The anatomy of the Sun

J. B. Zirker

Solar Interior and Atmosphere. Edited by A. N. Cox, W. C. Livingston and M. S. Matthews. *University of Arizona Press: 1991. Pp. 1,416. $65, £57.95. Distributed by Eurospan in Europe.*

OUR Sun proves the rule that the closer you look at anything in nature, the more complicated it becomes. For at least 40 years, astronomers have sought satisfactory explanations for some of the most obvious solar phenomena. Why does the Sun's equator rotate faster than its poles? Why is its outer atmosphere so incredibly hot? What causes its 11-year cycle of activity? What, exactly, is a sunspot? How, indeed, does the Sun generate the huge explosions that rattle the Earth's magnetic field?

During the past decade, dramatic progress has been made in answering these questions. We now have better equipment on the ground and in space, and a deeper knowledge of plasmas and elementary particles, coming in part from the controlled fusion programme. Solar problems now attract some of the best minds in astrophysics, and there is a growing realization that we have much to learn from other stars similar to the Sun. Solar astronomy has grown to become solar physics, and new generations of physicists have answered the call.

All these developments have been exciting, but devilishly difficult to keep up with. At last, this blockbuster of a book has appeared to summarize the subject and point the way to the future. It is one of two volumes on the Sun in the University of Arizona Press Space Science Series*. Two years in the making, with an international cast of 101 authors and around 1,400 pages, this monumental volume consists of a well-integrated collection of topical reviews of many of the principal aspects of solar phenomena. Readers need a graduate's competence in physics and mathematics and a good grounding in solar observations. For the most part, the book is written clearly and scholarly, but not pedantically. Each chapter has an abstract and a summary. There is a useful glossary and a comprehensive up-to-date list of references. A fine sense of the excitement of research comes through in several chapters, and, understandably, there is a flavour of controversy, even contradiction.

The book is divided into five main sections covering the physics of the solar interior, including convection theory, structural modelling and dynamo theory; solar-oscillation observations and theory; the structure of the solar surface; solar magnetic activity in all its guises; and the Sun as a star.

The chapters on helioseismology are particularly enjoyable. This field is only about 15 years old and is developing into a marvellous tool for exploring the deep interior of the Sun. The subject is elegant, both in its experimental and theoretical aspects. More importantly, the study of oscillations is guiding attempts to understand how the Sun generates magnetic fields and why the solar cycle behaves as it does.

One cannot fail to be struck by the shift of emphasis that has occurred since G. Kuiper's compendium *The Sun* was published in 1953. At that time, radiative transfer, spectral-line analysis and nonthermodynamic equilibrium studies were at the cutting edge of research. Now the focus is on hydrodynamics, hydromagnetics and the interaction of large- and small-scale systems. Indeed, the basic mechanisms underlying flares, the heating of the corona and the solar wind, all involve solar magnetism at many spatial and temporal scales.

The authors present current observations without much discussion of the instruments that made them possible. This is something of a shortcoming, because there has been a revolution in solid-state detectors, X-ray telescopes, imaging spectroscopy and computer analysis of huge data sets. But even in a tome of this size, something has to be omitted.

For all our increased knowledge about the Sun's behaviour, new questions keep popping up. Where are all the missing neutrinos? How is the solar wind driven? There is, fortunately, no end to the fascinations of this seemingly prosaic star. □

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* The companion volume is *The Sun in Time* edited by C. P. Sonett, M. S. Giampapa and M. S. Matthews, an interdisciplinary review of the Sun's evolution written by 83 collaborating authors. $60.

Difficult superconductivity

A. C. Rose-Innes

High-Temperature Superconductivity: An Introduction. By Gerald Burns. *Academic: 1992. Pp. 199. $19.95, £13.*

GERALD Burns admits to having found this book difficult to write. I am not surprised; it has been estimated that 20,000 papers were published on high-temperature superconductivity in the five years after its discovery. To read their titles alone would probably take about 30 hours.

Burns is surely over-optimistic when he says that there has been a "remarkable rate of progress" in the study of high-temperature superconductors; my impression after reading this book is that there is in fact still little understanding of these materials and few areas in which they have been successfully applied. This situation will probably persist until reasonably large single crystals are readily available for experimentation. I am reminded of the similar confusion over the properties of semiconductors in the early 1950s before the advent of single crystals of germanium and silicon.

It is not clear to me for whom this book is written. It is a curious mixture of the very elementary, such as a basic introduction to perfect diamagnetism, and of advanced concepts, such as a detailed discussion of Ginzburg–Landau theory. But it is not really suitable for novices such as undergraduates. Indeed, does Burns really believe that the topic of high-temperature superconductivity involving highly anisotropic extreme type II superconductors, the understanding of which is defeating established experts in the field, is suitable for "students taking their first solid-state physics course"?

For experts, by contrast, the information on high-temperature superconductors is diluted by presentations of elementary superconductivity, even though the author states that readers are assumed to have this background knowledge already.

Despite the inclusion of elementary and sometimes irrelevant material, the book provides a much needed review of the field up to 1991. It is to a large extent a catalogue of often conflicting experimental and theoretical results. In this respect, the summary sections will prove to be particularly valuable. No one can fully cover the vast amount of literature on high-temperature superconductivity — I know workers who feel so overwhelmed that they have given up attempting to read the literature at all. A review volume such as this will certainly be useful to them. Indeed, every researcher in high-temperature superconductivity would benefit from obtaining a copy. □

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