

These apperceptions derive from copious archival extracts, which make *Friedmann* a useful book, even though many readers may be discouraged by an indifferently edited, literal translation of a poorly written Russian volume published in 1988.

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Representations and Characters of Groups

**Gordon James
and Martin Liebeck**

Cambridge U. P., New York,
1993. 419 pp. \$69.95 hc
ISBN 0-521-44024-6

Gordon James and Martin Liebeck have produced a delightful text, which could be used in a graduate or advanced undergraduate applied mathematics course or to supplement a physics or chemistry course on applications of finite group theory. It is primarily concerned with group algebra and matrix representations, which is really what group theory in physics is all about. Physics students who sign up for "real" group theory courses in mathematics departments often are disappointed when they discover that the course deals only with abstract classification of groups and not with their physical applications. James and Liebeck's book helps to make both worlds of group theory accessible to students of the physical sciences.

James and Liebeck use general algebraic and group matrix representation properties to help analyze abstract group properties and classify the finite groups. They exhibit the unity of mathematics, starting with number theory, which is the basis of so much of modern mathematics. Their book lets students learn useful things about the abstract groups as well as their matrix representations, particularly the irreducible representations and characters (representation traces) needed for standard spectroscopic applications.

There are a number of mathematical concepts and properties that are clearly explained in this book but are not found in most other texts, except, perhaps, in less accessible mathematical treatments. For example, *Representations and Characters of Groups* contains a proof that the dimension of an irreducible representation must evenly divide the order of the group. Most of the group-theory texts available to physicists will show how the order of a subgroup or a class must divide the

group order (Lagrange's theorems), but they seldom discuss this numerical property of the representation order. The order of irreducible representations is physically important, because it determines the order of spectral degeneracy.

The main subject of this book is the derivation of irreducible characters (and in certain cases also the representations) of virtually all simple groups of order less than 1000. Until recently, most physicists cared about only a few molecular point groups and blissfully ignored most of the members of the huge finite-group "zoo." However, times are changing; exotic species of floppy molecules and atomic clusters are beginning to appear in laboratories around the world. Some of these have extraordinary symmetry groups that would rival that of Rubik's cube.

Much of the text is written in the lemma-proof-theorem style characteristic of mathematical literature. However, unlike most mathematical texts, it is written in English, and a very fine English it is. One can read this book; it is usually not necessary to decipher it. Many of the problems are very challenging, but 52 pages of detailed solutions are given at the end of the book. The book is also one of the few mathematical descriptions of group representations that has (in the final chapter) a description of normal-mode calculations for symmetric polyatomic molecules that begins with just two coupled oscillators.

Instructors in physics or chemistry departments may find this book inappropriate for the main text of an applied group theory course. However, as a problem source and a supplemental reference on the mathematical details of finite group representations, it is definitely an excellent choice.

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Introduction to Conformal Invariance and its Applications to Critical Phenomena

**Philippe Christe
and Malte Henkel**

Springer-Verlag, New York,
1993. 260 pp. \$47.00 hc
ISBN 0-387-56504-3

Ever since the renormalization group theory of critical behavior explained the phenomenon of universality at second-order phase transitions—the property that all such systems fall into distinct classes, each uniquely

characterized by a set of critical indices and scaling functions—it has been the theorist's dream to describe all such classes. An important step in this direction was the recognition that each class corresponds to a renormalizable quantum field theory. Yet, in general, this problem remains unsolved, as does the more difficult one of computing these universal numbers and functions exactly. In two dimensions, however, the situation is more favorable, and in the last ten years a more or less complete solution has been found, thanks to the fact that the scale invariance of such systems enlarges to a larger symmetry—that of conformal invariance. In two dimensions, as solvers of electrostatics and fluid mechanics problems know, this brings to bear the whole mathematical power of complex analysis.

The breakthrough in applying ideas of conformal symmetry to two-dimensional critical phenomena began in the mid-1980s, inspired by ideas originating in string theory. Indeed, the continuing connection to string theory has been one of the most striking examples of cross-disciplinary fertilization in modern theoretical physics. However, this has often meant that much of the fundamental work has been couched in the language of quantum field theory and has been inaccessible to those without a formal training in some of quantum field theory's more esoteric aspects.

This book, written by two young researchers who have each contributed significantly to the subject, is an attempt to rectify this problem. In my view, they have only partially succeeded. The main problems of two-dimensional critical behavior and the principal results obtainable using conformal methods are clearly presented. However, perhaps in a misguided attempt to avoid undue technicalities, the explanations of some of the basic concepts of the theory have been fudged. In my experience this is just where beginning students may have difficulties. For example, in introducing conformal transformations, the authors do not distinguish between Weyl transformations of the metric and coordinate transformations. The physics of each of these is quite different from the other. At no point do the authors discuss radial quantization, which underlies the operator formulation of the theory. As a result, when the Virasoro generators are introduced, it is by no means clear on what space they are acting; likewise, the precise relation between the transfer matrix on a cylinder and the Virasoro generators, central to much of the subsequent discussion, is lost.

The authors are much more at home when presenting some of their own contributions. Nowhere else, to my knowledge, is there such a complete account of the finite-size scaling predictions and numerical tests of the theory. Coulomb gas methods and the calculation of correlation functions are also well described. However, in introducing massive theories and S -matrices, the authors once again make the mistake of merely quoting the basic formulas rather than deriving them from simpler principles.

On the whole, this book will serve better as a compendium of important results than as the introductory text intended by its authors. There are too many places where a student working alone is likely to find conceptual gaps.

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Introduction to the Theory of Laser-Atom Interactions

Marvin H. Mittleman
Plenum, New York, 1993.
326 pp. \$59.50 hc
ISBN 0-306-44432-1

A single atom, alone in the void, encounters a few photons from time to time. What could be simpler to describe with the tools of elementary quantum theory? But increase the photon flux by 10 or 20 orders of magnitude and this model universe becomes a very different place. Traditional time-dependent perturbation theory, the staple of introductory courses in quantum theory, cannot begin to provide even a qualitatively adequate description of all the quantum changes that then occur.

The last two decades have been a time of major theoretical and experimental efforts to describe this new physics. Textbooks and monographs now offer readers at all levels of expertise and interest advice under such labels as quantum optics and multiphoton processes. Special issues of journals and conference proceedings regularly survey advances in portions of this subject. What Marvin Mittleman presents, at a level commensurate with an early graduate physics course and from the viewpoint of a theoretical physicist well versed in scattering theory, is a brief survey of a few of the topics that the book's title suggests. He shares with readers his insights into this theory, while ac-

knowledging the rapid growth of research on laser-atom interactions that hinders any attempt at a comprehensive or up-to-date review.

Although the idealization of an isolated atom (the central model of this book) resembles the "spherical, collisionless chickens" that are said to inhabit the barnyards of theoretical physicists, the quantum mechanics of this apparently simple system has many challenges for theory and holds many surprises. As Mittleman

shows, the theoretical constructs of the scattering matrix and time-dependent Green's function can be put to use here. For example, he discusses at length a time-domain version of the more customary energy-domain use of projection operators to derive effective Hamiltonians.

Many of the topics discussed by Mittleman were unanticipated by the physics community, although hindsight removes much of the surprise. Among these, some of the most re-

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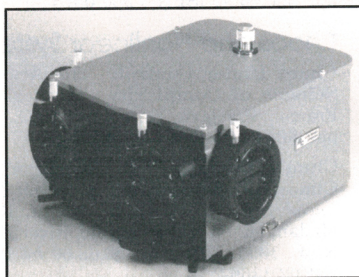
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