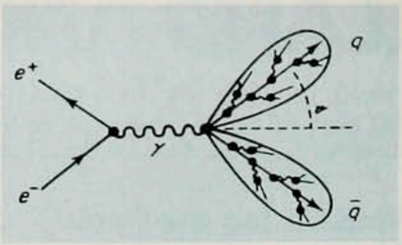
fields, an important question arises in teaching graduate students with a research inclination toward elementary-particle theory: How much time should one devote to teaching non-gauge field theories and canonical quantization methods before proceeding to gauge theories and path integrals? The answers to this question suggested by the three books under review range from one entire year to complete omission. Clearly, there is no consensus, and a given teacher's inclination on this question will likely determine which of these excellent textbooks to choose.

The book by de Wit and Smith is the first volume of a projected two-volume work on field theory. Because discussion of gauge theories is delayed until the second volume, these authors answer our question with "up to a year of lectures." Their comprehensive coverage of kinematics includes the calculation of cross sections and decay rates. The Feynman rules for spins 0, $\frac{1}{2}$ and 1 are discussed; for example, the Proca formalism for massive spin-1 particles is explained. Slightly more sophisticated topics, such as dimensional regularization and minimal subtraction, are introduced near the end of the book. The pace is slow and thorough, and I eagerly await the second volume for an equally careful treatment of gauge theories.

Ryder's book steers a middle course. It neatly intertwines discussions of canonical quantization and path integrals; similarly, it provides parallel treatments of non-gauge and gauge theories. There are thoughtful expositions of the quantization and renormalization of gauge fields and of relativistic wave equations and canonical quantization. Some exercises would have been helpful for those who plan to use the book as a text. Ryder devotes little space to applications of the theory to the standard electroweak theory or quantum chromodynamics. Overall, the book is an excellent introduction to the formalism of field theory. I like its layout, especially the chapter summaries, and the parts I read in detail were carefully and pedagogically presented.

As its title suggests, the book by Becher, Böhm and Joos (translated from German) contains no warm-up discussions on non-gauge field theory or canonical quantization. It begins with a survey of the phenomenological basis for the standard gauge theory of strong and electroweak interactions, including quark colors and flavors, and the parton model. In chapter 2 follows the formulation of



Electron–positron annihilation in hadrons creates a quark–antiquark pair via a virtual photon. These primary quarks radiate mostly soft, almost collinear gluons, which together with the primary quarks, hadronize in two jets. Jet axes are therefore determined by the direction of the primary quark pair. (Reproduced from *Gauge Theories of Strong and Electroweak Interactions* by permission of the publisher.)

chromodynamics and its quantization, renormalization and renormalization group properties, as well as discussion of the lattice approach, instantons and applications of perturbative QCD. Finally, in chapter 3, the Glashow–Salam–Weinberg electroweak theory is formulated, followed by a brief outline of grand unification. This book is more advanced than the other two and provides an excellent perspective on modern gauge theories, including most of the key formal and phenomenological aspects.

Writing out lecture notes for advanced-level classes is a time-consuming business. Polishing the notes into book form takes even longer and is a selfless task—not, as a general rule, proportionately rewarded either in remuneration or in peer recognition. (My colleague Eugen Merzbacher is the perfect exception to prove this rule.) Thus, I wish to applaud the labors of all six authors involved in creating these three books. They have set a high standard in didactic writing and scientific soundness.

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Hot-Electron Transport in Semiconductors

Edited by Lino Reggiani
Springer-Verlag, New York, 1985. 275 pp. $52.00 hc
ISBN 0-387-13321-6

The effects of hot electrons (that is, electrons accelerated by large electric fields) in semiconductors have been interesting subjects for research for several decades because they allow us to investigate situations extremely far from equilibrium. With the recent advent of submicron fabrication techniques, hot-electron transport has taken on new life. Modest voltages produce large electric fields in submicron structures, and hot-electron effects are unavoidable. *Hot-Electron Transport in Semiconductors,* which summarizes and tabulates many of the basic results in hot-electron physics, is particularly welcome in this rapidly growing field.

The book contains seven review articles, by internationally prominent, longtime workers in the hot-electron field. The emphasis is on properties of bulk semiconductors rather than inhomogeneous or submicron systems. This emphasis is a strength because the book carefully explains the physics of basic transport quantities (drift velocity and diffusivity), but a weakness because the book mentions the most interesting developments of recent years only briefly. Updating the classic book by Esther Conwell, *High-Field Transport in Semiconductors* (Academic, New York, 1967), *Hot-Electron Transport in Semiconductors* contains more information about noise, compound semiconductors and the large amount of information gained from Monte Carlo simulation. Though it covers fewer topics than *Physics of Nonlinear Transport in Semiconductors* (Plenum, New York, 1980), edited by David Ferry, John Barker and Carlo Jacoboni, Reggiani's book is both more systematic and more pedagogic.

Three sections of the book contain particularly good pedagogic reviews. First, Reggiani's own section on the theory of hot electrons emphasizes diffusion, noise and the Monte Carlo method (his specialty). Reggiani systematically presents both the formal aspects of the theory and the nuts and bolts of how to do a homogeneous-field Monte Carlo calculation for a real semiconductor. Unfortunately the article includes few actual numerical results of the Monte Carlo technique. And plots of the fundamentally important distribution function are not included at all. Second, Claudio Canali, Filippo Nava and Reggiani review the use of time-of-flight measurements to determine drift velocity and diffusion coefficients; their chapter contains ample experimental details on Si, Ge and GaAs as well as several other materials. Finally, in his survey of microwave measurements of transport parameters, Yuras Pozhela emphasizes results obtained for relaxation times from the conductivity and for diffusivity from the noise.

Apart from the basic physics of hot-electron transport, numerous fascinating but complex phenomena occur in semiconductors with hot electrons.

Reggiani has selected two specialized topics for inclusion in the book. Marion Asche discusses the symmetry breaking induced by high electric fields among equivalent valleys. And Susumu Komiyama, Tatsumi Kurosawa and Taizo Masumi review the "streaming" of particles in crossed electric and magnetic fields when optical-phonon scattering is the dominant scattering mechanism.

The final two sections of the book address spatially inhomogeneous materials but are unfortunately too short to do the subject justice. One increasingly important type of spatial inhomogeneity is the layering of III–V semiconductor compounds to form superlattices or heterostructures. Karl Hess and Gerry Iafrate briefly review this vast area. Their treatments of both real-space transfer (the transfer of electrons between layers of different materials) and capture of electrons by heterojunction lasers stand out as these topics are not usually covered in treatments of superlattices. Eugène Constant's chapter provides a link between bulk transport theory and submicron devices. He concentrates on results of applying Monte Carlo techniques to pulses of the electric field in time and space. How to transfer information from Monte Carlo simulations to simpler models of structures (in particular, how to extract relaxation rates) receives some attention. Unfortunately, Constant mentions true space-dependent phenomena—those that depend on an inhomogeneous self-consistent electric field—only briefly, at the end. A discussion of this crucial topic would have benefited both the chapter and the book.

Hot-Electron Transport in Semiconductors was written for starting graduate students who need a foundation in bulk hot-electron transport, and for researchers to use as a reference. Reggiani and his coauthors have by and large hit their marks.

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Lasers

Anthony E. Siegman
University Science Books, Mill Valley, Calif., 1986. 1283 pp. $65.00 hc ISBN 0-935702-11-5

Since the first laser was built, more than a quarter of a century ago, laser physics has undergone tremendous advances. Lasers have been finding applications in areas unthinkable just a few years back. The intense research activity and the many applications have generated a need for many