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Carlo Cercignani and Ester Gabetta (eds): Transport Phenomena and Kinetic Theory. Applications to Gases, Semiconductors, Photons and Biological Systems

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One hundred and thirty six years have elapsed since Boltzmann formulated the famous equation that now carries his name. Notwithstanding the large number of applications that it has generated, its mathematical properties continue to be a great challenge for applied mathematicians, theoretical physicists, engineers and scientists in a large variety of fields. In this collection of articles by experts in the field the reader is given a rather comprehensive overview of many of the mathematical aspects and applications of the Boltzmann equation illustrated by articles dealing mainly with the behavior of what is now referred to as complex systems.

The monograph consists of three parts, of which part 1 is devoted to theoretical aspects of the Boltzmann equation with contributions by Cercignani on rigorous results for conservation equations and the approach to equilibrium, by Gabetta on the optimal rate of convergence for spatially homogeneous Maxwell gases, and by Golse on non-resonant velocity averaging and the Vlasov-Maxwell system.

Part II consists of four articles dealing systems which are representative of modeling applications as well as inverse and computational problems in quantum kinetic theory. The articles in this section are more applied than those in the first part of the book and mainly devoted to semiconductor models. Some of the topics are multiband quantum transport models for semiconductor devices (Barletti, Demeio, Grosal), optimization models for semiconductor dopant profiling (Burger, Hinze, Pinnau), inverse problems for semiconductor models and methods (Leitao, Markovitch, Zubelli) and deterministic kinetic solvers for charged particle transport in semiconductor devices (Caceres, Carrillo, Gamba, Majorana, Shu).

Part III is devoted to a wider variety of applications in the natural sciences, touching on a broad spectrum of systems. These include an article on the methods and tools of mathematical kinetic theory in modeling complex biological systems (Bellonio, Bellouquid, Delitala), the kinetic modeling of late stages of phase separation (Manzi, Marra), the ground states and

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dynamics of rotating Bose-Einstein condensates (Bao) and two inverse problems in photon transport theory (Belleni-Morante).

As the editors emphasize, each chapter provides the state of the art in the particular field, an overview of the existing literature and some research perspectives. Although intended for scientists and engineers in the applied sciences, my own feeling is that investigators whose acquaintance with mathematics is at an advanced level are likely to be the main beneficiaries of this book. The presentation of the material is excellent, very well organized, and highly recommended to this audience.