

bear a rich and fruitful set of analogies.

The final section constitutes the essentials of non-Abelian gauge theory: the rudiments of Lie group theory and the geometry of gauge connections, Faddeev-Popov ghosts, anomalies and so on. This lays the foundation for a rather extensive overview of quantum chromodynamics and electroweak theory, from deep inelastic scattering and the parton model to quark mixing and flavor-changing neutral currents.

The orientation is definitely towards

perturbation theory and, while the authors are correct that much insight is attained through this route, one could wish for at least a survey of nonperturbative methods—particularly instanton calculus, soliton solutions and other semiclassical methods. Related to this is a de-emphasis of path integral intuitions, which provide a useful heuristic. However, these presentation choices on the part of the authors probably reflect a decision to take the shortest route to connecting

the formalism with the experiments it is designed to explain.

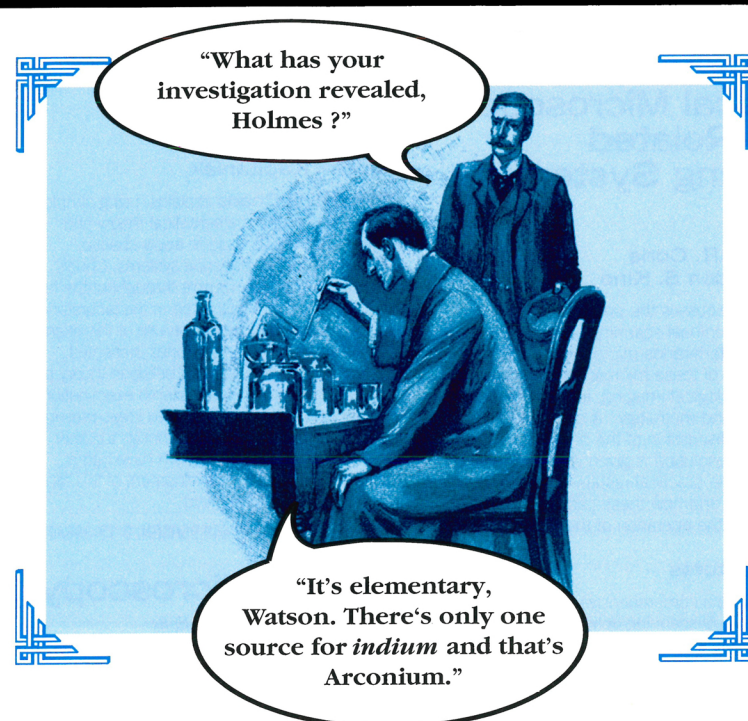
Students in my course on quantum field theory, most of whom are inclined toward experimental physics, liked the book; one applauded the avoidance of excessive formalism. They also found the problems at the end of each chapter worthwhile. The concrete calculations that permeate the text are helpful for the beginner, although a number of students wished for more intermediate steps to be shown.

In the past, it has been common for beginning students of quantum field theory to rely on a variety of source materials. Peskin and Schroeder have replaced this hodgepodge with a single, coherent introduction to this vital area.

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Plasma Astrophysics

J. G. Kirk, D. B. Melrose

and E. R. Priest

Springer-Verlag, New York,

1994 (Reissue). 324 pp.

\$68.00 hc ISBN 0-387-58327-0

Plasma Astrophysics is number 24 in the highly respected Saas-Fee Advanced Course series, based on an annual school given in the Swiss Alps. Like its predecessors in the series, *Plasma Astrophysics* consists of three sections on a closely related theme. These, titled magnetohydrodynamics, kinetic plasma physics and particle acceleration, were prepared respectively by Eric R. Priest, Don B. Melrose and John G. Kirk, all prominent scientists in their respective disciplines. The authors pitch their material at a level between those of introductory texts for astrophysics graduate students and the primary journal literature. Each section is about 100 pages long and covers substantial ground. The result is a superior monograph that is certain to be valuable to both graduate students and practicing researchers for its compact but comprehensive theoretical treatment of several fundamental—and often technically difficult—areas of astrophysics.

Priest's section, on MHD, begins with a beautifully illustrated observational account of magnetic activity in the solar corona. He then lays out the basic equations of MHD, discusses the properties and uses of force-free and current-free solutions in magnetostatics and describes the families of MHD waves and MHD shocks.

Priest devotes a chapter each to solar wind and magnetic reconnection models. The remainder of his section applies the foregoing ideas to the mod-

eling of phenomena in the solar corona—heating of the x-ray bright points by small-scale reconnection; creation of prominences by suspension of a cold, dense plasma sheet in a magnetic “hammock”; and formation of flares by massive reconnection events following magnetic-stress buildup. In general, Priest’s section is very readable and has a comfortable mix of formal derivation and citation of research results. While he understandably limits the discussion to solar MHD phenomena—where MHD theory has the longest pedigree—it is a little disappointing that scarce mention is made of MHD applications in other areas of astrophysics (even cases of such close correspondence as astrophysical jets and the magnetized solar wind).

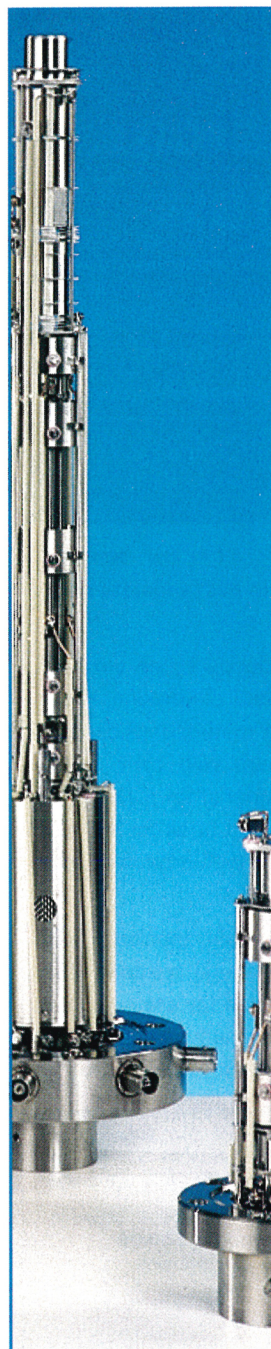
In his section on kinetic plasma physics, Melrose guides the reader at a breakneck pace through the general quasilinear formalism for resonant wave-particle interactions in a magnetized plasma, along with a number of specific astrophysical applications. Much of the mathematical development is self-contained, although the reader is referred elsewhere to find the derivation of the crucial formula for wave emission by a single particle. Melrose begins with a sketch of the dielectric response formalism and the solutions for the wave families in cold and thermal plasmas. After a nice physical discussion of the wave-particle resonance requirement, he presents the general wave-emission formula, together with the Einstein coefficients relating the rates of stimulated and spontaneous emission and true absorption. As an application, Melrose considers in some detail the case of resonant pitch-angle scattering of high-energy particles by magnetic fluctuations in relation to cosmic ray diffusion through the magnetized interstellar medium. The other main wave-particle interaction process studied is gyro-magnetic emission and absorption, which is explored in both low-energy and high-energy (synchrotron) limits in the solar system and Galactic and extragalactic environments.

While the topic of Kirk’s section might appear somewhat more specialized than the first two, the problem of relativistic particle production lies at the heart of high-energy astrophysics. High-energy electrons produce Galactic and extragalactic synchrotron radiation; high-energy ions, observed as cosmic rays with power-law spectra extending to 10^{19} eV, are a dynamically important component of the interstellar medium. Kirk’s first, primarily pedagogical discussion is of magnetic pumping, in which compression and expansion of a magnetic “bottle,” inter-

leaved with isotropization of the particle distribution, leads to a net energy increase. This sets the stage for the analysis of diffusive first-order Fermi acceleration in shocks, considered the most successful general scheme because it predicts power-law emergent energy spectra. The next several sections cover generalizations of the diffusive mechanism, including relativistic effects, time and space dependence and radiative losses, with applications

to supernovae remnants, extragalactic jets and active galactic nuclei. In addition to diffusive acceleration, Kirk also explores shock-drift acceleration, which can be important in relativistic shocks.

Plasma Astrophysics is one of the more mathematical volumes in the Saas-Fee series. While each section contains considerable discussion of observations, thorough mathematical exposition remains the prevailing concern. Nonetheless, the authors evince



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great enthusiasm for the natural phenomena—not just the equations—that they study. I highly recommend this book. It will be much appreciated in an astrophysics community sated with conference proceedings but frequently starved for authoritative, up-to-date, graduate-level references like this one.

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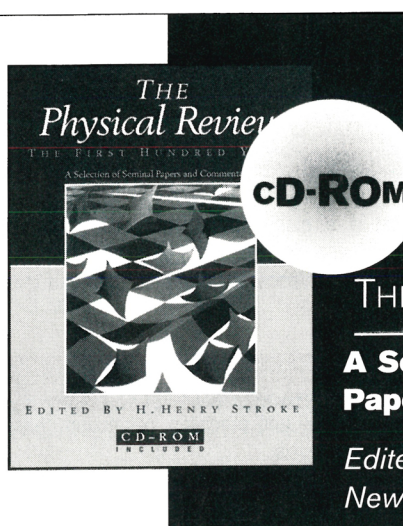
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