

ANOTHER PLACE TO TURN FOR ACCELERATOR BASICS

Introduction to The Physics of High Energy Accelerators

**D. A. Edwards
and M. J. Syphers**
Wiley, New York, 1993.
292 pp. \$54.95 hc
ISBN 0-471-55163-5

Reviewed by William Barletta

The field of accelerator physics has been marked by a singular lack of archival literature. Accelerator builders have generally been content to "publish in steel and concrete," relegating much of the supporting analysis to internal laboratory reports. Proceedings of major accelerator conferences constitute a somewhat more accessible source of materials written for the historical record, but textbooks have been nearly nonexistent.

Compounding the problem is the way most accelerator physicists enter the field: not via formal university education specific to accelerator physics, but rather from on-the-job learning after switching from other disciplines. University courses have been few and limited to a small number of institutions. Consequently, the writer of a textbook on accelerator physics faces the challenge of selecting and organizing appropriate material without benefit of a broad context of synthetic and pedagogical material on which to build.

The temptation to try to cover all important topics, then, is enormous. To their credit, Donald Edwards and Michael Syphers have avoided this pitfall, focusing carefully on physics issues central to the design of proton storage rings. The authors are well matched to the task: Edwards (recently retired) was associate director for accelerators at the Supercon-

ducting Super Collider Laboratory, and Syphers has been leader of the SSC's accelerator theory group. The book grew out of courses they have given at the US Particle Accelerator School (a "classroom without walls" that meets twice a year at various sites).

The authors write for advanced undergraduates in physics and engineering. They guide the student carefully through the mathematics, preferring clarity of physical principles to strict mathematical rigor. The text is equally well suited to a graduate course or self-instruction, especially if supplemented with a list of primary source materials.

Unfortunately, the bibliography is general and meager (only 17 references); other excellent books on accelerator and beam physics, such as *Charged Particle Beams* (Wiley, 1990) and *Principles of Charged Particle Acceleration* (Wiley, 1986) by Stanley Humphries Jr, *The Physics of Charged-Particle Beams* (Oxford U. P., 1988) by John Lawson and *An Introduction to the Physics of Intense Charged Particle Beams* (Plenum, 1982) by Ronald Bruce Miller, go unmentioned. In particular, while Edwards and Syphers have avoided a too-shallow treatment of too many technologies, their synopsis of the types of accelerators in Chapter 2 is all too brief. A detailed bibliography of this topic would be a substantial improvement.

Among the highlights are a clear discussion of phase stability and an extended section on preserving beam emittance in hadron storage rings. The problem sets expand upon many important points only hinted at in the main text. Thus the authors encourage the student to develop a strong, active knowledge of the subject through analytical and computer calculations. The computational problems related to the effects of sextupoles and octupoles provide especially instructive examples of the subtleties of nonlinear effects upon transverse motion.

In contrast, the book's presenta-

tions of the effects of synchrotron radiation and space charge are too brief. To learn about synchrotron radiation, the student would be better advised to read Matthew Sands's outstanding monograph, *The Physics of Electron Storage Rings—An Introduction*, a Stanford Linear Accelerator Center publication (1971). However, while Edwards and Syphers may not quite match Sands's elegance of physical explanation, they have written a thoroughly readable and modern treatment of their chosen topics. Their book is a much needed contribution to the literature of particle accelerators and beam physics.

Physical Properties of III–V Semiconductor Compounds: InP, InAs, GaAs, GaP, InGaAs and InGaAsP

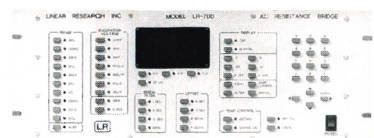
Sadao Adachi
Wiley, New York, 1992.
318 pp. \$64.95 hc
ISBN 0-471-57329-9

Over the last decade Sadao Adachi has written several useful and extensive review articles on material parameters for a range of III–V compound semiconductors, such as antimonides and arsenides. It is very convenient for researchers that he has now expanded the review articles into a book. The title of the book, however, sounds more inclusive than the book's actual contents, which cover mainly properties of InP, $\text{In}_{1-x}\text{Ga}_x\text{As}_y\text{P}_{1-y}$ and $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$, whose lattices are matched to that of an InP substrate.

The III–V compound semiconductors GaAs and InP and their related alloys are important to a variety of photonic and electronic applications. In particular, a combination of $\text{In}_{1-x}\text{Ga}_x\text{As}_y\text{P}_{1-y}$, $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$ and InP is used to make light emitters and photodetectors for fiber-optic

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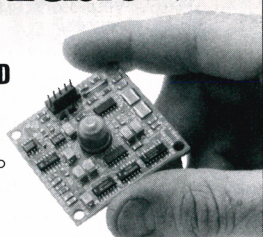
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In general, the quaternary $\text{In}_{1-x}\text{Ga}_x\text{As}_y\text{P}_{1-y}$ compound is not as well studied as the more readily available GaAs, InP and $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$, which are used extensively in electronic devices. The book tries to present data on $\text{In}_{1-x}\text{Ga}_x\text{As}_y\text{P}_{1-y}$, lattice-matched to InP, placing special emphasis on $\text{In}_{0.53}\text{Ga}_{0.47}\text{As}$ for $y=1$ whenever such data are available. When they are not, interpolation of data for binary compounds becomes necessary. The interpolation scheme is conveniently summarized in an appendix. This book covers the properties of III–V compounds quite comprehensively, including structural, mechanical, elastic, thermal, optical, piezoelectric, electromechanical, elasto-optic, electro-optic, band-structure, carrier-transport, phonon and strain properties. A short summary of the importance of the topics begins each section.

Although some properties of all four binary compounds are given, sometimes only InP is discussed. Some noteworthy inclusions and omissions are discussed below: In chapter 2 on structural properties, for example, Adachi provides the usual data on crystal structures and lattice parameters for InP, InGaAs and InGaAsP. He also includes a discussion on an important but seldom-included fact: that the cation-anion distances in InGaAs and InGaAsP deviate from the average interatomic distances in those compounds but are close to the bond lengths in pure parent crystals of GaAs and InP. Chapter 2 also covers ordering but not spinodal decomposition, which is important for laser reliability.

Chapter 6 gives a very good and detailed discussion of electronic energy-band structure, bowing parameters and electron effective masses and hole effective masses. It also discusses the effects of temperature and pressure on the band gap. The chapter shows conduction-band and valence-band offsets of not only the InGaAsP / InP and InGaAs / InP systems but also the InGaAs / InAlAs heterojunction. However, Adachi does not mention the band offsets of the interesting InAlAs / InP, which has a type II, or staggered, band lineup.

Chapter 10 presents data on the transport properties for both majority and minority carriers, but to be more meaningful, the velocity-field curves should indicate the individual doping levels. Chapter 11 deals with strain, and it gives a detailed list of disloca-

tion etchants for InGaAsP. For the critical layer thickness, however, the chapter discusses InGaAs on GaAs, instead of the InGaAsP / InP system, which is the main material system discussed in the book. Chapter 11 could have been expanded, because strain is an increasingly important degree of freedom in device design.

I recommend this book to those who work on long-wavelength optoelectronic devices; the wealth of information is directed especially to them. The book might be more broadly useful if data on all related binary compounds were included.

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What Makes Nature Tick?

Roger G. Newton

Harvard U. P., Cambridge,
Mass., 1993. 257 pp.

\$27.95 hc ISBN 0-674-95085-2

In the present climate, with many people claiming that science is too hard to understand, it is most important that competent scientists present science to the nonscientist in simple terms. Authors also should try to cover the aspects of their science of special interest to the readers to whom the work is addressed. Now there are many different kinds of nonphysicists, according to their background knowledge, their interests and what they would like to understand. In this volume, Roger Newton, a distinguished theoretician, who has many important contributions to his credit, above all in scattering theory, presents an outline of the laws of inanimate nature, that is, essentially of physics, for the non-physicist who is philosophically minded.

The book is for readers who are more interested in the methods by which physicists arrive at their conclusions than in the conclusions themselves. This is not stated explicitly, but it is seen by implication from the treatment, in the course of which the author explains carefully and clearly the ways physicists reason. For example, the introduction starts with the question whether the most characteristic thing about physics is its high precision. An alternative title for the book might well be, *What Makes Physicists Tick?*

The author credits his readers with powers of abstraction. He reminds them on one page what logarithms are, and on another he introduces partial differentiation and partial differential