mizuka—deserve great credit for what must have been a demanding task. They have organized about 500 authors, mostly American academics, to write nearly 1000 articles, each occupying an average of two two-column pages. The typography is excellent, and the three volumes are a pleasure to handle. They also, as do others of their kind, present something of a hazard to the casual, distractable reader, who may start off hoping to learn something of Feynman diagrams but be caught and carried away by fiber optics and by fields (electric, gravitational, Higgs, magnetic) to the point of forgetting the original intention.

There is some unevenness of treatment, which is natural given the wide range of readers—especially those with little technical expertise—being addressed. Anyone who needs to look up ammeters, for example, may well find Clifford algebra confusing (I certainly did!), but variety of coverage is inevitable, indeed praiseworthy, in a work such as this.

A more pertinent criticism is of redundancy: Is it necessary to have separate articles on ammeters and voltmeters, if both, we are told, are based on the d'Arsonval galvanometer, which is separately described? Since there are cross-references at the end of each article and a well-organized index, a rather longer entry on electrical measurements would surely have given better value. As another example (and not the only other by any means), the five articles whose headings begin with "gravitational" (attraction, constant, force law, lensing and wave) are by different authors and occasion unnecessary overlaps. Unfortunately, none describes how G has been measured; the same is true for most of the other constants of nature. This leaves one (perhaps intentionally) with the impression that physical ideas, especially those of more recent discovery, are more significant than the experiments by which they were brought to light, and this is not wholly commendable.

On the other hand, there are some excellent historical articles, especially the biographical notes on great physicists. Presumably, it was an editorial decision to limit the number of biographies to 50, and only a captious critic would suggest replacing more than a very few among them. For my part, if Edwin Hubble is to appear, I should plead for Arthur Eddington as well, and I should be prepared (but only in private) to suggest sacrificial victims to make room for him—and for Arnold Sommerfeld and Peter Debye and, above all, Henry Cavendish, whose remarkable electrical researches get hardly a mention and whose determination of G gets none. In this connection, I am sad to find nothing about that rather elusive figure, John Michell, who devised the apparatus that Cavendish used for G, invented the torsion balance before Charles Coulomb did and remarked, before Pierre Laplace did, on the possible existence of black holes.

It is hard to squeeze a complete historical story into a small space, and the multiplicity of authors compounds the problem. Thus, in various articles, we find attributed to Coulomb and to Jean-Baptiste Biot and Félix Savart the basic ideas that inspired André-Marie Ampère's theory of the magnetic field, while James Hofmann, who is responsible for the biographical note on Ampère and who has written a detailed study of his work, regards him as having developed his views in a different and highly individual way. A similar discrepancy attends descriptions of Galileo's study of falling bodies: The physicists tend to believe he dropped objects of different weight from the leaning tower of Pisa, but his biographer is dubious. Simon Stevin, the Flemish mathematician and engineer who described the experiment some years before Galileo did, shares Michell's fate in being ignored. On the whole, if one has to judge between the physicists and the historians as narrators, it is the historians who win hands down.

As for the encyclopedia's principal aim—to cover as wide a range as possible of physical ideas in an accessible form—every reader will find a mixed bag, though most will find a great deal to approve. Along with much that is described clearly and correctly, there are occasional errors more serious than simply confusing the Braggs, father and son, or conflating Vitaly Ginzburg and Evgenii Lifshitz into a single colleague of Lev Landau's. For instance, in a derivation of the Coriolis force—a notorious pitfall for textbook writers—the correct form is written, but it does not result from carrying through the verbal description of the mathematical operations, if only because equation 2 is wrong. At a different level, the reader tackling the article on the vacuum state is presented with some wholly mysterious remarks on symmetry while being casually invited to write off infinite energy densities as irrelevant. Here, as with superstrings and other modern concepts, the author was faced with a task of such immensity that he may be forgiven for providing the reader with little more than soundbites appropriate to cocktail party conversation. By contrast, the article on matrix mechanics would genuinely help the reader who has only a vague awareness of matrices.

The longer I look at these volumes, the more I am irritated by little faults—obscurities, omissions, diagrams inadequately captioned or poorly labeled (for example, on page 634, we find two strange elements, ${}_2Li^8$ and ${}_6B^{10}$)—yet the more I admire the editors' success in bringing their enterprise to a conclusion. There is much excellence here, and if, as I hope, further editions are called for, the trivial errors can be corrected with patient and critical reading. Failure to explain deep thoughts in simple terms may be beyond repair, but this is not a common fault here. It is admirable for so bold an attempt to have been made.

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Introduction to the Theory of Ferromagnetism

Amikam Aharoni
Oxford U. P., New York, 1996. 315 pp. $70.00 hc
ISBN 0-19-851791-2

Introduction to the Theory of Ferromagnetism is a much needed, thorough introduction and guide to the literature. It is full of wisdom and commentary. Even more, it is Amikam Aharoni at his best—telling a story. His textbook might have been called "The Foundations of Micromagnetics."

Micromagnetics would be interesting enough in its own right, even if it were not as important as it is to information technology. It serves as a prototype of complexity arising from simple laws. As ferromagnetism is not at all well covered in textbooks on electricity and magnetism, Aharoni provides the background physics sufficient to the task. After an introduction that includes nomenclature, Weiss domains, the Bohr–van Leeuwen theorem and diamagnetism, the next four chapters are headed "Molecular Field Approximation," "The Heisenberg Hamiltonian," "Magnetization vs. Temperature," and "Anisotropy and Time Effects."

In chapter 6 he unveils "Another Energy Term" anticipated throughout the first five chapters. The protagonist, magnetic charge, appears on the scene after the stage is set and all the other characters are established. Magnetic charges come from divergence of the magnetization in the bulk and normal components of the magnetization at surfaces. The Weiss domains arise to suppress the magnetic charges. This is called the pole avoidance principle.

The last five chapters are everything one should know before becoming a practitióner of micromagnetics: classical exchange, the Landau and Lifshitz wall, magnetostatic energy and the pole avoidance principle, Bloch and Néel walls, Brown's equations, the nucleation problem and analytic and numerical micromagnetics. While he establishes the quantum mechanical origins of micromagnetics, Aharoni emphasizes that the classical aspects are sufficient for almost all applications.

Aharoni remains a principal force in the development of micromagnetics. He retells the story, much of which has been forgotten or never heard, in this age of information overload. He tells what is needed. He guides and warns the reader. He is fun to read. Admitting to a strong bias, I can hear his voice and envision his telling, for I have heard parts of it from him over the decades.

As a text, *Introduction to the Theory of Ferromagnetism* works, if one takes into account the students and the limits on the amount of material that can be absorbed in a one-semester course, at the graduate or advanced undergraduate level for engineers or physicists. The extensive references provide an advanced review of micromagnetics and supply sources for suitable exercises.

By the end of the course, the students should be able to program the equations of micromagnetics and apply them to an endless variety of possible magnetic configurations. Yet, as Aharoni warns, "The computer is a very useful and powerful tool . . . . But it is not a substitute for thinking." He discusses five computational pitfalls to be avoided: inappropriate choice of grid size, approaches to infinity that cannot be well defined numerically, failure to use the self-consistency tests he has developed, results presented in incomprehensible three-dimensional pictures of two-dimensional arrows and being fooled by too large a criterion for convergence.

The Internet (http://cobalt.nist.gov/mumag/prob1/prob1report.html) reveals strong evidence for the need among the practitioners of micromagnetics for Aharoni's book and advice. Six groups worked on the same "standard problem" of micromagnetics, producing hysteresis loops that show little resemblance to one another. At least five of the groups must be doing something incorrectly. And that is the state of the art! Since many of the results in the literature should be doubted, there is much for the student to do with the guidance provided by *Introduction to the Theory of Ferromagnetism.*

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Theory of Nuclear Reactions

Peter Fröbrich
and Reinhard Lipperheide
Oxford U. P., New York, 1996.
476 pp. $115.00 hc
ISBN 0-19-853783-2

To quote from the preface of Herman Feshbach's *Theoretical Nuclear Physics: Nuclear Reactions* (Wiley, 1992): "The development of the experimental and theoretical understanding of nuclear reactions is one of the more important achievements in physics during the last half of this century." Indeed, the study of nuclear reactions is *the* major source of our knowledge of the structure of nuclei as well as being a subject of great richness and interest in its own right.

As a graduate student, I was primed to embark upon a career directed toward understanding nuclear properties in terms of the newly revived nuclear shell model. At the same time, I was constantly reminded that what we knew of those properties frequently arose from nuclear reaction experiments, particularly those involving the so-called direct nuclear reactions that were blossoming during this period. Perhaps we should understand these better, I thought. I never really escaped from that diversion.

Theory of Nuclear Reactions by Peter Fröbrich and Reinhard Lipperheide, distinguished researchers in the field, is the latest addition to the literature on nuclear reaction theory and one that I can endorse unreservedly. Growing out of a decade of graduate-level lectures, it is well suited to its roles as both an introduction to the subject and an aid in leading the reader up to an overview of our present understanding of these reaction processes. Consequently, it contains much of interest to the seasoned researcher as well as to the beginning graduate student.

Of course, as is inevitable in such a broad field, there are subjects not covered, which the authors readily admit. In particular, they mention the omission of the entire field of nuclear reactions at high energies, *R*-matrix and similar low-energy theories, as well as precompound reactions and statistical fluctuations. These omissions are not serious; indeed, they leave space for a more rigorous discussion of such topics as the scattering of wavepackets and their interpretation in terms of experimental cross sections—topics frequently glossed over in treatments of scattering and reactions.

Furthermore, about a third of the book is devoted to discussion of compound-nucleus reactions and deep inelastic scattering. These are subjects not covered in two other books that invite comparison, both entitled *Direct Nuclear Reactions* and both issued in 1983, one by Norman Glendenning (Academic) and one by me (Oxford U. P.). As their titles imply, these books are devoted to the class of direct nuclear reactions, and they could be regarded as elaborations of the corresponding sections of the Fröbrich and Lipperheide book, with particular emphasis on the details of the models that have been developed for direct reactions and their applications.

I would also draw attention to Fröbrich and Lipperheide's succinct discussions of classical and semiclassical descriptions of scattering, including the scattering by complex potentials. These concepts have become increasingly useful as supplements to fully quantal treatments and have provided considerable insights into the physics of many problems, particularly since heavy-ion scattering has become so popular.

The book appears to be remarkably free of misprints. The only one that caught my eye concerns equation 8.144, in which primes have been omitted from the labels a and b in the matrix element of W_β on the final line.

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Cosmology and Controversy: The Historical Development of Two Theories of the Universe

Helge Kragh
Princeton U. P., Princeton, N.J., 1996. 500 pp. $35.00 hc
ISBN 0-691-02623-8

In 1948, Fred Hoyle, Herman Bondi and Thomas Gold proposed a bold alternative to the evolutionary view of the cosmos. The evolutionary view had enjoyed widespread support since the rise of relativistic interpretations of Edwin Hubble's distance–redshift relation for galaxies in the early 1930s. Hoyle, Bondi and Gold's skillful advocacy of a steady-state universe engendered a vigorous controversy that lasted for two decades. *Cosmology and Controversy* offers the first extended historical analysis of the origins, progress and denouement of this significant controversy which, although it