especially welcome since perturbation theory, based on a hard-sphere reference fluid, has been the most useful theoretical development of the past decade. The discussion is very complete. However, the discussion of the optimized cluster theory might have been clearer if it were given in the notation of the closely related mean spherical approximation. This would eliminate much of the overlong and overcomplex exposition and make clearer the relation to and significance of the approximation. The assessment of the relative virtues of the alternative formulations of perturbation theory, based in part on their application to a system with a repulsive r^{-12} interatomic potential (a system of limited physical interest, existing only in a computer, and not one for which perturbation theory was designed), is misleading. An examination of two-dimensional fluids (such as an adsorbed gas), a dilute solution near the triple point of the solvent or liquids under pressure would have led to more balanced conclusions.

Hansen and McDonald devote three excellent chapters to time-dependent phenomena. Their book concludes with a useful chapter on fluid–solid and liquid–vapor phase transitions including the scaling and renormalization-group treatments of the liquid–vapor critical point.

In contrast to the completeness of their development of mathematical techniques, Hansen and McDonald give a rather sparse outline of the applications of these techniques. More seriously, the applications are entirely to theoretical models (for instance, the Lennard-Jones fluid). Anyone desiring to know about the application of the theory to real liquids (even argon), the nature of intermolecular forces or methods for dealing with three-body forces will have to look elsewhere.

The book by Watts and McGee meets this need admirably. The authors begin with an extended discussion of the origin and nature of intermolecular forces and of methods of determining these forces. The theoretical techniques for equilibrium and non-equilibrium phenomena (including a balanced assessment of perturbation theory) are each dispatched in brief but adequate chapters. The application of these techniques to various systems, real as well as model, are treated in succeeding chapters.

A particularly useful chapter is that on water. The authors give a balanced account of both mixture and continuum theories, although they apparently favor the continuum theories. A full discussion of the water–water potential is also given. Both the earlier semi-empirical and the more recent *ab initio* pair-potentials are covered. The application of computer-simulation methods to calculate the properties is reviewed. Watts and McGee also include a discussion of the role of the reaction field and its importance in calculations of the dielectric coefficient. However, the impression is given that the reaction field is equivalent to an Ewald summation. Actually, the situation is far more subtle. When an Ewald sum is used, the periodic boundary condition introduces spurious correlations which do not seem to arise if the reaction field is used.

A discussion of fluid–solid and liquid–vapor interfaces might have been included in either book but was not—perhaps this omission reflects the early stage of development of the theory.

Misleading or erroneous statements are rare. However, on page 196 Hansen and McDonald state, after an examination of the first three terms, that the perturbation expansion of the dipolar hard-sphere free energy is "widely divergent for $\beta\mu^2/\sigma^3 \gtrsim 1$." The authors really mean that the series is slowly convergent, since the Padé approximant that they use as the sum of the series is convergent for all states of physical interest.

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Douglas Henderson is a member of the IBM Research Laboratory in San Jose, Calif., and is the co-editor of a multi-volume treatise on physical chemistry. His work in the field, he told us, includes collaboration on the development of "the first successful perturbation theory of the liquid state."

Some Modern Mathematics for Physicists and Other Outsiders, Vols. 1 and 2

P. Roman
666 pp. Pergamon, Elmsford, N.Y., 1975. $35.00

This is a remarkable set of volumes. It is unusual to find first-rate mathematical texts authored by a non-mathematician; Paul Roman tells us that he found his mathematical knowledge inadequate for keeping up with modern developments in theoretical physics, and that he spent some hard study in digging out from the mountains of existing literature those concepts and tools without which he felt he could no longer be productive. The result was a course for graduate students, and then these books.

Two things need to be said at the outset. The title notwithstanding, these are textbooks of *mathematics*. And, secondly, they have nothing in common with the hodge-podge of ill-connected subjects, techniques, examples, approximation methods and so on, that form the core of the traditional course for physics graduate students labelled "Introduction to Mathematical Methods in Physics." Instead, we have here a compendium, carefully organized and subdivided, of those basic subjects of mathematics that the author found worth his efforts.

Chapters 1 and 2, "The Raw Materials of Mathematics," deal with the all-pervading notions of set, relation, and mapping. Chapter 3 is a short introduction to the general concept of algebraic systems, with emphasis on their interrelations and mappings between them. Chapter 4 discusses in turn groups, rings and fields, linear spaces in general and linear algebras, with a brief mention of non-associative structures (mainly Lie algebras). Chapter 5 deals with the general concepts associated with the idea of limit and of continuity (topological spaces). Chapter 6 contains a discussion of four frequently occurring properties of topological spaces, connectedness, separability, compactness, and completeness (for metric spaces). Chapters 7 and 8 are devoted to a short course on the theory of measure and integration. The second volume continues with Chapters 9 and 10 on the basic facts about Banach and Hilbert spaces. Chapter 11 deals with linear functionals, and chapters 12 and 13 contain the most important facts on operators and their spectral analysis.

A salient characteristic of these books is the emphasis on *structure* and on *logical interrelationships*. Not everything is proved, but theorems and definitions are carefully stated. But what is perhaps even more important in books of this sort, there are many small enlightening and cautionary remarks to keep the unwary reader away from misunderstanding (many of these remarks occur as footnotes, to which the reader is urged to pay attention). Well chosen examples and problems accompany each topic. Up-to-date notation is used throughout, but nothing is left unexplained, so the reader need not be frightened off by unfamiliar symbols. A typical habit of the author, showing his good pedagogic sense, is to mention alternative notation or terminology when appropriate. The style is lucid and to the point (but none too compressed), yet informal enough to let the reader become aware of the author's enthusiasm both as a student and as a teacher.

No review should be solely laudatory, and here is one critical comment: With all the excellent qualities of the book under review, one may perhaps be skeptical about the need to have one more book where library shelves full of good—indeed, equally excellent—books already exist. (As a starter, Roman's 47-item list will do.) Furthermore, it is doubtful whether the Roman book is more adapted to the needs of "outsiders" than any of the rest. Perhaps the mere fact that a physicist wrote them will make these volumes attractive to some; but it is likely that such readers will stay with them only if they are truly attuned to the spirit of mathematics in the first place. If you think you are so attuned, but fear that you don't know enough, you could hardly do better than use these books for your guide.

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Contemporary Optics for Scientists and Engineers

A. Nussbaum, R. A. Phillips
511 pp. Prentice-Hall, Englewood Cliffs, N.J., 1976. $19.95

In recent years optics has experienced a remarkable resurgence in activity. This increased interest stems from a number of far-reaching developments, foremost among these being the development of the laser and its applications to science and engineering. In particular the unique properties of laser radiation have been extensively utilized in two areas that otherwise would not likely have flourished—holography and nonlinear optics. The resulting applications and potential applications are numerous: the use of holography in the testing of materials, in biological research, in medical research and diagnosis, and in art; the use of lasers in quality control, in precision industrial measurements, in rapid scanners and in medical treatment, and the use of nonlinear effects in the development of tunable lasers, laser modulation and communications.

Besides lasers and their application, there have been significant developments resulting from the marriage of optics with Fourier methods. In particular, Fourier techniques play a major role in the filtering of optical images, in image enhancement and restoration, and in character recognition. There have also been significant developments in geometrical optics with the advent of matrix and in-

Preparation of a hologram of a piece from 14th-century Spain. Cincinnati Art Museum.