

and cosmology. Indeed Frampton's discussion in this section is rather superficial.

My most serious disappointment with both books concerns their overall approach to quantum field theory. They take the traditional course of discussing renormalization and renormalizability of a gauge theory as if the Lagrangian describing the theory were an accurate description at arbitrarily short distances. Twenty-five years ago, this would have been a reasonable attitude. Even 15 years ago, the modern view of the subject was understood completely only by a few pioneers like Kenneth Wilson. But today, all working particle theorists realize that any specific quantum field theory, and almost certainly quantum field theory itself, is only a provisional, approximate description of the world, useful in a limited range of energy or distance. Pokorski and Frampton understand this very well, and discuss it in passing: Pokorski in his chapter on effective chiral Lagrangians, and Frampton in his treatment of effective gauge theories. But neither adopts the effective-field-theory language consistently from the start.

This is a mistake, in my view. Unfortunately, although most working particle theorists have a nuts-and-bolts understanding of effective-field theories, the old-fashioned view still dominates texts, and survives as well in many archaic, inappropriate words for ideas whose significance has changed in the modern view (such as "triviality" and "Landau ghost"). If we are to educate students properly, so that they learn the lesson of effective-field theories in their coursework rather than having to relearn field theory when they actually use it, we need texts that adopt the modern view from the beginning.

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Differential Geometry, Gauge Theories and Gravity

M. Göckeler and
T. Schücker
Cambridge U. P., New York,
1987. 230 pp. \$49.50 hc
ISBN 0-521-32960-4

The past decade has witnessed a dramatic rise in the mathematical sophistication of mainstream elementary-particle theory. With the discoveries in the mid-1970s of monopoles and instanton solutions in non-Abelian gauge theories, there entered into physics a number of concepts and tools from differential geometry and

topology, such as fiber bundles and homotopy theory. The study of fermion fields in the backgrounds of such topologically nontrivial solutions led to the appreciation by physicists of characteristic classes and index theorems. This, in turn, fueled the renaissance of the theory of chiral anomalies in the early 1980s. The string theory revolution (brought on in part by a study of anomalies that was made possible by this renaissance) has brought into physics results from Riemann surfaces and even number theory.

Having said this, I must add that I, along with many other physicists, share a distrust of very abstract mathematics, and prefer to avoid it unless it proves to be absolutely necessary for the understanding of a physical problem. This reluctance to learn "new" mathematics is partially due simply to the inaccessibility of much of the mathematics literature to those with only a physicist's training.

This book by Meinulf Göckeler and Thomas Schücker is a recent effort to address this problem, at least in the area of differential geometry. The authors recast in mathematically more abstract and general settings certain results from tensor calculus and gauge theory that are familiar to physicists. In this way, the authors hope to familiarize the reader with new mathematical notions while at the same time indicating their physical relevance. Specifically, the book begins with an exposition of differential forms, which have become an established part of the particle theory vocabulary. After an interlude on gauge theories and Einstein-Cartan theory, the text proceeds with discussions of manifolds and Lie groups, thereby building up to fiber bundles and classical topological solutions. The two final chapters are on anomalies.

This effort to present mathematics effectively to physicists is largely successful. The presentation is in general quite careful and concise; many proofs are not supplied, but neither are they missed. This is not to say that the book can be read like a novel—the chapter on fiber bundles in particular is not easy. Unfortunately, the authors stray from their thorough and pedagogical approach in the last two chapters, which are rather sketchy. This is somewhat surprising in view of the fact that the chapter's subject—anomalies—is one on which Schücker has worked. Also, the handling of references is sometimes puzzling. For instance, in the brief discussion of lattice gauge theory (Göckeler's specialty), there is no

mention of Kenneth Wilson; and the discussion of the so-called positive-energy theorem does not mention Edward Witten's proof.

The mathematics prerequisites for reading this text consist of linear algebra, tensor calculus and some acquaintance with Lie groups. The physics prerequisites are familiarity with classical Yang-Mills theory and with relativity—say, at the level of Steven Weinberg's *Gravitation and Cosmology* (Wiley, New York, 1972)—except for the chapters on anomalies, which assume knowledge of quantum field theory. Thus the text should be accessible to graduate students in elementary-particle theory. At the end of each chapter there is a set of problems. Although many involve verifying results stated in the text, the reader may find these exercises useful study aids.

A number of excellent reviews for physicists on differential geometry and related topics have already been available for some time. Compared with the well-known review article "Gravitation, Gauge Theories and Differential Geometry" by Tohru Eguchi, Peter Gilkey and Andrew Hanson (Phys. Rep. **66**, 213, 1980), Göckeler and Schücker's text is somewhat slower paced and treats certain topics in more detail. However, their text has a much smaller scope, as it does not discuss index theorems or characteristic classes, except for a section on Chern classes. Other recent related texts include *Geometrical Methods of Mathematical Physics* by Bernard Schutz (Cambridge U.P., Cambridge, UK, 1980) and *Topology and Geometry for Physicists* by Charles Nash and Siddhartha Sen (Academic, London, 1983). Göckeler and Schücker's text does not fill an urgent need. Nevertheless, it should serve usefully as both a study guide and a reference.

RAFAEL I. NEPOMECHIE
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Kelvin's Baltimore Lectures and Modern Theoretical Physics: Historical and Philosophical Perspectives

Edited by Robert Kargon
and Peter Achinstein
MIT P., Cambridge, Mass.,
1987. 547 pp.
\$40.00 hc ISBN 0-262-11117-9

In the fall of 1884, William Thomson, professor of natural philosophy at the University of Glasgow, who became Baron Kelvin in 1892, delivered a set

of 20 lectures at Johns Hopkins University on "Molecular Dynamics and The Wave Theory of Light," in which he took issue with what he described as "the so-called electromagnetic theory of light." Kelvin was then 60 years old and at the height of his reputation; Maxwell had already died, in 1879. Kelvin's informally delivered lectures attracted attendees from various countries, including Lord Rayleigh, but were mainly for the benefit of a group of American physicists who called themselves the "21 coefficients" (from the symmetric 5×6 matrix describing an elastic solid). Among the latter were Henry Rowland, Albert Michelson and Edward Morley. The original lectures, transcribed by A. S. Hathaway and corrected by Kelvin, are printed here for the first time, together with a set of historical and philosophical essays about half of the volume) collected in 1984 to commemorate the centenary of the lectures.

Kelvin spent much of two decades that followed "improving" the lectures, which were finally published, in greatly altered form and with 12 appendices, by Cambridge University Press in 1904. In the new preface Kelvin said, "I chose as subject the Wave Theory of Light with the intention of accentuating its failures," and he assured all his "Baltimore coefficients still alive" that every difficulty presented by the ether theory had subsequently received a satisfactory dynamical explanation, except for "the one and only serious objection"—that raised by the experiment of Michelson and Morley. (Einstein, pay attention!) Referring to the collegial atmosphere in which he had delivered the lectures at Baltimore, he wrote, "I spoke with absolute freedom and never had the slightest fear of undermining [the auditors'] perfect faith in ether and its light-giving waves." The 1904 volume also contains Kelvin's famous "two clouds" address to the Royal Institution, cloud I being the Michelson-Morley experiment and cloud II "the Maxwell-Boltzmann doctrine regarding the equipartition of energy." No merely minor atmospheric disturbances—relativity and quantum mechanics—would be needed to dispel those clouds.

The original Baltimore lectures are important documents of the history of physics, so libraries should acquire this book on that account alone. The nonhistorian physicist, however, while able to appreciate the accompanying essays, will probably find the lectures themselves difficult to read, and will be frustrated by misprints in formulas and by the archaic language. (Among the then-

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novel terms are *radian* and *frequency*.) On the other hand, there are occasional illuminating flashes, some humor, and from our present point of view an undue reliance on crude mechanical analogies, some of which were turned into working models that were exhibited to the audience.

Most of the historical and philosophical essays in the centenary volume, especially the philosophical ones, are only loosely related to the Baltimore lectures (except inasmuch as science as a whole is unified). Howard Stein's essay on "the subsequent development of physics," that is, what followed the lectures, is an exception. Mainly dealing with the Lorentz electron theory, Stein objects to Thomas Kuhn's characterization of this theory as *normal science*, arguing that a theory that is incomplete (and in that sense a failure) can be revolutionary, providing it is convincing in its failure. Other philosophical essays deal with such concerns as parts and wholes (Abner Shimony), the ontology of space-time (Paul Teller), locality vs action at a distance (John Earman), the quantum measurement problem (Arthur Fine) and the older natural philosophy vs the modern metaphysics of science (Thomas Nickles).

M. Norton Wise and Crosbie Smith lay their emphasis on the practical side of Kelvin, who was a prodigious inventor and whose theory of the electric telegraph had convinced him of the existence of longitudinal ether waves. Peter M. Harman makes the point that Maxwell's electromagnetic theory was based on a hydrodynamic model, even though, like Kelvin, he sought also to realize it by a mechanical analogy. Lawrence Badash argues (unsurprisingly) that Ernest Rutherford, in spite of his good-natured joshing of theorists, was himself a part-time theorist, while Bruce J. Hunt describes G. F. Fitzgerald's unsuccessful attempts to make a Maxwellian out of Kelvin. On the whole, this is a stimulating, if somewhat heterogeneous work on the cultural side of physics.

LAURIE M. BROWN
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The Quantum Universe

Tony Hey and
Patrick Walters

Cambridge U. P., New York,
1987. 180 pp.

\$47.50 hc ISBN 0-521-26744-7;

\$16.95 pb ISBN 0-521-31845-9

Tony Hey and Patrick Walters believe that what the lay reader most wants to know about the quantum

theory is its practical impact, and after that what it has to say about matter and the universe. With due acknowledgment of their debt to the late Richard Feynman, they freely adopt his pedagogical style and accept his philosophical (one might say *anti-philosophical*) stance.

The Quantum Universe has little to say about mystical implications of the quantum theory. Like Feynman, its authors simply accept that the quantum world is run by peculiar rules that thwart our feeble attempts to visualize it, because that's the way things are. Queer as they may be, these rules gave us the computer chip, lasers and nuclear energy, and enable us to understand the heart of a nucleus or of a collapsing star.

Also in the Feynman spirit, Hey and Walters would rather find an apt analogy to illuminate each topic than stick to a unified treatment. Roller coasters and pinball machines serve their purposes and then are discarded. One exception is double-slit interference (another Feynman favorite), a unifying theme that occurs several times in the text.

The book is lavishly illustrated both with color photographs and with line drawings far more vivid than the usual textbook fare. As a result, it has much of the feel of those marvelous BBC television science specials. Indeed, in places the text reads a bit like a TV script, skipping past sticky points with bursts of verbal legerdemain.

Hey and Walters are exceptionally attentive to history. Every child has heard of Albert Einstein and Niels Bohr, but John Bardeen and Heike Kamerlingh Onnes are hardly household names, and few outside the semiconductor industry are aware of how much we owe to Jack Kilby, Robert Noyce, Ted Hoff and the pioneers of the microchip.

Popularizers often drag their own work into the story, and for Hey this means gauge invariance, on which he has written an important monograph. Unfortunately, this hobbyhorse ride is quite out of place in this book. Though professionals may marvel at how much physics comes out of such a parsimonious assumption, the lay reader has no frame of reference from which to be similarly impressed. But other lapses into formalism are, by and large, confined to appendices, so that on the whole this is an exceptionally successful popularization for the many readers who love science for its wonders, but care little for its structure.

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NEW BOOKS

Astrophysics

The Cambridge Atlas of Astronomy. Second edition. J. Audouze, G. Israël, eds. Cambridge U. P., New York, 1988. 431 pp. \$90.00 hc ISBN 0-521-36360-8. *Reference*

The Color Atlas of Galaxies. J. D. Wray. Cambridge U. P., New York, 1988. 189 pp. \$79.50 hc ISBN 0-521-32236-7. *Reference*

Observer's Handbook 1989. R. L. Bishop, ed. Roy. Astron. Soc. Canada, Toronto (M5R 1V2), Canada, 1988. 224 pp. \$10.00 pb ISSN 0080-4193. *Reference*

Uranometria 2000.0, Vol. 2: The Southern Hemisphere to +6°. W. Tirion, B. Rappaport, G. Lóvi. Willmann-Bell, Richmond, Va., 1988. 473 pp. \$35.00 hc ISBN 0-943396-15-8. *Reference*

Biophysics

Imaging Techniques in Biology and Medicine. *Physical Techniques in Biology and Medicine.* C. E. Swenberg, J. J. Conklin, eds. Academic, San Diego, Calif., 1988. 369 pp. \$70.00 hc ISBN 0-12-679070-1. *Monograph compilation*

Introduction to Theoretical Neurobiology. *Cambridge Studies in Mathematical Biology* 8. H. C. Tuckwell. Cambridge U. P., New York, 1988. **Vol. 1: Linear Cable Theory and Dendritic Structure.** 291 pp. \$49.50 hc ISBN 0-521-35096-4. **Vol. 2: Nonlinear and Stochastic Theories.** 265 pp. \$49.50 hc ISBN 0-521-35217-7. *Monograph*

Nuclear Analytical Techniques in Medicine. *Techniques and Instrumentation in Analytical Chemistry* 8. R. Cesareo, ed. Elsevier, New York, 1988. 404 pp. Dfl 245.00 (\$129.00) hc ISBN 0-444-42911-5. *Monograph compilation*

Elementary-Particle Physics

Antiproton Science and Technology. Proc. Wksp., Santa Monica, Calif., October 1987. B. W. Augenstein, B. E. Bonner, F. E. Mills, M. M. Nieto, eds. World Scientific, Singapore (Teaneck, N. J.), 1988. 759 pp. \$88.00 hc ISBN 9971-50-587-8

Charm Physics. *China Center of Advanced Science and Technology Symposium Proceedings* 2. Proc. Symp., Beijing, China, June 1987. M. Ye, T. Huang, eds. Gordon and Breach, New York, 1988. 561 pp. \$85.00 hc ISBN 2-88124-233-2

Cosmology and Particle Physics. Proc. Sem., Peñíscola, Castellón, Spain, June 1986. E. Alvarez, R. Domínguez-Tenreiro, J. M. I. Cabanell, M. Quirós, eds. World Scientific, Singapore (Teaneck, N. J.), 1987. 283 pp. \$64.00 hc ISBN 9971-50-259-3; \$37.00 pb ISBN 9971-50-314-X

Neutrino Physics. Proc. Wksp., Heidelberg, FRG, October 1987. H. V. Klapdor, B. Povh, eds. Springer-Verlag, New York, 1988. 333 pp. \$55.90 hc ISBN 0-387-19254-9