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Guide to the Sun

Kenneth J. H. Phillips and Stephen M. White

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Perpetuating the Electromagnetic Legacy of English Scientists and Engineers

Magnetism: Principles and Applications

Derek Craik
Wiley, New York, 1995. 459 pp.
$49.95 pb ISBN 0-471-92959-X
$79.95 hc ISBN 0-471-95417-9

Reviewed by Robert W. Brown

Want a good bet? The next time you hear of a research breakthrough or listen to someone discussing a new project in science or engineering, it is quite likely that state-of-the-art magnetism is involved. An even better bet is that, whatever the magnetic phenomenon, you can find detailed technical information or mathematical modeling for it in *Magnetism: Principles and Applications*, the new book by Derek Craik of the University of Nottingham.

Craik's distinguished, 30-year career as a researcher and expositor, particularly in magnetic materials and numerical methods, has put him in position to compile a book chock-ful of the latest magnetic doings and devices. The increased demand for microscopic understanding of macroscopic tools is met by Craik's detailed discussions of the quantum mechanics of magnetism.

In applications, Craik offers very helpful discussions, such as those on the infamous **B** and **H** field conventions and units. Numerous calculations cover the waterfront from standard magnetostatics through magnetic forces and domain–crystal modeling and on to quantum density matrix theory—each more densely detailed than I am accustomed to seeing in textbooks. I was surprised from time to time by the elementary help offered, such as the reminder that $\sin 2\theta = 2 \sin\theta \cos\theta$. I liked having it.

Now for the caveats. I wish I could use this as a primary textbook for any of our existing magnetism courses, or even a new course, but I can't. A major difficulty is the absence of problems for students to work through. Another is the way the book is laid out, which I find frustrating. It is divided into six chapters, with the first one, a general survey, taking up almost one-third of the 400-plus pages. A skeletal table of contents in the front of the book is closely followed by detailed contents, but for chapter one only. Readers will have to burrow through to five different places to find analogously detailed tables of contents for the remainder of the book. And when they do, they will find various topics, such as magnetic domains, revisited at numerous times and places throughout the book. This makes it hard—particularly for the first-time instructor—to plan a course syllabus.

There are few books to which a fair comparison can be made, but a contemporary candidate might be *Introduction to Magnetism and Magnetic Materials* by David Jiles (Chapman and Hall, 1991). Jiles's book does have exercises and a linear organization of material, and it is nicely readable, perhaps because of its layout and its less advanced presentation. Craik presents much more comprehensive material, such as relaxation, Bloch equations and their derivation.

I would happily use Craik's detailed treatise on magnetism in modernity as a supplementary text for a standard junior or senior course on electromagnetism, for an introductory solid-state course, for a numerical methods course or for an imaging course. The book is another notable contribution in magnetic studies by Craik and is in the tradition of Nottingham—a school that perpetuates the electromagnetic legacy of English scientists and engineers. In view of their rich history in this field, we have come to expect such tomes from them.

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Guide to the Sun

Kenneth J. H. Phillips
Cambridge U. P., New York, 1995.
386 pp. $15.95 pb
ISBN 0-521-39788-X

Cambridge University Press has released Ken Phillips's *Guide to the Sun* as part of its readily affordable paperback series. This book attempts to cover virtually everything having to do with the Sun at a level similar to that of *Scientific American* or *New Scientist*. It does so without the use of equations, relying instead on figures and verbal descriptions, but still without shying away from the relevant physics. Particularly in the earlier chapters, Phillips goes out of his way to use everyday analogies to the more complicated physical processes. The scope of the book is remarkably ambitious, ranging across the solar neutrino problem, stellar populations, photosynthesis and solar observing for amateurs.

Chapter topics include a review of the early history of the study of the Sun, the solar interior and helioseismology, solar energy and solar observatories. With such a sweeping portrait, some of the topics are necessarily shortchanged. I thought this particularly true of the discussion of the earliest ideas about the Sun, where prominent events are mentioned but not always fleshed out. As a result, the reader doesn't have a sense of the context in which these ideas arose. That is a minor complaint, however, since the history of solar studies occupies whole books in its own right.

Solar physics is a mature discipline, with what may seem to the novice to be a bewildering array of phenomema (and jargon) to master. Phillips describes much of this phenomenology clearly without getting too bogged down in details. I liked the fact that, even while covering all these phenomena (spots, pores, faculae, prominences, spicules and so on), he still makes a point of emphasizing the "big" issues that they raise, which are more accessible and relevant to the intended audience than would be the technical sidetracks on which professionals necessarily spend much of their time. Phillips includes a little more spectroscopy than do most general discussions, but that is one of his research areas, and it is clearly described and made to fit seamlessly into his discussion of the photosphere.

The bulk of *Guide to the Sun* is taken up with a summary of our knowledge of the solar atmosphere, which is Phillips's area of expertise. And there are many good illustrations in black and white. (The book was written prior to the launch of the Yohkoh satellite and thus does not feature any of its results, but the content remains current nonetheless.) Phillips consistently avoids explicit citation of research material except in figure captions, although he does include a valuable glossary and a general bibliography.

The book is well written, and despite the breadth of coverage the reader doesn't get the impression that Phillips is cramming in too much information, thanks to his facility for linking different topics smoothly. For example, the chapter on the Sun's place among the stars covers a lot of basic astronomy without ever becoming just a recitation of facts. The chapter on solar energy, which might have seemed out of place, starts with a discussion of the solar irradiance (which once was called the solar constant but no longer is because it isn't) and its measurement, and, as it proceeds to the exploitation of different forms of energy, Phillips makes clear that nearly all of the sources of energy we have stem, directly or indirectly, from the Sun and stars. The various means for directly exploiting solar energy are discussed, again at a very accessible level.

It is difficult for me to judge the potential success of the book in conveying ideas to its target audience, but I found it easy to read for the most part, and it contains so much material that even professionals may find it a valuable summary of the general state of knowledge in fields outside of their own specialties. I can therefore recommend it highly to both the interested outsider and the professional.

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The Quantum Dot: A Journey into the Future of Microelectronics

Richard Turton
Oxford U. P., New York, 1995.
211 pp. $25.00 hc
ISBN 0-19-5211-57-X

Microelectronics has evolved at a pace unprecedented in the history of technology. In *The Quantum Dot* Richard Turton explains the physics that allowed this to happen, reports on many interesting recent experiments on electronic motion in small structures and explores a wide range of adventurous proposals for further progress, with an emphasis on computer logic. Along the way the author explains a good deal of physics. Unfortunately, this laudable and ambitious project is not a complete success.

The book is intended for both first-year undergraduates in electrical engineering and physics and an audience with little physics background. As a concession to its intended general audience, the book avoids equations completely and circuit diagrams appear only in a disguised, symbolic form. In a book that is heavily quantum mechanical, Planck's constant turns up only in the second half, and there it makes but brief and incidental appearances. As a result of such concessions, too many explanations are inadequate or hard to follow. In the first two chapters, which explain quantum mechanics and band structure, we find a particularly high density of flawed explanations.

We are told that "if we use a golf ball to represent a proton, then an electron is just a tiny bead a few millimeters in diameter." The Pauli exclusion principle is presented without reference to spin, in a statement that "just two electrons are allowed in any given level." Why two instead of five? Band structure is explained by way of a questionable analogy: In trailers parked in a lattice arrangement in a campground, four children in each trailer attempt to find suitable noninterfering frequencies for talking on walkie-talkies to their favorite neighbors. This is simple only if simplicity is identified with a minimum of algebra and physics. It leaves the reader with no insight into the behavior of band structure.

For a book intended for a broad audience there is surprisingly little history, and some of that is misleading. We are told that the ENIAC computer, whose fiftieth anniversary will be celebrated this year, was replaced by transistorized computers, ignoring over a decade of highly successful and widely distributed electron-tube computers and calculators. Turton dates the first working semiconductor field effect transistors from 1962, but they were actually reported in 1960. In connection with single-electron tunneling and the Coulomb blockade, observed in tunnel junctions with very small capacitances at low temperature, we learn that "until 1985 no one really gave this any thought." John Lambe and Robert Jaklevic published their pioneering experiment on this in 1969.

Turton takes up a remarkably wide assortment of innovative proposals for the future. Most of these come from scientists with a basic research orientation who pay little attention to the need to control device behavior in large systems. (The author of this book, indeed, is far more reasonable than most of the enthusiastic advocates who organize the conferences and the special issues of journals.) Turton does point to some of the problems with these proposals, particularly in his concluding chapter. Nevertheless, there are some lapses, and the attention given to these schemes will mislead the novice who is unaware of the great number of such proposals that have failed.

The author is also optimistic about unguided optical interconnections, which I consider a recipe for disaster, putting light where it is not intended to go. The author perceptively points to the fact that decimal machines required devices with ten accurately defined positions, which led to their replacement by binary machines. But later on Turton celebrates tunneling devices that have many possible states. His discussion of tunneling devices does not tell us that tunneling depends exponentially on device parameters and is therefore hard to control.

The "quantum dot" of the book's title refers to small conducting volumes, small enough to let quantization control the behavior of the electrons in the structure. The interaction between such dots has often been suggested as a basis for computer logic, but such suggestions have typically contained too few details to permit an evaluation. One proposal from a group at the University of Notre Dame does provide a complete description and is discussed in the book. Unfortunately, Turton does not mention that the forward flow of information in this scheme can become trapped in nonpropagating metastable states.

This is not a bad book; almost everyone can learn from it. It is, unfortunately, just not good enough.

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Fundamentals of Optical Fibers

John A. Buck
Wiley, New York, 1995. 264 pp.
$59.95 hc ISBN 0-471-30818-8

For the past 15 years optical fibers have been the transmission medium of choice for most high-capacity communications applications. Introductory books on fiber optics usually cover the fiber, sources and detectors, and communications receivers and applications, because these subjects are so interdependent. Although there are advantages to this overview approach, there is interest in more specialized texts that concentrate on a narrower