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Book Review: *Physics and Chance*

Physics and Chance. Philosophical Issues in the Foundations of Statistical Mechanics. Lawrence Sklar, Cambridge University Press, Cambridge, 1993.

This book presents an engaging exposition of the material it sets out to discuss, namely the foundational issues in statistical mechanics. The topic is not one that lends itself to lucid presentation. Part of the reason, as the author suggests, is the multiplicity of what constitutes the "foundations problem" in statistical mechanics. This is accompanied by the diversity of perspectives and methodologies that bear on the discussion. The book sets out to bring into focus the various problems and the attempts to resolve them in a systematic fashion. Overall, it is fairly successful. An unqualified success in this endeavor might have to await the completion of the program the book discusses. In a sense, this is one of the conclusions of the author also.

The book begins with a historical sketch of the beginnings of statistical mechanics at the hands of Maxwell, Boltzmann, and Gibbs. This sketch, including discussions of the H-theorem, the early objections, the introduction of probabilistic notions, the ergodic hypothesis, and so on up to the summary of the state of the science by the Ehrenfests, makes fascinating reading. Part of the fascination is inspired by the author's efforts at highlighting how much of the debate of that time still persists.

The next two chapters of the book survey probability, interpretation of probability, and statistical explanation, as preparations for the discussion to follow.

The book goes on to a discussion of the equilibrium theory, describing the contributions of von Neumann, Birkhoff, Khinchin, the KAM theorem, and Ya. Sinai's demonstration of ergodicity in a realistic system.

The next two chapters discuss nonequilibrium, stating the various approaches to describing nonequilibrium, such as the BBGKY approach and the master equation approach. Rationalizations of the approach to equilibrium are discussed at length.

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The last three chapters discuss, respectively, the connection between cosmology and irreversibility, the reduction of thermodynamics to statistical mechanics, and the issue of the direction of time.

Issues such as the uniqueness of the invariant probability distribution, the invocation of phase space sets of measure zero, idealization of physical systems, random external perturbations, the limit of time going to infinity, and the thermodynamic limit are visited repeatedly in the book. The author's summary of the present state is that many of the important questions remain unanswered. He certainly produces sufficient evidence in support of this view.

The material has been presented in a well-organized manner. The exception, perhaps, is the absence of crisp summaries at the end of each of the chapters. Given the range of material and in-depth discussion of the philosophical issues, it is often hard to keep in focus what the preceding discussions have amounted to. The book has been written to be accessible to readers without an extensive knowledge of the relevant physics or philosophy. Given how little the book assumes, it communicates remarkably much. However, the reader cannot escape the feeling that a full appreciation of the material requires considerable preparation or additional concomitant learning. With regard to the latter, the book follows the commendable practice of supplying references annotated in some detail.

The readers who will benefit most from this book are certainly students and investigators with a serious interest in the foundations of statistical mechanics. For them, this book will no doubt prove valuable. Students and scientists less prepared or committed will find the book demanding. But, given the inclination, the effort will be worthwhile.

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