flow (page 125), because of outgassing effects. I doubt, too, that in practice mechanical-pump manufacturers can maintain 2-to-3-micron tolerances (pages 204 and 383). Although the references end in 1974, some subjects are not brought up to date—for example, the equipment descriptions for molecular pumps and diffusion pumps—while space is allocated to obsolete equipment such as evapor-ion pumps.

There are other minor faults: One is that references are unnumbered and not referred to chapters; thus, it is impossible to crosscheck from the alphabetical index back to the text.

Generally, the style is clear, the figures well made and chapters well organized. However, the book could profit from careful editing—it deserves it. (For example, on page 221 Roth informs us that pumps are made in sizes from two to 40 inches, but on page 227 a 48-inch pump is described.)

Roth's book has been advertised in relevant journals and through related engineering societies. It certainly deserves the exposure.

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Quantum Collision Theory

J. C. Joachain
710 pp. American Elsevier, New York, 1975. $89.95

The inevitable first questions about this book are: Is it necessary? and Is it worth the price?

The main competitors of this book are Marvin L. Goldberger and Kenneth M. Watson's *Collision Theory* (919 pp. Wiley, New York, 1964. $37.50), Roger G. Newton's *Scattering Theory of Waves and Particles* (681 pp. McGraw-Hill, New York, 1966. $26.00), C. S. Wu and Ohmura's *Quantum Theory of Scattering* (495 pp. 1962. $16.95) and Leonard S. Rodberg and Roy M. Thaler's *Introduction to the Quantum Theory of Scattering* (398 pp. Academic, New York, 1967. $18.00). Rodberg and Thaler's book covers only the basic essentials, so probably it should not be compared to the others. Wu and Ohmura's book is slightly more complete, but does not match the remaining books in completeness.

Of these remaining three, Joachain's is certainly the most complete. For example, Joachain and Newton both discuss the Fadeev equations extensively, whereas Goldberger and Watson do not; in fact, Joachain has a 63-page chapter on three-body problems. Joachain has a good 15-page treatment of dispersion relations while Newton spends about six pages on the subject, but Goldberger and Watson's book has an excellent chapter of over 100 pages on the subject. The most complete discussion of the Mandelstam double-dispersion relation is in Newton's book. Again, Joachain has a good 19-page discussion of complex angular momentum and Newton has a 15-page chapter, but Goldberger and Watson's book does not mention the subject. There are several other subjects where Joachain shares a good treatment with either Newton or Goldberger and Watson, but not both. However, if you combine Newton's and Goldberger and Watson's volumes, you have a 1600-page book that covers almost everything in Joachain's book, plus a lot of extra electromagnetic-scattering material in Newton's book—all for $26.45 *less* than the outrageous price of Joachain's book.

This brings us to the second question. Despite the fact that the first paragraph of the preface states "It is primarily aimed at graduate students . . .", my publishing and library friends tell me that the publisher is counting almost solely on the "captive" library buyers who have blanket orders with all major book companies. I cannot imagine a graduate student, or even a professor, buying this book at the listed price. Finally, on the subject of price, after being given a $90 book I find it hard to write the above seemingly ungrateful comments.

Joachain's book deals mainly with nonrelativistic potential scattering, but it includes relativistic topics at appropriate points. Occasionally the reading gets tedious as the author belabors the fine points of topics that are his speciality. The book is divided into four parts: Description of Collision Processes, Potential Scattering, General Scattering Theory, and Applications. The first part is followed by twenty problems for students, and the second part is followed by sixty problems, but there are no problems for parts three and four.

Joachain is certainly well qualified to write a treatise on scattering theory. As the numerous references in each chapter indicate, he has many papers on the subject and has written many other papers jointly with several of the major contributors to the subject. His work ranges from esoteric theoretical development to the comparison of numerical calculations with atomic-scattering experiments.

The book is, in technical publishing terms, of the highest quality. I found not more than ten errors of any type in reading it. A publishing device that I found to be very convenient is the inclusion at the bottom of each odd-numbered page the statement "References and notes on page—." This enables one to find references for a particular chapter easily, both while reading that chapter and while reading later chapters—the latter being facilitated by the references' presence at the end of the chapter.

This is an excellent book, but I feel that the combination of Newton's, Goldberger and Watson's books is a better buy.

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Quantum States of Atoms, Molecules and Solids

M. A. Morrison, T. L. Estle, N. F. Lane
575 pp. Prentice-Hall, Englewood Cliffs, N.J., 1976. $25.50

The subjects of atomic, molecular and solid-state physics have only rarely been treated at an advanced level in a single volume. The notable exception, of course, is John C. Slater's *Quantum Theory of Matter*. In the present book the three authors, Michael Morrison, Thomas Estle and Neal Lane, stress the unity among these fields by emphasizing the concept of electronic quantum states in atoms, diatomic molecules and crystalline solids. Such a combination should be of basic interest to students in a variety of scientific fields and also forms the basis for more advanced work in those three subjects themselves. This is a textbook of applied quantum mechanics directed to advanced undergraduate and graduate students in physics, chemistry and engineering; the authors assume a previous introduction to quantum mechanics.

After a review of basic quantum mechanics, the first part contains the solution to the one-electron atom, two chapters on approximation methods, two on spin and three on multi-electron atoms. In Part 2 the authors treat the diatomic molecule, first through the use of an exactly soluble one-dimensional model and then by approximation methods applied to a three-dimensional model. The emphasis is heavily on electronic states; vibrational and rotational motion are treated only very briefly at the end of the section.

In the third part, after a preliminary discussion of crystals, lattices and Brillouin zones, we get into a perturbation treatment of a one-dimensional model using the free-electron and the weak-binding approximations. Step by step, the authors then take us through two dimensions and finally to three, where concepts such as energy bands and the Fermi surface are introduced. As in Part 2, the principal focus is on electronic states, but a final chapter on vibrations in solids helps to round out the picture. The five short appendices include a welcome one on atomic units.

This carefully thought out and well written book should provide the student with a well paced introduction to each of the areas under consideration, at a somewhat lower level than Slater's book.

Each chapter has a set of problems, graded according to their difficulty by several groups of students who have studied the material at Rice University. The authors' occasional use of whimsical section titles (such as "The Disappearance of Diabolical Degeneracies") and their inclusion of well chosen quotations at the beginning of each chapter help to maintain a sense of liveliness. This feeling also comes through in their style of writing.

My chief complaint about the book is its complete lack of any connection to experiment. No photographs of spectra, no tables of data, no comparisons of deduced results with any experimental values appear in this book. In fact, virtually no reference is made anywhere to the real world. At some time or other we have all heard and been appalled by stories of the early Greek philosophers, who deduced many results through their logical analyses from theoretical models but who refused to make even the simplest experimental tests to see if their deductions agreed with observations. Perhaps today we are moving back in that direction; this book is not the only one that ignores the question, "Do this model and the deductions based on it have any correspondence with physical reality?" If you want a book to help teach your students to apply quantum-mechanical methods to the central-force problem, the one-dimensional N-electron atom, the double square-well potential and other theoretical models, this book will do it and do it well. But if you feel that students also ought to acquire some basis for judging the validity of models or that they should learn something about how to inquire into the way Nature behaves, then this book must be supplemented with other material to provide a complete presentation of atomic, molecular and solid-state physics.

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Science in Flux

J. Agassi
553 pp. D. Reidel, Boston, 1975.
$48.00

It is quite in keeping with the style of Joseph Agassi's book, which is at once racy and down-to-earth, to begin a review of it with some practical questions. About the quality of the mind displayed in it there can be no doubt—Agassi in these essays is lively, penetrating, often brilliant. But what inducement might there be for a person, or a library, to acquire this large and expensive book? Or for a scientist, for example, to embark on the "enjoyable hours of reading" promised on the dust-jacket?

The book is obviously about science, and Agassi has had a lot of good and original thoughts about science, which have been published here and there in philosophical journals. Many of these thoughts are republished here, with afterthoughts in the form of recurrent appendices, many of them also previously published. The net effect of all this is impressive and confirms his high standing among philosophers of science. But, while impressive, the result is less unified than its collection into one volume might lead one to hope (or even give one a right to expect). This criticism holds not only for the arrangement of the book but also for its contents. To quote the dust-jacket again, "An avant-garde comprehensive view of science should emerge from this collection of essays." Yet, even after a consecutive reading, Agassi's special contribution to the philosophy of science is hard to pin down with any precision.

In a way, of course, the title gives us fair warning; precision and neatness are hardly to be expected of a subject in flux. But there is something unsatisfactory about that as a final characterization of science. The title repudiates the inductivist–positivist view that science grows ineluctably toward perfect knowledge, but hardly anyone now holds that view, and Agassi admits that he doesn't take it seriously either. To see what is going on, one must place the book in its proper professional and historic context. The philosophical tradition to which Agassi belongs is that of Sir Karl Popper and his followers; the dedication of *Science in Flux* is to Popper, "in gratitude; with admiration and dissent," and Agassi says disarmingly in the preface that he wishes to play Maimon to Popper's Kant—that is, in effect, to go beyond the Master by the application of his own critical methods to the results of his own work. Now Popper has been of very great importance and influence in the philosophy of science, principally through his special interpretation of probability, his concept of demarcation, and his principle of falsification. Roughly speaking, Popper believes propositions to be scientific only when they take a certain kind of risk—that is, when the predictions they lead to are highly improbable. A lot of actual confirmations of a theory are of far less interest than a single *possible* falsification, and it is by their offering such possibilities that we can distinguish scientific theories from merely metaphysical ones. These views have led to a certain amount of controversy and misunderstanding, which Agassi tries, sometimes gently, sometimes with considerable impatience, to resolve or clarify. In particular he corrects—against his own admitted earlier misunderstanding—the popular view that Popper has been mainly interested in the *actual* falsification of theories.

The arguments on this and other points are, however, intricate and nuanced, and there is little point in trying to summarize them for an audience of scientists. Agassi's book finds its place naturally enough in its context, but putting it there restricts its readership to a handful of professionals in the philosophy of science. If even philosophers can find Agassi sometimes disconnected, always idiosyncratic and often more subtle than the arguments with which he deals deserve, scientists are not likely to find him an easy entry into the philosophy of science. And yet some of them might like to try it anyway. Emerging from the detail of the graduate seminar, Agassi comes to examine, toward the end of the book, positive evidence as a social institution, for example, and the relationships between reason and religion. Many of his insights are formulated with trenchant precision; some of his images are powerful and memorable—for example, he represents the old positivist view by a monumental socialist sculpture, square-jawed and far-seeing, in contrast to Agassi's own perception of the wisest of humans as a clown on a tightrope. He ends, as Maimon did, poised between scepticism and metaphysics, between stability and flux, between agnosticism and assurance.

I now revert to my own questions and answer them: Time spent on this book will not be wasted for anybody who shares Agassi's sense of the simultaneous grandeur and oddity of the scientific enterprise, and though one might not be inclined to invest in the book oneself, it would always be good to know where one could lay hands on it.

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book notes

University Physics, 5th edition. F. W. Sears, M. W. Zemansky, H. D. Young. 811 pp. Addison-Wesley, Reading, Mass., 1976.

The basic philosophy and outline of this popular general-physics text remain unchanged, but much of the material has been rewritten and reorganized. The chapter on electromagnetic waves has been entirely redone, and the material on atomic and nuclear physics has been expanded to include elementary-particle, high-energy and solid physics. One finds a chapter on relativistic mechanics added, as well as several new sections throughout the book. The principal system of units employed, with SI conventions and nomenclature, is the mks scheme. Also, the authors have included some 300 new problems, for a total of more than 1400.