Book Review: *Equilibrium and Non-equilibrium Statistical Thermodynamics*

Equilibrium and Non-equilibrium Statistical Thermodynamics. M. le Bellac, F. Mortessague and G. G. Batrouni, Cambridge University Press, Cambridge, 2004.

This book was written by three faculty members of the university in Nice, It is a significant extension of the book, Thermodynamique Statistique, by the first two authors and is intended to be a text for a graduate course. The first two–thirds deal with equilibrium systems and are excellent, and the last one–third deals with non-equilibrium systems and is more pedestrian.

Chapter 1 is entitled: Thermostatics: approaches thermodynamics from the point of view of Callen. The only quibbles that I have here are that it should be stated that in a reversible process both the system and its surroundings can be returned to their initial states and that an equilibrium state is one in which the thermodynamic properties are independent of time, there are no fluxes, and the state can be approached from all directions.

Chapter 2 is entitled: Statistical entropy and Boltzmann distribution. It contains an excellent discussion of the second law and irreversibility as well as discussions of the classical and quantum canonical and grand canonical ensembles. Chapter 3 is entitled: Canonical and grand canonical ensembles: applications and treats many phenomena which can be described using classical concepts. The only sight misstatement here is that the radial distribution function, $g(r)$, in a canonical ensemble does not approach 1 for r large but is of order $1/N$, which is important in discussing number fluctuations in closed systems.

Chapter 4 is entitled: Critical phenomena is the best in the book and includes deep and readable discussions of mean field theory, Landau theory and the renormalization group. The fifth chapter entitled: Quantum statistics discusses applications of Bose–Einstein and Fermi–Dirac statistics to a variety of problems, including ideal gasses, black body radiation,

and the Debye model of specific heats in crystals and more esoteric subjects such as neutron and white dwarf stars.

Chapters 6–9 move on to irreversible processes. Chapter 6 entitled: Irreversible processes: macroscopic theory discusses the concept of local equilibrium. It covers some of the basics of the thermodynamics of irreversible processes and focuses on hydrodynamics and Onsager symmetry relations. It is an adequate treatment of these topics.

Chapter 7 is entitled: Numerical simulations and concentrates on classical and quantum Monte Carlo techniques as applied mainly to spin systems. Path integrals are briefly mentioned. It would have been nice to include molecular dynamics techniques in this chapter.

Chapter 8 is entitled: Irreversible processes: kinetic theory and focuses, as one would expect, on the Boltzmann–Lorentz model and the Boltzmann equation and Chapman–Enskog approximations. There is a brief description of the limitations of the Boltzmann equation. Chapter 9 is entitled: Topics in non-equilibrium statistical mechanics and contains a discussion of classical and quantum linear response theory. Projection operator techniques which lead to the Langevin–Mori–Zwanzig equation are described. Applications to classical Brownian motion and the Langevin equation, Ornstein–Uhlenbeck processes and the Fokker–Planck equation are presented. This treatment is essentially the same as in Chandrasekhar's famous article. There is no mention of Lorentz's argument against the Langevin equation or the feedback of the Brownian particle on the fluid.

In sum, the chapters on irreversible processes are not on the same level as the chapters on equilibrium systems.

One of the remarkable features of this book is the number and quality of the exercises and problems which occur in each of the chapters. These range from fairly straightforward applications of the topics in the text to deep research problems which significantly expand the textual topics. These are a wonderful stimulus for students and teachers. The other unique feature of this book is the number of references to European authors compared to those in American volumes.

I strongly recommend this book as a graduate text and as a reference work for active workers in the field.

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