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Book Review: *Molecular Driving Forces: Statistical Thermodynamics in Chemistry and Biology*

Molecular Driving Forces: Statistical Thermodynamics in Chemistry and Biology. Ken A. Dill and Sarina Bromberg, Garland Science, New York, 2003.

This is a book on statistical thermodynamics that deals with forces governing molecular behavior. These forces cause atoms and molecules to bind, adsorb, dissolve, permeate membranes, to undergo chemical reactions, and to undergo conformational changes.

The text is accessible to students with a variety of backgrounds and highly recommended for self-study. It is intended for both graduate and advanced undergraduate students. In addition, the student unfamiliar with thermodynamics, chemical kinetics and quantum mechanics will find this book extremely useful because the authors manage to explain complicated concepts in very simple terms and because each topic is treated step by step, advancing from the most elementary concepts to more complex ones. For example, a student unfamiliar with quantum physics and differential equations would ordinarily find it impossible to understand the statistical mechanics of a quantum ideal gas and the Einstein model of a solid. In this book, the authors give an introduction to quantum mechanics, solving the Schrödinger's equation for a particle in a box with translational freedom, the harmonic oscillator model, and the rigid rotor model. These solutions are accompanied by figures, plots, and detailed mathematical derivations and explanations. To complete the introduction to quantum mechanics the authors analyze several applications, for example calculating the energy levels for argon and the vibration and rotational partition functions of O_2 in a macroscopic box. Also, the fundamental concepts of physics as they arise, are discussed in great depth throughout the text. This provides confidence and the ability to any reader to understand new concepts based on the knowledge of previous ones. Two of the principal goals of the authors are that the book should provide mathematical tools and physical concepts required in remaining chapters on applications. Chapters 1, 4, 5, and 17 lay

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out mathematical concepts that underly statistical topics covered in the book. Those chapters are devoted to probability theory, infinite series, vectors and calculus. The inclusion of these chapters have the great advantage of providing all of the mathematical tools that are prequisites for developing the physical topics discussed later in the book.

Simple model are used in Chapters 2 and 3 to demonstrate that entropy can be regarded as a driving force. In Chapter 6 they define entropy and derive the Boltzmann distribution. The principles of thermodynamics are described in Chapters 7–11. Chapter 12 uses simple models to explain concepts that underly temperature and heat capacity. To this end the authors develop a conceptual picture of temperature, heat capacity, and related quantities using the ideal gas and the two-state Schottky model. Chapter 13 applies principles of statistical thermodynamics to chemical equilibria. Chapter 14–16 develop simple models of liquids and solutions. These chapters make use of lattice models to provide more greater insight into the behavior of real molecules.

Chapters 18 and 19 deals with the dynamic processes exemplified by diffusion, transport, and physical and chemical kinetics in terms of random walk theory and the Langevin equation, Onsager relations, time-correlation functions, and transition-state theory. Chapters 20 and 21 introduce and discuss Coulomb's law and electrostatic potentials. Chapters 20–23 deal with electrostatics. They give an extensive treatment and focus on understanding the structure of proteins, nucleic acids, micelles, and membranes. They deal with protein and nucleic acid-ligand interaction and the behavior of channels as well as the classical areas of electrochemestry and colloid science.

Chapters 25 and 26 focus on cooperativity, phase equilibria, solubilities, critical phenomena, and conformational transitions, described through mean-field theories, the Ising model, helix-coil transition, and Landau theory. Chapters 27 and 28 describe binding polynomials. Chapters 29 and 30 describe water in its role as a solvent, the hydrophobic effect, and solvation. Finally, Chapters 31–33 treat the theory of polymer conformations that give rise to the elasticity of rubber, the viscoelasticity of solutions, the immiscibility of polymers, reptation, and the folding of proteins and RNA molecules.

An excellent feature of this book is the large number of solved problems. They are explained very clearly and provide a complete framework for understanding the topics under discussion. Also, the exercises suggested at the end of any chapter bring a useful tool for teachers and students. The suggested readings, as well as the references at the end of every chapter enable the interested reader to delve more deeply into many of the topics discussed in the book. The references range from very classical

ones to most recent ones. It is important to remark that the book has one or more historical passages in almost all of the chapters. On one hand, these notes make for pleasant reading, and on the other, they deal with the background that motivated various important scientific discoveries

In summary, the organization and presentation of the material are excellent. I highly recommend the book. Beside the chapters on statistical thermodynamics itself, the student and teacher will find discussions of mathematical tools and physical concepts used to the deal with the material in the text. In my opinion, the intention of the authors to write a clear book on statistical thermodynamics focusing on forces that govern molecular behavior has been achieved in splendid fashion.

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