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Book Review: *Physical Kinetics*

Physical Kinetics. By E. M. Lifshitz and L. P. Pitaevskii. Pergamon Press, New York, 1981. 452 pages.

I seriously doubt that there exist many physicists in the world today who do not have at least a few of the volumes of the Landau–Lifshitz series *Course in Theoretical Physics* in their personal libraries. There are many reasons for the enormous popularity of these books: the wide range of topics covered, the presentation of the material in a lucid and decidedly nonpedestrian manner, the fact that many important advances in theoretical physics were due to L. P. Landau and his coworkers, and, certainly, the fact that if one has a very intelligent question about some point of physics one is likely to find that question discussed and answered somewhere in the Landau–Lifshitz books.

The book under review, *Physical Kinetics*, is the final volume in the series, and it is characterized by all the virtues mentioned above. Here the authors, E. M. Lifshitz and L. P. Pitaevskii, present the statistical theory of nonequilibrium processes in a variety of systems including gases, plasmas, quantum liquids, superconductors, metals, and insulators. The choice of topics is relatively up to date with sections on fluctuations in nonequilibrium systems, solitons, instabilities, and on the dynamical scaling theory for transport processes in systems that are undergoing phase transitions.

The book opens with a long but very succinct chapter on the kinetic theory of classical neutral gases with short-ranged forces, based on the Boltzmann equation. Two derivations of this equation are given—one at the beginning of the chapter is a modernized version of Boltzmann's derivation, and the other, due primarily to Bogoliubov, is based on the BBGKY hierarchy equations. The usual range of applications of the Boltzmann equation is clearly presented and I was pleased by the discussions of kinetic boundary layers and of molecules with angular momentum. There is also a nice description of the generalization of the Boltzmann equation to higher densities, including a discussion of the triple-collision operator and of the divergence difficulties and resulting logarithmic terms in the density expansion of the transport coefficients. As someone who has recently been working on the same topic, I was particularly impressed by the careful discussion of fluctuations in nonequilibrium gases with all the subtleties clearly exposed. This is followed by a chapter on the use of

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Fokker–Planck and related equations to describe various transport processes, such as diffusion in mixtures of light and heavy particles.

The coverage of plasma kinetic theory is quite extensive, as might be expected considering L. P. Landau's fundamental contributions to the kinetic theory of plasmas. Here the coverage includes, among other topics, the theory for collisionless plasmas, the Landau collision integral and the Balescu–Lenard–Guernsey equation, relativistic plasmas, the effects of magnetic fields, and the theory of fluctuations. With the exception of a short chapter on phase transitions, the remainder of the book is devoted to a treatment of systems where quantum effects must be taken into account. Much of the work discussed here has been done by Landau and his coworkers. The fact that the equilibrium properties of these systems have been treated extensively in the volumes of *Statistical Physics, Parts I and II* and the others in the course is a decided advantage since it makes it possible to cover a large variety of topics without having to provide a lot of introductory material for each one. There are excellent discussions of thermal conduction in insulators and metals, as well as of the effects of large magnetic fields on the electrical conductivity of metals. The chapter on quantum liquids is mainly devoted to Fermi liquids. However, I would have appreciated a more extensive discussion of superfluids than is provided in this chapter.

The reader will find the list of references to be more extensive in this volume than in the previous ones, with some coverage of both the Russian and Western literature, including an occasional journal citation. As always with the Landau–Lifshitz series, the reader will get more out of this volume the more he brings to it. Its approach reflects the direct, technical analysis of the previous volumes. I would have liked to see some discussion of a unified approach to kinetic equations, showing, for example, how the kinetic theory for molecules with short-ranged forces and that for plasmas can be obtained as different limiting cases of the solutions of the BBGKY hierarchy equations. Further there is no discussion of the time correlation function approach to transport theory which has been under active development during the past 20 years or so and where the computer has played such an important role.

Nevertheless, this is an excellent book and I can recommend it enthusiastically.

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