The volume concludes with a number of offbeat philosophical discussions between Ulam and Rota on the nature of mathematics, skillfully transcribed from tape recordings.

In the end it does not much matter why Ulam shied away from technical mathematics; what matters is that we see him as he was, a very human hero who succeeded in turning a weakness into major strength. Rota's scientific and psychological portrait in the introduction, suffused with love, pain, understanding and admiration, succeeds in bringing Ulam to life.

The book originally appeared as a special issue of *Los Alamos Science*. The unusual and unusually beautiful design and artwork, including three portraits of Ulam by Jeff Segler, enhance its value and the pleasure it gives; the editor, Necia Grant Cooper, has earned our gratitude.

Geomagnetism

Edited by J. A. Jacobs
Academic, San Diego, Calif., 1987.

Volume 1. *627 pp. $112.00 hc ISBN 0-12-378671-1*

Volume 2. *579 pp. $112.00 hc ISBN 0-12-378672-X*

The field of geomagnetism has seen an enormous explosion in knowledge since Sidney Chapman and Julius Bartels, nearly 50 years ago, summarized what was then known about the terrestial magnetic field and its variations in their classic two-volume treatise *Geomagnetism*. Chapman and Bartels's book was published before any *in situ* measurements of the Earth's ionosphere and magnetosphere had been made. By the 1960s a wealth of information acquired from satellite and rocket-borne detectors had greatly supplemented the inferences made using the purely remote sensing techniques available in the era of Chapman and Bartels. In 1967 there appeared a two-volume set edited by Sadami Matsushita and Wallace Campbell, *Physics of Geomagnetic Phenomena* (Academic, New York), which provided an updated view of the character and origin of the Earth's magnetic field. Since then, experimenters have used planetary probes (for example, Mariner and Voyager) to acquire *in situ* measurements of the magnetic fields and charged-particle environments of the many planets and moons of the solar system. The subject that was once called geomagnetism should now more properly be referred to as planetary magnetism.

These new data have given researchers good cause to reexamine the origin of planetary magnetic fields. This fact coupled with the rapid evolution of models for generation of the planet's main field and for the formation of planetary magnetospheres has made imperative the assembling of an updated summary of knowledge in this field. The two-volume set *Geomagnetism*, edited by John A. Jacobs, attempts just that task.

Jacobs has a long history of involvement in studies of the geomagnetic field. During the early stages of his career, he concentrated on investigating the evolution of the Earth's core and on studying dynamo mechanisms to explain the origin of the main magnetic field. He has spent the most recent portion of his career concentrating on these issues as well, but from 1958 to 1968 he was a major contributor to studies of fluctuations in the terrestrial magnetic field (particulary those dealing with the origin of geomagnetic pulsations). Jacobs's background in both space physics and solid-Earth physics gives him a unique perspective from which to mold the content of a modern summary of the origin of magnetic fields in the solar system.

This new set of volumes is particularly strong in two areas. The physics of the Earth's core and the origin of the geomagnetic field are dealt with in a most comprehensive fashion by a series of chapters by Paul Roberts and David Gubbins in the second volume. This outstanding presentation of the theoretical foundation for dynamo theory sits side by side with a summary by Christopher Russell of the most modern *in situ* observations of planetary and magnetic fields. Russell's chapter introduces the reader to the unexpected properties of the magnetic fields of Mercury and Uranus, which pose a challenge to theorists interested in the origin of solar system magnetic fields.

A third volume covering the state of knowledge of short-term fluctuations in the geomagnetic field is in preparation. Since this area of research occupied a good half of the earlier treatises by Chapman and Bartels and by Matsushita and Campbell, the eventual publication of the third volume of *Geomagnetism* will obviously help fill an important void in the coverage of planetary magnetic fields. The first two available volumes of the book also do not cover terrestrial paleomagnetism; perhaps a chapter in a later volume will.

Geomagnetism is clearly oriented toward the professional researcher or senior graduate student dealing with problems in solid-Earth and space physics. The reader who wishes to put these volumes on his personal bookshelf will find the cost somewhat intimidating. However, *Geomagnetism* represents an excellent effort to update the field of solar system magnetism; no institutional library should be without these volumes.

GORDON ROSTOKER
University of Alberta
Edmonton, Canada

Riemann, Topology and Physics

Michael Monastyrsky
Birkhäuser, Boston, 1987. 158 pp. $39.50 hc ISBN 0-8176-3262-X

Felix Klein and Sophus Lie: Evolution of the Idea of Symmetry in the Nineteenth Century

Isaak Moiseevich Yaglom
Birkhäuser, Boston, 1988. 237 pp. $40.00 hc ISBN 0-8176-3316-2

It is at first sight odd to find combined in one book two essays centered upon such seemingly disparate subjects: a scientific biography of Georg F. B. Riemann, and a short overview of qualitative topological methods in condensed matter physics and field theory. But this impression vanishes quickly in *Riemann, Topology and Physics* when one realizes that standing constantly in the background of this concise and lucid account of the interaction between topology and physics is the figure of Riemann, the generator of many of the ideas that shaped modern mathematics.

The contributions of Riemann to mathematics and physics are as profound as they are varied: the formulation of Riemannian geometry (which provides the basic language of general relativity), the theory of Abelian functions and Riemann surfaces, the determination of the asymptotic distribution of prime numbers, the first ideas on index theory and the relation between analysis and topology, the theory of differential equations, and more in this vein.

In the first part of the book, Michael Monastyrsky gives a terse and beautiful account of some of the questions and insights that motivated Riemann's work. His relation with other notable mathematicians of the 19th century like Richard Dedekind, Peter Gustav Lejeune Dirichlet, Ferdinand

Eisenstein, Karl Weierstrass, and others give us information about how his ideas were accepted by the scientific community. Presenting Riemann in his historical context allows the reader to better appreciate the tremendous progress in mathematical thinking that his ideas generated.

The second part of the book surveys the applications of topology in physics. The author gives an excellent perspective on many physical systems whose qualitative properties are elucidated by topological ideas—for instance, superconductors and flux quantization, defects in liquid crystals, symmetry breaking and solitons in gauge theories. The treatment is rather modern, and one can see how many of the ideas that Riemann introduced in the last century have become quite useful in modern theoretical physics. Some of the most direct recent applications of Riemann's work can be found in superstring theory, so far the only known candidate for a consistent quantum theory of space–time and gravitation.

The first part of the book is a delightful and very recommendable scientific biography of one of the most influential minds in the history of science. The second part provides the reader with an unusually good exposition of some of the topological aspects of several branches of theoretical physics. In the words of Freeman J. Dyson's introduction: "The quality that makes Monastyrsky unique among expositors of contemporary physics is his depth of historical focus. He sees modern ideas in a perspective that goes all the way back to Riemann." The only drawback this book has is that it is too short.

One of the most important subjects in modern mathematics and physics is the notion of symmetry, embodied in the theory of groups and their representations. Very often the dynamical equations describing real systems are so complex that symmetry arguments may be the only way to proceed to obtain useful information on their solutions. The study of group theory in recent years has become part of the standard training of physicists and mathematicians. This was certainly not the case in the 19th and the first half of the 20th centuries.

Isaak Yaglom's *Felix Klein and Sophus Lie* provides a beautiful account of the origin and evolution of the notion of symmetry. The starting point of the book is the celebrated memoir Evariste Galois wrote with feverish haste on the night before the duel that took his life. This memoir contains nothing less than the theory of groups, a key to modern algebra and modern geometry. In particular, it gives the solution to deciding whether the roots of an algebraic equation can be obtained by radicals, a problem that had remained open for centuries. Before discussing the central figures of the book, Lie and Klein, the author describes many of the 19th-century contributions to geometry together with biographical sketches of the contributors, among them Gaspard Monge, Victor Poncelet, August Monge, Hermann Grassmann, Niels Abel, Riemann, Arthur Cayley and Jakob Steiner.

Late in the century Klein and Lie met in Paris and started a friendship lasting the rest of their lives. They also began to understand the central importance of group theory in mathematics. Klein concentrated mostly on discrete groups, while Lie devoted his life to a systematic study of continuous groups. Klein's famous Erlangen program explains the central role of group theory in the unification of various fields of mathematics. This line of thinking finally brought recognition to the non-Euclidean geometries of Janos Bolyai and Nicolai Lobachevski. In different contexts, both Klein and Lie realized the power of group transformations and group invariants in the classification of different geometries as well as in mechanics, differential equations, automorphic functions and other areas.

Yaglom presents a very lucid exposition of the contributions of these great mathematicians, and gives many interesting details of their lives. The book also contains extensive notes on the main text so that the interested reader can pursue selected points in greater depth. This is a very recommendable book for anyone interested in the problems, ideas and motivations that generated one of the most useful concepts in modern physics and mathematics.

Luis Alvarez-Gaumé
Boston University

Introduction to Synchrotron Radiation

Giorgio Margaritondo
Oxford U. P., New York, 1988. 280 pp. $45.00 hc ISBN 0-19-504524-6

Twenty years ago, the users of synchrotron radiation were a small band of enthusiasts willing to travel to distant lands (for example, Stoughton, Wisconsin) to perform their experiments. Today, the users of synchrotron radiation can be numbered in the thousands, and they are still willing to travel to distant lands (for example, Upton, New York). A third generation of synchrotron radiation sources is now under construction, with price tags in the $100–400 million range. Synchrotron radiation science has therefore become "big science," yet most of its practitioners would place themselves in the "small science" community.

Giorgio Margaritondo's brisk survey conveys in less than 300 pages the breadth and excitement of the field. Margaritondo has done distinguished research using synchrotron radiation; he is currently the associate director for research at the Synchrotron Radiation Center in Wisconsin. It is fitting that his *Introduction to Synchrotron Radiation* should appear in 1988, the 20th anniversary of the Wisconsin SRC, which was the first source dedicated solely to the production of synchrotron radiation for research purposes.

The first 90 pages of the book define synchrotron radiation and discuss how it is produced, how it is monochromatized and how it is delivered to the samples on which measurements are to be made. This part of the book is essential reading for newcomers contemplating experimental work with synchrotron radiation. The book continues with a discussion and presentation of the rudiments of various disciplines that use synchrotron radiation: optical spectroscopy and EXAFS (both gas phase and solid state), photoemission spectroscopy, elastic x-ray scattering, photodeposition, microscopy, fluorescence and other techniques. The overall coverage is fairly even, although Margaritondo has forgivably dwelt at greater length on his own specialty, photoemission investigations of semiconductor surfaces and interfaces.

There is a particularly interesting chapter on synchrotron radiation in technology and medicine. The possible implementation of x-ray lithography using synchrotron radiation has stimulated considerable activity in the US, Europe and Japan. One can foresee the use of small storage rings as components in production lines for the manufacture of microelectronic chips. A principal potential medical application is noninvasive angiography. Present methods of angiography require the use of catheters, making the diagnosis of heart disease as hazardous as the corrective surgery itself.

The book's level of presentation is agreeably conversational and largely qualitative. The most sophisticated piece of mathematics is the Fourier transform connecting EXAFS with the