book. The present volume suffers from neither of these defects. It is thorough, carrying the reader or student all the way from a background in basic physics to fine details of transistors with good examples of real device characteristics. Further, the author has devised novel explanations of various phenomena and took the pains to construct many original figures especially designed to illustrate points.

The first half of the book is devoted to the energy-level structure and the statistical mechanics of semiconductors and to the kinetic processes, recombination and carrier transport, that are basic to the operation of semiconductor devices. The latter part of the book is devoted to models of transistors that can be used to predict their performance in circuits, and includes reproductions of manufacturer's data sheets for several devices. The interpretation of the information on these sheets is explained in the text and they are used to work out a few circuit problems.

Each chapter is provided with a selection of problems and with a chapter summary that provides a quick review of the main points. These features add to the volume's usefulness as a text. The book's value to the practitioner as a reference work is limited by the absence of a comprehensive body of references to the published literature, although some very good suggestions are helpful.

Another unusual characteristic of the book is the author's informal style and his attempts to interject a certain amount of humor into the text. This may strike different readers in different ways. Concerning faults, it is sometimes hard to find references in the text to material presented earlier in the book. The book also contains a few typographical errors.

The book will serve as a text to bridge the gap between the understanding of semiconductors that is provided by physics and the use of semiconductor devices in electronics.

ROBERT W. KEYES
IBM Thomas J. Watson Research Center
Yorktown Heights, N.Y.

An Introduction to Lattice Dynamics

A. K. Ghatak and L. S. Kothari
234 pp. Addison-Wesley, Reading, Mass., 1972. $11.50

Over the last decade the impact of neutron spectroscopy and laser Raman spectroscopy on lattice dynamics has been such that there has been a rapid increase in the number of workers concerned with the calculation and analysis of phonon spectra in solids. However, through much of the 1960's, it was difficult to find an introductory textbook that bridged the gap between the rather cursory introduction of the subject found in the standard solid-state textbooks and the several excellent but detailed treatises on the subject. The present book is one of several recent introductory textbooks that appear to have been undertaken for this reason. Ajoy Ghatak is on the faculty of the Indian Institute of Technology, New Delhi, and Laxman Singh Kothari is a Professor of Physics at the University of Delhi. Both authors have contributed to the field of lattice dynamics and thermal neutron scattering from crystals. Students at the introductory graduate course level interested in lattice dynamics may find this book useful as a supplement to the standard solid-state textbooks.

There is a detailed account of the standard linear-chain problems, and of second quantization of the lattice waves in one dimension, and a clear introduction to elastic waves in continuous media. The lattice dynamics of three-dimensional crystals is also dealt with, and a detailed discussion given of specific-heat calculations, including some interesting discussions of frequency spectra of microcrystallites and of anisotropic crystals. The last part of the book is devoted to a detailed account of thermal neutron scattering from crystals.

Some confusion is caused by the fact that various aspects of frequency spectra, such as the root sampling methods and Van Hove singularities, are all treated in different parts of the book instead of together; the same is true of specific-heat calculations. This leads to a certain amount of repetitiveness and loss of clarity. Although choice of subject matter is inevitably a matter of personal taste and bias, I feel that a long table of neutron cross sections and a detailed account of elastic scattering from polycrystalline materials really have little relevance to a book on lattice dynamics. The main criticism I have, however, is that this book has a rather dated air about it. Thus figures of calculated frequency spectra presented for illustrative purposes are quite outdated considering the resolution and accuracy customarily obtained in more recently published calculations. Instead of dealing with general tensor force constants, interplanar force constants, or axially symmetric force constants, which are currently used in analyzing dispersion curves, the authors have chosen to present De Launay's 1956 formulation of special central and noncentral forces and a phenomenological way of taking the effect of the "electron gas" into account in metals. One cannot help feeling

that a brief account of the pseudopotential formulation for simple metals would have been far more useful and even simpler to understand.

The book is also marred by a number of careless and misleading arguments in several places, examples of which are the reasoning which attempts to associate momenta $\pm \hbar q$ with lattice waves having the form $\exp[\pm i(qx - \omega t)]$, the derivation of a Debye–Waller factor by the expedient of replacing $(1 - x)$ by e^{-x} (on the grounds that x is small), or the claim that surface and edge modes contribute to the frequency spectrum of a crystal with *clamped* surfaces.

S. K. Sinha
Iowa State University

Philosophy of Physics

Mario Bunge
248 pp. D. Reidel Publishing Company, Boston, Mass., 1973. $18.50

In the last few years positivist–operationalist philosophies of science, such as the "Copenhagen interpretation of quantum mechanics," have begun to lose the authority they enjoyed in the 1930's and 1940's. There seems to be a return to a more *realistic* approach—one more closely related to the attitude of the working scientist—and, what may or may not be the same thing, a *Realistic* philosophy, based on the assumption that we are dealing with a world that exists by itself independently of our observations and experiments on it. At the same time it is being recognized that quantum mechanics and relativity are not the only topics that should be discussed by the philosopher of science; even within physics there are other problems of philosophical interest. A good example of these trends is the short treatise *Philosophy of Physics* by Mario Bunge, professor of philosophy at McGill University and author of numerous works on physics and the philosophy of science.

Bunge's book is in part an argument that the "official philosophy of physics" (as he calls it) is wrong or inconsistent and should be replaced by "critical realism." (I would have preferred to see a little more concrete evidence that this philosophy, i.e., operationism and similar views, really does dominate contemporary physics.) He then goes on to advocate and illustrate the axiomatization of physical theories. These two goals are interrelated because, according to Bunge, the official philosophy teaches that the referents of physical theories include the "observer" of natural phenomena yet fail to supply a precise description of the role of this observer, and hence make it difficult or impossible to state the axioms of the theory in a form amenable to logical analysis.

Pursuing his campaign to sweep away the "philosophical fog" that surrounds quantum mechanics, Bunge arrives at some interesting conclusions: the "fourth indeterminacy relation," $\Delta E \cdot \Delta t \geq \hbar/2$, is wrong and hence the meson theory of nuclear forces is invalid; "wave-particle duality" is an obsolete concept; there is no place for the "complementarity principle" in the more sophisticated areas of quantum theory; quantum theory does not require the abandonment of determinism (if you are willing to accept the concept of "stochastic determinism"), and there is no "quantum logic" different from ordinary logic.

While much of the book is concerned with the interpretation of quantum mechanics, Bunge does bring in a number of examples based on other areas of physics, such as classical continuum mechanics, where there has been considerable recent interest in axiomatics. The one example he chooses to illustrate axiomatization is the Kirchhoff–Helmholtz theory of electrical networks. There is a brief discussion of relativity and the problem of "non-relativistic limits" that emphasizes the importance of Maxwell's electromagnetic theory.

Bunge is writing primarily for physicists and does not bother much with the linguistic squabbles that consume the energy of many of his colleagues in the philosophy of science. His background in theoretical physics and his informal style (with only occasional roughness and typographical errors) make this an attractive introduction to philosophy for physicists, though there is no pretense of impartial treatment of the various competing viewpoints. The book might have been even more interesting if some discussion of topics such as the Schrödinger cat paradox and the Everett–Wheeler–Graham "multiple universes" theory had been included (see B. S. DeWitt, PHYSICS TODAY, September 1970, pages 30–35).

In addition to recommending the book for the philosophically minded physicist, I think it would be a valuable text for a graduate course in philosophy of physics, provided it is used together with other readings presenting the conventional operationist philosophy. The reader is assumed to have a knowledge of quantum mechanics and some familiarity with elementary logic and set theory.

Stephen G. Brush
University of Maryland
College Park