several electronographic tubes, photoelectrically intensified photographic plates. Perhaps because improvements in dynamic range have been so recent, the new silicon-intensified targets or their combination with image intensifiers are only briefly mentioned.

Since there is a good deal of emphasis here on the spectrometry of extended sources (starfields, nebulae), this text may also be useful to those performing remote sensing or spectroscopy on microscopic samples, as well as to astronomers. Many spectroscopists outside astronomy, however, may find it difficult to find or adapt any novel approaches to their field. A discussion of the merits of the "state of the art" of spectrometers was left out intentionally.

When it comes right down to it, Meaburn asserts in the final paragraph: "In practice there is often no good substitute for building several closely competitive devices for a particular problem, and trying them in the prevailing conditions before deciding which is best. More often than not the spectral information obtained in this way proves to be complementary, each device giving somewhat different insight into the nature of the source . . . ."

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Aristotle, Ptolemy and Copernicus (l. to r.) exchange views in an imaginary debate depicted on the frontispiece of Galileo's dialog, published in 1632, on the Ptolemaic and Copernican models.

Matter in Motion: The Spirit and Evolution of Physics

E. S. Abers, C. F. Kennel
412 pp. Allyn and Bacon, Boston, 1977. $11.95

Over the last decade, the one-semester introductory (and usually also terminal) physics course for non-science majors has become firmly established at a wide variety of colleges and universities, for it caters to an audience that might otherwise get no exposure to physics at all.

One of the more salutary features of this course is its stubborn refusal to settle down to a single fixed curriculum. Boiling down the standard full-year course is clearly impossible, so that the textbook author is left a free field. The number of available formats is, to first order, equal to the number of titles in print.

A course of this sort has two obvious goals. The first is to provide the scientific literacy essential to a citizen of a technically advanced society that wishes to remain democratic. The second is to dispel the widely held misapprehension that science consists of little more than a vast collection of uncontestable facts meticulously gathered and catalogued by individuals distinguished primarily by their ability to repress their emotions completely. Unfortunately, most introductory science courses only serve to reinforce this impression. Combating it is particularly urgent when the clientele consists of individuals pointed toward graduate study in disciplines now caught up in a pell-mell rush to adopt rankly empirical methods, a trend defended by the claim that "this is how the hard sciences succeeded." Where but in physics, with its history of great intuitive leaps from a few scattered clues, can this message best be delivered?

Unfortunately, it is nearly impossible to do justice to both goals in a single term, and Ernest Abers and Charles Kennel make no such vain attempt. Instead, they land entirely in the second camp.

Most books that choose this route extend the history of physics beyond the Galileo-to-Faraday span of so many traditional courses. Many extend primarily into the modern era, but this book goes in the other direction.

In the hands of Abers and Kennel, Greek and medieval science finally get their day in court. The achievements of the ancients in astronomy were striking, and the physics built on those achievements by Aristotle and Eudoxus provided Galileo with a firm base as well as something to rebel against. While Galileo's persecutors may have quoted scripture against him, the skeptical Greeks regarded the absence of observable stellar parallax as a more telling blow against the heliocentric theory of Aristarchus. And Ptolemy emerges as an almost-modern positivist, fully conscious of the arbitrary nature of his "Fourier analysis" of planetary motion. In the medieval era, Nicholas Oresme and the Merton College school both realized the necessity of dealing with non-uniform motion, but they were stymied by a mathematics that scarcely extended beyond arithmetic and geometry.

The astronomy is strong and detailed, and most instructors, at least, will take pleasure in teaching the closest modern equivalent to the actual calculations performed by the ancients and Kepler (whether students will be equally entranced remains to be seen). The mathematical presentation moves at a measured pace, with ample textual motivation and numerical examples that often precede the derivation of general formulas. Some of the mathematics is relegated to short appendices at the end of each chapter, allowing the instructor some freedom to tailor the level to the audience.

In this book Newton's laws at last emerge in the context from which they actually arose, which was astronomy rather than the pulleys and inclined planes of conventional texts. Indeed, meticulous historical fidelity is the trademark of the book.

Abers and Kennel then move to geometric and physical optics, magnetism and electricity (again, historical fidelity dictates treating magnetism first). Here the authors unfortunately abandon their well-conceived mathematical approach for a more qualitative treatment.

The mathematics returns in a final

chapter on relativity, which is the weakest in the book. There are too few examples to do more than whet the student's appetite, and the treatment of the special theory moves ponderously toward the velocity-addition rule, hardly the most judicious choice for a climax. The total absence of $E = mc^2$, the most celebrated formula of twentieth-century physics, is bound to be noticed by students. This is an unfortunate by-product of a total neglect of the energy concept (the word does not even appear in the index!).

Finally, historical fidelity is abandoned in the treatment of general relativity, which is presented as a reform of Newtonian gravity rather than the complete conceptual break it truly represents.

Despite its few failings, this book is one of the best of its genre, and it deserves a permanent niche in the wide spectrum of books for the one-term course.

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Polarized Electrons

J. Kessler
223 pp. Springer-Verlag, New York, 1976. $24.60

Although spin polarization of free electrons is a concept that developed with quantum theory, the attendant development of an extensive, reliable body of data based upon direct experimental observation has been much slower. Most of these data have emerged in the last 12 years. *Polarized Electrons* is the first self-contained monograph on this topic. Joachim Kessler states his objectives clearly: The style of presentation is to resemble a textbook; the material is intended for "readers at the graduate level, and while it may demand concentration, I hope it will not require deciphering."

These objectives are reflected in both the material presented and the order of presentation. The author begins with an exposition of why the Stern–Gerlach method is unsuitable for electrons, advances to a brief description of mathematical methods for depicting spin states and then launches a formal analysis of spin polarization. This analysis is contained in a single chapter that composes nearly a third of the book. The analysis starts with a development of the Dirac equation and then concentrates upon the spin polarization that results from the scattering of electrons. A variety of relevant equations are developed, and the results are expressed in several formalisms—scattering cross sections, density matrices, Sherman functions, vector sums and others. Throughout this analysis the primary emphasis is upon the development of a formal understanding of spin polarization. Simple physical models, introduced after the formal results and the presentation of limited experimental data, are designed to clarify and support the formal understanding.

The topic of exchange processes in electron–atom scattering, a specific scattering process not included in the preceding analysis, provides a transition in emphasis. Numerous results from the formal analysis are used and several natural extensions of those results are developed, but the emphasis shifts from the polarization of the electrons to the insight into atomic nature that the information about this polarization provides.

The remainder of the book provides a survey of experimental results for two major subject areas, polarized electrons by ionization and polarized electrons from solids, and brief glimpses into less well documented areas. The book concludes with a brief summary of the current level of understanding of spin polarization and with some very helpful indications of future work and its promise.

Consistent with his pedagogical objectives, Kessler has used a number of helpful techniques. First, every major subdivision in a chapter begins with a brief statement about the results to be developed and the procedures used in the development. Second, all the problems in the book are accompanied by complete solutions; often these solutions are quite detailed. Third, internal citations (references to other sections in the monograph that are related to a given discussion) are common. Finally, the presentation of ideas consistently moves from the conceptual to the practical, with the author carefully refraining from the introduction of too many practical concerns; such concerns might have detracted from the reader's conceptual understanding. This restraint is vividly illustrated in a statement that occurs in the discussion of sources: "It should, however, be pointed out that each of the sources mentioned took several years (sometimes a decade) for its development." This last feature of the monograph seriously reduces its use as a reliable guide for selections between competing experimental techniques, but this fact is fully consistent with Kessler's goals.

In contrast to the general excellence of this book, a number of minor but significant flaws occur. First, the author has been over zealous in his stated goal of limiting citations. For instance, I found the lack of any direct reference to Sherman functions, an essential and often used term, a distraction. Second, the use of pseudologarithmic plots without any discussion of their utility (or any reference to remedy this lack) was particularly disruptive; the use of these plots during the discussion of simple physical models that complement the formal analysis only served to intensify this disruption. Third, in the final chapter the author was very careful to point out that criteria other than the polarization are needed in judging a source. He proceeded to justify several different quantitative figures of merit. However, in the subsequent discussion of sources he often deviated from his own criteria without clearly indicating the reasons for these deviations.

As I indicated previously, the flaws in this monograph are minor. Kessler has achieved a valuable realization of his goal—a self-contained, intelligible introduction to the physics of spin-polarized free electrons. This monograph is an excellent guide for graduate students and research scientists interested in understanding either the growing field of polarized electrons or the insights this field can provide for other areas of physics.

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Classical Electrodynamics, 2nd edition

J. D. Jackson
848 pp. Wiley, New York, 1975. $20.95

Since the appearance fifteen years ago of the first edition of J. David Jackson's *Classical Electrodynamics,* his book has been gaining ground steadily as *the* text for electromagnetism in the core curriculum of graduate-physics programs. During these years, both students and teachers using this book have noticed several shortcomings. Undoubtedly many have shared my personal wish that these defects would be remedied one day. With pleasure I report that, indeed, the second editon has fulfilled most of my wishes (both as a student and teacher of the first edition and as a teacher from the second).

A complete, detailed listing of the salient changes incorporated in the new edition would far exceed the space allocated here. Apart from that consideration, it seems inappropriate to duplicate the author's own list in his new preface. I will only mention a few points in brief.

At the general level, the most welcome change is the weaving of a large amount of physics into the old text's contents; often I heard the complaint: "Jackson [the first-edition book] is a bag of mathematical tools!" Indeed, it is easy to lose sight of the physics in the jungle of Bessel functions and multipole moments. This new edition succeeds in turning the (conscientious) reader toward the reality of experimental numbers and the limitations of theoretical formulae whenever appropriate; the introductory survey and sections 6.7, 7.5e, and 11.2 provide a few examples of the shift. Other general improvements are the substantial references to *recent* articles and a large number of new, interesting problems.

The major revisions take place at the