

tract however, from an excellent historical review of research and development at Los Alamos.

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Lasers and Optical Fibers in Medicine

Abraham Katzir
Academic, San Diego, Calif.,
1993. 317 pp. \$85.00 hc
ISBN 0-12-401940-4

This book is an excellent introduction to a rapidly expanding field of scientific endeavor. The author places more emphasis on optical fibers than on lasers, but this is as it should be, because it is frequently the availability of a suitable optical fiber that makes feasible the use of a laser in medical applications.

What you will learn from this book is that optical fibers provide access to all parts of the body. When they are used in conjunction with endoscopes inserted into the normal body openings, the procedures are entirely non-invasive—that is, no cuts or holes have to be made in tissues or membranes. When used in conjunction with catheters, laparoscopes or hypodermic needles, the procedures are minimally invasive compared to older techniques, which often require surgery. Optical fibers are principally used in three ways: to image and view distal structures, a function that is gradually being replaced by charge-coupled device chips located at the internal end of the endoscope; to deliver optical energy to the tissue in order to alter the tissue in a therapeutic way; and to interrogate the tissue with exciting light and detect tissue response for diagnostic purposes. It is the latter two applications that require the high spatial coherence of the laser in order to couple sufficient energy into the fibers to accomplish the desired goals.

The book is well written and easy to read. The author knows his subject and knows how to explain it. Well-drawn figures and a liberal use of interesting photographs help clarify the text. The references at the end of each chapter are well chosen and can serve as a useful resource for the reader who is going beyond the introductory level.

The author uses a pedagogical technique in which the material of each chapter is covered three times: first on a "fundamental" level for the novice, then on an in-depth level called "principles" and finally on a level called "advances," which in-

cludes many scientific details. As a reviewer, I read the book in a linear fashion and found going over the same ground three times occasionally annoying; it would be interesting to get feedback from the novices for whom the approach is intended, to determine its effectiveness.

The early part of the book, which is meant to be an introduction to laser physics for physicians, will not be of much interest to most readers of PHYSICS TODAY, except perhaps as a resource for a high school teacher or undergraduate instructor. The remainder of the book, which covers many medical applications, would be of great value to those physicists who are entering or considering entering the field of biomedical optics.

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Alexander A. Friedmann: The Man Who Made the Universe Expand

**Eduard A. Tropp,
Viktor Ya. Frenkel
and Artur D. Chernin**
(Translated from Russian
by Alexander Dron and
Michael Burov)
Cambridge U. P., New York,
1993. 267 pp. \$49.95 hc
ISBN 0-521-38470-2

Alexander Alexandrovich Friedmann (1888–1925) was the brightest star of Russian physics during the late tsarist and early Soviet period. He came from a distinguished line of artists and intellectuals. He performed brilliantly in school and at the University of Saint Petersburg, where he completed his first diploma in exact sciences in 1910 and the examinations required for a master's degree—the degree corresponding to a state doctorate in other countries—in 1913. From his school days, Friedmann found an inseparable companion in Jacob Davidovich Tamarkin, who at the end of his career was one of Brown University's most distinguished mathematicians.

Friedmann's passion was the mathematical study of atmospheric physics, which he pursued at the Central Aerological Observatory near Saint Petersburg, and his research impelled him to visit Vilhelm Bjerknes at Leipzig. During World War I, he served in the Russian army as an aviator, an instructor and eventually, under the revolutionary regime, as the head of an airplane factory. The

victim of incipient heart disease, he resigned the last post in favor of a professorship at the University of Perm in south-central Russia. In 1920 he returned to the Central Aerological Observatory in Petrograd as a senior researcher and, following Russian tradition, taught at a number of institutions in the city. In 1925 he became director of the observatory and head of the weather bureau of the Russian Republic. His health was weakened by years of war and revolution, and Friedmann succumbed to typhoid fever at age 37.

In 1922 Friedmann had begun to explore general relativity. This interest resulted in an important paper and several monographs. The paper, an expanding-universe solution to the field equations of general relativity, provides the present book's subtitle. Yet this interest, which has received considerable attention from historically minded commentators over the past 70 years, was essentially an extracurricular indulgence. Friedmann belongs to the tradition of cosmical physics, in which researchers such as Charles Maurain, Emil Wiechert, Stjepan Mohorovičić, the Bjerknes dynasty and perhaps Sir Harold Jeffreys focused mathematical talents on diverse, larger-than-laboratory-sized phenomena. Because they constructed their universe around partial differential equations that described the way continuous matter stretched and strained, they scrutinized Einstein's revolutionary approach to large-scale matter in motion. Maurain, Jeffreys, and Friedmann embraced Einstein's thought; Wiechert, Mohorovičić, and the two elder Bjerkneses did not like it.

A leitmotif of this biography is the central importance of friendships in an aristocracy of talent—between master and pupil as well as among ambitious apprentices. The prose is sometimes intensely personal, reflecting Friedmann's close association with Yakov Ilyich Frenkel, the physicist father of coauthor Viktor Ya. Frenkel. We see how, under the early Bolsheviks, young physicists and mathematicians quickly arrived at positions of authority and how they vigorously pursued research by their own hands once they had settled into commanding situations. Physics was at the time in great vogue, and educational administrators favored energetic striplings over slow-moving mossbacks. Successful physicists mining the most recondite seams of physical law were careful—as Friedmann was careful—to cultivate the politicians who facilitated their good fortune.

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.