy galactic cosmic rays that produce the ^{14}C in the earth's atmosphere vary in intensity as the solar magnetic fields in interplanetary space vary. Stronger magnetic fields tend to shield the earth from cosmic rays. Thus, with tree rings to fix the date, investigators have stepped back through time to create a yearly index of solar activity. This index is found to correlate remarkably well with climatic variations, which are known fairly well over the last 1000 years. Lower solar activity correlates with colder temperatures on the earth. The mechanism for this relationship remains a mystery, although, as discussed by Eddy, the interplanetary magnetic fields themselves may play an important role. Clearly this is an aspect of solar physics that has implications for the well-being of our civilization.

The subjects covered by the other two reviews in the book are just as new and exciting and have just as much promise for advancing our understanding of the sun and other stars. The volume belongs on the shelf of every astonomer.

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Stellar Deaths

Planetary Nebulae. Observations and Theory. Papers from a symposium, Ithaca, N.Y., June 1977. YERVANT TERZIAN, Ed. Reidel, Boston, 1978. xxii, 376 pp., illus. Cloth, $37; paper, $24. International Astronomical Union Symposium No. 76.

Planetary nebulae are believed to result from the explosive ejection of the outer layers of stars that have exhausted their available nuclear energy sources. For high-mass stars the gravitational collapse that follows the extinction of the energy source leads to a supernova explosion, whereas for stars of one to several solar masses the process is much less violent and results in a planetary nebula, a luminous expanding shell ionized by the hot remnant of the stellar core.

The planetary nebula phenomena last about 10^4 years, and the space density of known planetary nebulae is in approximate agreement with the expected death rate of solar-mass stars. Modern spectroscopic observations have succeeded in producing a consistent picture of the ionization structure, dynamical evolution, energy balance, and crude chemical composition of planetary nebulae. However, many of the details are not understood. The physical process that produces planetaries, the nature and evolution of the stellar remnant, chemical abundances and the role of dust in the dynamics, energy balance, and abundance of heavy elements are all subjects of current research.

International Astronomical Union Symposium No. 76 brought together researchers to discuss outstanding problems concerning planetary nebulae. The published proceedings of the symposium contain the review papers, abstracts of the contributed papers, and the very informative discussions that followed each paper. Among the important advances that have occurred in the past decade have been the discovery of dust in planetary nebulae shells (discussed by Balick and by Mathis), the discovery of the H_2 molecule in the shell (Rank), the technical advance of instrumentation that has led to accurate emission-line intensities (Miller, Gurzadyan, Pottasch, Rank, Terzian), and a substantial advance in the theoretical models of the expanding nebular shells (Harrington, Mathews). Workers are also beginning to construct accurate models of the central star (Hummer, Lutz, Shaviv, Paczyński), an important development if we are to fully understand the planetary nebula phenomenon.