Journal of Statistical Physics, Vol. 112, Nos. 1/2, July 2003 (© 2003)

Book Review: *Statistical Mechanics: A Concise Introduction for Chemists*

Statistical Mechanics: A Concise Introduction for Chemists. Benjamin Widom, Cambridge University Press, Cambridge, 2002.

This book was written to be used primarily in an undergraduate physical chemistry course or in a course for graduate students. In fact, students need to be familiar with thermodynamics, chemical kinetics, kinetic theory of gases and quantum mechanics, at the level which these subjects are normally treated in undergraduate physical chemistry to make full use of this book.

Chapter 1 starts with an introduction to the Boltzmann distribution law. For the sake of concreteness two specific cases are discussed, the Maxwell velocity distribution and the barometric distribution. A discussion of these special cases shows that an exponential form appears in the composition of probabilities for independent systems. The connection of the free energy to the partition function is made comparing the mean energy by the Gibbs–Helmholtz equation of thermodynamics. At the end of the first chapter there is a qualitative discussion of energy fluctuations in a system of fixed temperature, and finally a connection is established to a microcanonical system. A generalization of the theory for classical analysis to a quantum formulation is not required later in the book since the Boltzmann distribution law is stated for discrete state systems, and quantum mechanical energy-level notation is used throughout the book.

Traditional applications of statistical mechanics are covered from Chapters 2 to 5. Chapter 2 analyzes the statistical thermodynamics of the ideal gas of molecules with internal structure as well as *ortho-* and *para-*hydrogen. Chapter 3 contains a discussion of one of the early applications of statistical mechanics to chemistry, namely a derivation of the chemical equilibrium constants of gas-phase reactions from partition functions. Ideal harmonic solid and black-body radiation are studied in Chapter 4. Chapter 5 deals with the statistical mechanical basis of the third law of thermodynamics. Chapters 6 and 7 are devoted to non-ideal gas and the liquid state.

0022-4715/03/0700-0433/0 © 2003 Plenum Publishing Corporation

Two sections are devoted to computer simulations in Chapter 7. Both molecular dynamics and Monte Carlo simulations are described and compared. The final chapter treats quantum ideal gases, including the degenerate electron gas as a model for electrons in metals.

The author's initial intention was to write a concise and introductory book. In my opinion this objective has been attained in splendid fashion. The introductory level since the first page to the last one is never abandoned. Readers will find this book extremely accessible and useful. The author's style is also concise and extremely pedagogic. An excellent future of this book is the comprehensive discussion of the physical system to be described before applying the formalism of statistical mechanics to analyze it. Any hypothesis used to describe the particular physical system is discussed in depth. Another very useful characteristic is the clear explanation of the mathematical tools used in the analysis. In my opinion the selection of mathematical topics explained by the author have been chosen with great skill. Quite generally these topics relate to those familiar to the student. A graduate student in physics should be able to handle any topic in this book without being slowed by unfamiliar mathematics techniques.

The number of solved problems is well selected and plentiful. These are well selected and give insightful illustrations of the topics under discussion. In problems requiring numerical computations, the actual numerical values are realistic for ones for the values of the quantities in real physical systems. Furthermore, the sections on computer simulation convey good intuitive insights, as well as sufficient detail about the fundamentals to enable an interested reader to delve into more specialized books about it.

The only negative point about this book is that there are no excercises. It might be quite diffucult for a teacher to find a problem set relating to the level of the book and nearly impossible work for a student using it for self-study.

In summary, the book is clearly written. Both the organization and presentation of the material are excellent. I highly recommend the book both from the point of view of a teacher and a student.

Leonardo Dagdug
Center for Information Technology
National Institutes of Health
Bethesda, Maryland 20892
e-mail: dagdug@helix.nih.gov