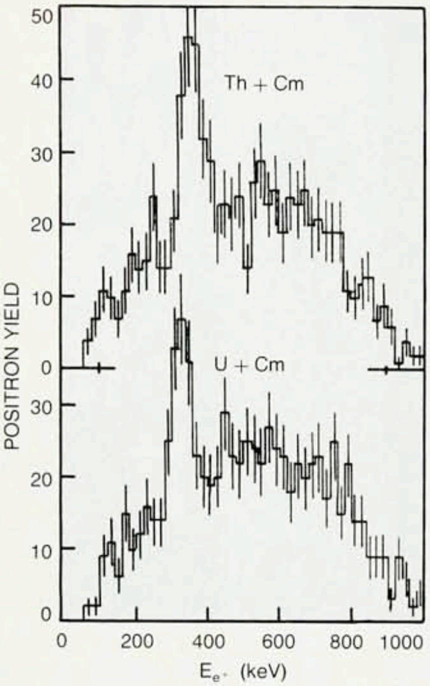

Mysterious positron peaks around 300 keV rising above a broad continuum are seen in many different collisions of heavy ions with heavy atoms. The collision energy for the spectrum shown was about 6 MeV per atomic mass unit. (Adapted from *Treatise on Heavy-Ion Science, Volume 5,* by permission of the publisher.)

apparent coincidence with the positron lines has deepened the mystery of the origin of these pairs. Despite such subsequent discoveries, this splendid review, with its full documentation, will remain useful to orient anyone who wants to study the fundamentals of heavy-ion–atom collision physics.

The volume concludes with a pedagogic review of beam-foil spectroscopy by one of its practitioners, Indrek Martinson, now at the University of Lund (Sweden), but formerly at the University of Arizona, where much of the development of this elegant spectroscopic tool was done. Martinson provides an overview of the method and its applications. He does not hide the limitations of beam-foil spectroscopy and sometimes seems overly modest about its accomplishments. The chapter's bibliography is extensive, up to 1980.

Physics of Highly Charged Ions, by one Yugoslav (Janev) and two Soviet physicists (Presnyakov and Shevelko), is a fine, carefully organized monograph on the theory of ion–atom collisions, especially at the lower energies that are relevant to controlled fusion plasma physics and astrophysics. It is an excellent modern sequel to M. R. C. McDowell and J. P. Coleman's *Introduction to the Theory of Ion–Atom Collisions* (North Holland, New York, 1970). Experimental results are cited only to illustrate the theory, which is covered in sufficient detail to make this a textbook for graduate students. It is remarkable that a book written by a collaboration of three authors can present the subject in such a unified, systematic and consistent manner.

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Carrier Scattering in Metals and Semiconductors

V. F. Gantmakher and
Y. B. Levinson
North Holland, New York,
1987. 459 pp. $136.75 hc
ISBN 0-444-87025-3

The ultimate purpose of any investigation of carrier scattering is to determine its influence on the transport characteristics of an electron gas. Therefore, solutions of the kinetic equation and of the scattering problem traditionally accompany each other in monographs and textbooks.

The present monograph, written by two well-known Russian theorists, is quite different in that the authors do not even consider the problem of finding nonequilibrium electron distribution functions. Instead they restrict themselves to estimates of the energy and momentum loss rates for a test electron—averaged over an equilibrium electron distribution. On the other hand, they describe the microscopic relaxation times in such detail that interested readers can find in this book the "techniques" for frontier investigations of their own.

This approach is justified by the fact that in many instances, especially in metals, no practical solution of the kinetic equation exists anyway because of the complicated Fermi surfaces and the unknown dispersion laws. In these cases one has to be satisfied with the averaged characteristics: Knowing them, at least, helps one have a qualitative understanding of transport processes.

The monograph begins with an introductory chapter containing a general description of the band picture of an ideal crystal, a lucid introduction to the quasiparticle concept, and a pedagogically excellent discussion of the basic band structure properties of cubic semiconductors, including the well-known Kane model. Several chapters are devoted to such traditional topics in carrier scattering as the mechanisms of electron interaction with various types of phonons and with charged or neutral impurity centers; the authors calculate the energy and momentum relaxation times in detail both for simple bands and for bands with multiple valleys or a degenerate spectrum. Throughout, the authors support the quantitative results with original qualitative analyses that many a reader will find highly instructive. (Especially happy will be those readers who do not wish to be bothered by the mathematical detail.)

Particularly noteworthy is the authors' description of diffusion in **k** space—a very useful approximation that allows one to determine the momentum relaxation time of electrons interacting with acoustic phonons in a metal with a complicated Fermi surface. The book gives an exhaustive analysis of the role of electron–electron interaction in the establishment of a nonequilibrium form of the electron distribution function. Considerable attention is paid also to the role of *umklapp* processes in electron scattering—a question rarely discussed in textbooks.

Among other topics description of which is hard to find in monographs, but extensively discussed in the present book, are the influence of a magnetic field on the elementary act of scattering and various effects leading to spin relaxation in the electron gases of semiconductors and metals. In addition to the paramagnetic resonance effects where manifestations of the electron spin relaxation have been known for a long time, the book describes optical spin polarization of the electron gas in semiconductors, an effect that was fully developed (both experimentally and theoretically) only relatively recently.

Like most other books in the North Holland *Modern Problems in Condensed Matter Science* series, this one has a lavish appearance and costs a fortune. There is a fly in the ointment, though (or, as Russians would say, a spoonful of tar in a keg of honey). There are generally two types of bad scientific translations from Russian. One is done by scientists (like ourselves) whose mother tongue is not English. Their writing is often stilted; for example, the book editor of PHYSICS TODAY tells us that the present review was much improved by his red pencil (however hard this may be to believe). The other type is produced by perfectly literate English speakers who do not know the subject; such translators are likely to call an anomalous effect an"extraordinary" one or to put in a wrong article. (Russian, having no articles at all—except for those of the penal code—is much less definite a language than English, and a translator often has to guess.) The present translation is guilty on both counts; the text is often so awkward that we could hardly let it pass without comment.

This comment notwithstanding, the book will certainly find a large and grateful readership. Mature researchers will appreciate that it fills an important gap in the literature, many professors will be glad to have it as supplementary reading for their solid-state physics or electrical engineering courses, and students will enjoy learning from it. It will be most helpful to those who view carrier scattering theory entirely from a user's perspective. We anticipate that its reliable physical arguments will be quoted often in support of an estimate or a back-of-the-envelope calculation.

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The Shaky Game: Einstein, Realism and the Quantum Theory

Arthur Fine
U. of Chicago P., Chicago, 1986. 186 pp. $25.00 hc
ISBN 0-226-24946-8

Does it matter now, more than 30 years after his death, what Albert Einstein thought about quantum theory? The answer to that question may surprise you, but it is resoundingly clear. In 1985 alone, 50 years after it was written, there were 48 journal citations to the Einstein–Podolsky–Rosen paper! How many papers ever receive that many citations?

The Shaky Game spends part of its time examining Einstein's thoughts on the subject, and comes up with some surprising insights, based partly on Arthur Fine's discussion of unpublished correspondence. The rest of the book is an exposition of Fine's thoughts on the subject. Fine is a formally minded philosopher of science, and his discussion of the literature is taken largely from fellow philosophers, so the physicist reader will find no intuitive or physical explanation of Bell's theorem or of the work of John Clauser and Michael Horne, nor any discussion of the beautiful experiments that have been recently performed or their implications.

Instead the reader will find Fine's own version of Bell's theorem, which is quite interesting in its own right, but which I have a difficult time trying to derive any physical insight from. The author has discovered a set of theorems that use the results of defining simultaneous probabilities for the possible outcomes of a class of EPR experiments. Then if one integrates the results over, say, one particle, one arrives at a set of marginals that represent probabilities for the second particle, regardless of what happens to the first. Fine shows that in those cases in which the Bell inequalities hold, these marginal probabilities are positive, and so represent "classical probabilities." But in precisely those cases where the Bell inequalities are violated, these marginal probabilities become negative.

This result sounds fascinating, and one feels that it must be providing an important clue to quantum reality. But it involves integrating over situations that Henry Stapp has called "counter-factual," that is, situations that cannot be experimentally realized because they would violate the uncertainty principle. One must therefore make classically "reasonable" extrapolations to such situations, and it is difficult to know exactly what that means. Fine makes no real attempt to relate this approach to that of John S. Bell or to the more general one of Clauser and Horne, nor to answer the serious objections to his work that have been raised by such people as Abner Shimony. Rather, he presents his results as if they offered a complete explanation, which I found rather frustrating. (He gives some arguments for dismissing "locality" considerations, on which most other approaches are based. But they are based on his own models, for which he presents no details, so one cannot judge them critically.)

A further problem with the presentation is that while Fine's proofs are rather mathematical, this book is written with no mathematics whatsoever, which gives his explanations a rather fuzzy quality, as one is not aware of exactly what he has assumed or of how general the results are. Nonetheless I once heard Richard Feynman give a colloquium at MIT on his own unsuccessful efforts to introduce negative probabilities as an explanation for quantum theory, and I can't help but think that there is an important tie-in lurking here somewhere.

Fine also introduces his own nonrealist view of quantum theory, which he calls the "Natural Ontological Attitude," a sort of hands-off