

fundamental principles in any kind of comprehensive, rigorous fashion is already a vast undertaking. To keep the work up to date and to convey a sense of the exciting possibilities offered by current research in the field requires a breadth of knowledge possessed by a rare few. If then are added the pedagogical requirements—that the text be easy to follow for most students and that it provide ample instructive exercises—the magnitude of the problem becomes obvious.

The Oxford Master Series in Condensed Matter Physics offers an appealing alternative to conventional texts: a set of slim volumes, each on a separate topic and complete with exercises, written by active researchers who can combine a current perspective with the presentation of the relevant fundamental principles. *Band Theory and Electronic Properties of Solids*, by Oxford University physicist John Singleton, fits into the Oxford series between an upcoming volume on structure and dynamics and existing volumes on optical properties, magnetism, superconductivity, and soft condensed matter physics.

The focus of this particular volume is considerably narrower than the title suggests. The pedagogical strategy is to present the electronic properties of solids within the semiclassical theory of electronic transport. At that level, electronic properties depend only on bandstructure features and thus are largely independent of other details and complexities. For metals, the salient features include the effective dimensionality and density of states at the Fermi level, and topology of the Fermi surface. The analogous quantities for semiconductors are the gap and the effective masses. The semiclassical framework has the advantage of rendering the electronic properties of currently interesting systems (organic molecular solids, manganite oxides, and semiconductor superlattices) as accessible as those of the classic examples of copper and lithium. Sections that describe modern experimental techniques, particularly Fermi-surface determination, complement the theoretical discussion.

This clear-cut agenda is a definite strength of the book, but much is missing, and readers will have to adjust their expectations. There is virtually nothing about band theory per se—that is, how the details of bands in a specific material are related to that material's composition and crystal structure. Nor does anything appear about modern methods for performing the relevant

computations or about symmetry beyond lattice periodicity. The puzzles of the success of the one-electron approximation and of the nearly-free-electron approximation are hardly addressed, and there is no systematic explanation of the semiclassical approximation itself or the conditions for its breakdown. Electronic properties other than electrical and thermal conductivity are not covered.

The warm informality of the style makes readers feel as if they were attending the lectures. Neil Ashcroft and David Mermin's *Solid State Physics* (Holt, Rinehart and Winston, 1976) receives extensive homage, not only through numerous page references for more rigorous treatments but also through the copious use of footnotes and the sprinkling of humorous items through the index.

The level of presentation is quite qualitative. Technical terms and phrases, such as bandstructure engineering, spin density wave, and variable range hopping, appear in boldface. In many instances, verbal and pictorial descriptions replace equations. For some topics, this approach works well, the chapters on magnetoresistance being particularly successful. For other topics, oversimplification makes it harder, not easier, for readers to understand the concept.

Because of its origin as a course in the Oxford University physics curriculum, this book will not easily lend itself as the main text for a course in an American university. Although the book assumes some previous knowledge of solid-state physics (recapped in a series of appendices to make the book more self-contained) the discussion assumes only a passing acquaintance with quantum mechanics. For most advanced undergraduate physics majors, the reverse is more typical.

For a graduate course, the deemphasis of quantum mechanics is even more problematic. Moreover, the level of presentation is too qualitative for the book to be used on its own. However, as a supplementary text for students (and there are many of them) who find it heavy going to study higher-level texts such as Ashcroft and Mermin, or the more recent excellent monograph *Solid State Physics* by Giuseppe Grosso and Giuseppe Pastori Parravicini (Academic Press, 2000), this book is highly recommended. Its readable and enjoyable format will help students to develop an intuition for electronic properties.

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Harmonic Superspace

▶ A. S. Galperin, E. A. Ivanov, V. I. Ogievetsky, and E. S. Sokatchev
Cambridge U. Press, New York,
2001. \$90.00 (306 pp.).
ISBN 0-521-80164-8

Harmonic Superspace, by Alexander Galperin, Evgeny Ivanov, Victor Ogievetsky, and Emery Sokatchev is the first discussion, outside of the confines of the research literature, to present pedagogically the intricacies of its topic. This is a unique book.

There already exist such well known previous expositions as Julius Weiss and Jonathan Bagger's *Supersymmetry and Supergravity* 2nd ed. (Princeton U. Press, 1992), Peter C. West's *Introduction to Supersymmetry and Supergravity* (World Scientific, 1986), S. James Gates, Marcus T. Grusaru, Martin Roček, and Warren Siegel's *Superspace or One Thousand and One Lessons in Supersymmetry* (Addison-Wesley, 1983; see also <http://aps.arXiv.org/pdf/hep-th/0108200>), and I. L. Buchbinder and S. M. Kuzenko's *Ideas and Methods of Supersymmetry and Supergravity, or A Walk Through Superspace* (rev. ed., IOP Publishing, 1998). These treat the topic of $N = 1$ supersymmetry and superspace extensively while giving at most a cursory treatment of the so-called extended supersymmetrical theories.

Harmonic Superspace includes $N = 2$ extended theories in a manner that makes manifest, for both classical and quantum calculations, the consequences of the extended supersymmetry. As the four authors are the originators of the harmonic superspace, they are eminently qualified to be its expositors.

The authors adroitly manage in twelve chapters to introduce basic concepts, compare harmonic supersymmetry and superspace to $N = 1$ supersymmetry and superspace, motivate the approach, discuss the harmonic space generalization of Poincaré and conformal symmetries, introduce harmonic superspace, describe $N = 2$ supermultiplets from scalar to supergravity, develop harmonic superspace supergraph techniques, and present applications to hyper-Kähler geometry and nonlinear sigma models. The final chapter takes the reader to the frontier of the approach, with applications beyond $N = 2$ supersymmetry to $N = 3$ supersymmetrical systems. The appendix provides the reader with all the necessary foundational material (notation, conventions, definitions, and so on) upon which to build an operational proficiency in these techniques.

This book is aimed primarily at an audience that wants to master this important subject. Normally, this audience would be individuals either already engaged in research at the frontier of theoretical particle physics or intent upon engaging in such research (graduate students, theoretical or mathematical physicists, post-doctoral researchers, and active researchers from other fields). The authors have produced a readable narrative that clearly explains the applications and achievements of the approach. To maximize the effectiveness of the book as a pedagogical tool, the reader must use it as a guide to carrying out the calculations that undergird the narrative.

Although it may not be apparent that this presentation is related to the more widely studied topics of superstring or M-theory, studies of nonperturbative (as well as perturbative) nonrenormalization theorems in Seiberg–Witten theory have been undertaken precisely by exploiting the power of the harmonic superspace formalism. Another link to modern developments that this book treats is the important four-dimensional, $N = 4$ supersymmetrical Yang–Mills theory, which has well known relations to the low-energy effective action of open superstrings in harmonic superspace.

This is a demanding book, for those interested in more than a passing familiarity with this technique. Because of its content, it will likely be considered more difficult than either the Weiss and Bagger or the West book, and comparable in difficulty to the other two books mentioned earlier. The prose in *Harmonic Superspace* is clear, with a minimum of jargon. In my assessment, it succeeds in its goals.

There are two aspects of the book that might have received additional treatment. There could have been a more complete discussion of the relationships between 4D, $N = 2$ vector and supergravity multiplets, both within harmonic superspace and ordinary superspace. In addition, it is within these authors' capabilities to have included a discussion of harmonic superspace background field techniques and applications to effective actions.

The book is a worthy memorial to the late academician Ogievetsky, who died in 1996 (see PHYSICS TODAY, November 1996, page 102). Although it covers only one topic on which he worked during a productive career, it does so with the same sparkling creativity and demanding attention to

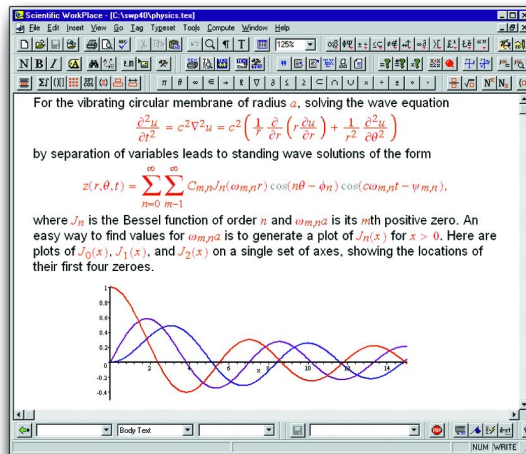
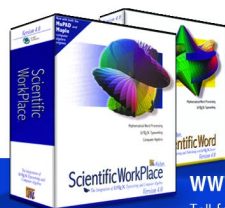
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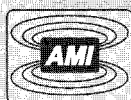
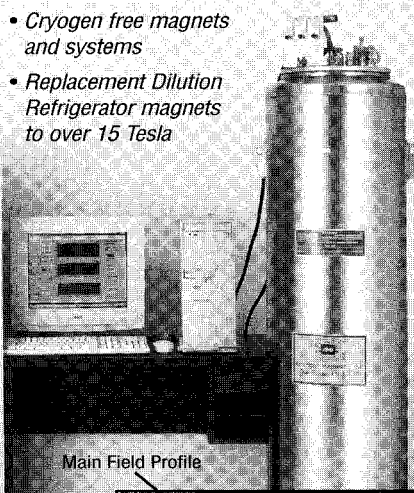
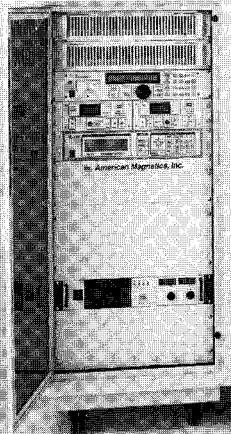


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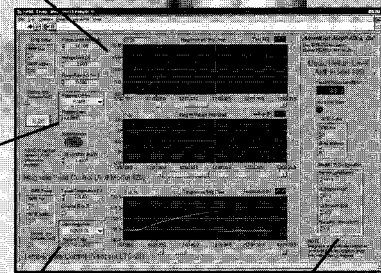
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Planetary Sciences

Imke de Pater and
Jack J. Lissauer
Cambridge U. Press, New York,
2001. \$75.00 (528 pp.).
ISBN 0-521-48219-4

The field now known as planetary science has a common origin with all of quantitative science and shares founding figures such as Isaac Newton, Pierre Simon de Laplace, and Joseph Louis Lagrange. The study of planets, however, gradually became a backwater of astronomy and astrophysics during the first half of the 20th century, when planets did not readily yield their secrets.

But the second half of the century changed all of that: detailed data from spacecraft and powerful telescopes, along with advances in computer technology, produced an explosive renaissance. Planetary science became profoundly interdisciplinary and incorporated modern fields ranging from astrophysics and geophysics to biochemistry and chaos theory. But it grew far faster than its expository literature, texts, and monographs.

There is still a dearth of good texts covering the entire field. Imke de Pater and Jack Lissauer laudably address this problem directly with their encyclopedic *Planetary Sciences*. De Pater is an astronomer at the University of California, Berkeley, who observes planets at wavelengths from visible to radio; Lissauer, from NASA's Ames Research Center, is primarily known for his theoretical research on rings and solar system origins. Although both are prominent in their fields, they freely admit that their book's breadth extends well beyond their expertise. They have been helped by an impressive list of colleagues.

Planetary Sciences is primarily intended for those who wish to dig into the subject quantitatively. Such seekers include graduate students in planetary sciences and related disciplines, upper-division undergraduates in the physical sciences, and practicing scientists seeking more details about the field or looking for interesting problems. The text does not shy away from equations, although it does not always offer a clear discussion of their origins.

It is not surprising, considering the authors' strengths, that the chapters on dynamics, atmospheres, magnetospheres, rings, and planet formation are strongest, along with sections on comet formation and the orbital properties of the Kuiper Belt and Oort Cloud. The chapter on rings (chapter 11) includes a nice presentation of shepherding and resonance effects, and would be a good place to start to understand density-wave theory.

How old are Saturn's rings? Shepherding theory and data seem to indicate that they must be much younger than the solar system, but chapter 11 shies away from accepting this result, perhaps hedging the bet until Saturn Cassini orbiter mission data come back in a few years.

De Pater and Lissauer don't do research on meteorites or planetary surfaces or interiors, so how satisfactory are those sections of their book? An earlier standard in the same subjects is John Wood's *The Solar System* (Prentice-Hall, 1979); it is laconic and out-of-date but still helpful and lucid (note that the second edition of Wood, 1999, has expunged all equations and thus no longer competes with the more quantitative surveys). *Planetary Sciences'* coverage of planetary interiors is workmanlike but not without mistakes.

In certain fields of planetary science, the information-doubling time is quite short, perhaps a couple of years, so how successful is *Planetary Sciences* in staying abreast of the tide? The best test of this is chapter 13, Extrasolar Planets, which covers a topic that is sure to explode in the 21st century. Only a half-dozen pages cover exoplanets; the material there is correct and nearly current, but one impatiently wants more details about the strange new perspective in which these new planetary systems cast our own Solar System. And bioastronomy, the search for life elsewhere in the Solar System, a topic still lacking an observational datum, gets little coverage. (*Planetary Sciences* wisely dodges a discussion of ALH84001, the putatively "bug"-laden Martian meteorite.)

Planetary science is an exquisitely visual field. It attracts many students by the impact of spectacular spacecraft images. The quintessential planetary image is the cratered surface, and it is important to convey to students the violent past that lies behind such an image. Unfortunately, illustrations are not the forte of *Planetary Sciences*. To keep the size and price down, the authors have mostly restricted their book to smallish, black-and-white line

drawings and photos, although a number of color plates are tipped in at the beginning. One figure reproduces a series of crater-density plots from now-classic work by Bill Hartmann on the cratering history of the terrestrial planets *Moons and Planets* (Thomson Learning, 1999). But de Pater and Lissauer's plots are too small and busy, and their explicatory text too disconnected, to do full justice to the fascinating story that they tell. So, for illustrations, I'd recommend J. Kelly Beatty, Andrew L. Chaikin, and Carolyn Collins Petersen's *The New Solar System* (4th ed., Sky/Cambridge U. Press, 1999). It is pitched at a lower level than *Planetary Sciences* (no equations), but each chapter, written by an expert in the relevant discipline, is reasonably rigorous.

I teach planetary sciences to graduate students and senior-level science majors. Would I use *Planetary Sciences* as a text? Yes, almost certainly. It is a massive achievement, and the well-considered problems and exercises at the end of each chapter will be particularly useful to students and to test one's own understanding.

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