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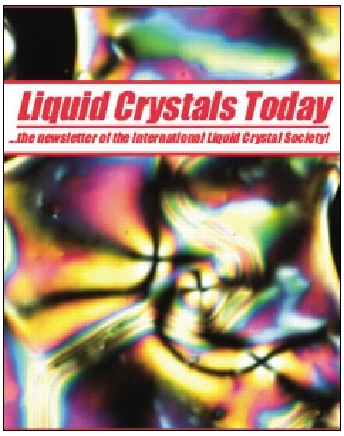

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Equilibrium Statistical Physics - Phases of Matter and Phase Transitions

Germano Iannacchione[a]
[a] Department of Physics, Worcester Polytechnic Institute, Worcester, MA, USA

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Book Review

Equilibrium Statistical Physics – Phases of Matter and Phase Transitions, by Marc Baus and Carlos F. Tejero (based on a series of lectures given in 2000 – translation by M. López de Haro), Springer, 2008, 364 pp., US$129, ISBN: 987-3-540-746317.

The book is intended as an undergraduate text for students in condensed-matter, physical chemistry or materials sciences as well as students in theoretical physics. There are no problems presented nor example problems worked out but many classical and quantum systems are analysed.

The work makes a valiant effort to distinguish itself from the crowded field of books on the subject of Statistical Mechanics. Perhaps, because of the nature of Statistical Mechanics – more a set of methods than a collection of self-consistent equations – most lecturers on the subject eventually bring their own unique perspective and get the 'bug' to write their own text. This is actually a very healthy outcome for the topic, although an incredible investment of time and energy for those inflicted.

The unique features of this text are the topics covered, the pedagogical approach and the ordering of the material. Given the aim of the book, these unique features are mostly liabilities for the work as a whole. Save for the exposition on some interesting topics (the quantum gases in Chapters 4–6 as well as the many phases discussed in Parts III and IV), as an introduction to the topic/field for undergraduates with a diverse background, the work falls short. The translation is generally good, although some tighter editing would have served the book better.

The specific impediments are the pedagogical approach and the ordering of the material. The book begins with Part I – 'Basics' in which the very first chapter presents a very brief Summary of classical and quantum mechanics. While a unique approach, the break-neck pace and presentation style make it of limited use for latter material. In an effort to be rigorous in the presentation, nearly all of the physical insights are hidden. While each chapter begins with an abstract, there is very little motivation for Chapter 1 other than it will be referred to later. Thus, while an intriguing beginning, this leading material may be far less useful to the general student. However, it is one of the finest short (17 pages) descriptions of mechanics and would make an excellent supplement (or perhaps a section in the Appendix).

The remaining parts more-or-less follow the standard order of material in more common texts on the subject and it is this later chapter of Part I where the pedagogical approach is most apparent.

The basic approach and intention is to make the discussion as rigorous mathematically as possible. However, this focus detracts from explaining the physics as the notation introduced is repeatedly defined and quantified. This approach is most apparent in Chapter 2 concerning an outline of thermodynamics. The reader here is left with the impression that thermodynamics is theoretically grounded and not an empirical science, this despite the later parts of this chapter simply presenting phase diagrams in rapid exposition as 'the physical situation'; for example, the laws of thermodynamics are not even clearly identified and some are described incompletely. Irreversibly is not discussed in terms of the Second Law (nor much at all), nor is the notion of heat, and the First Law is presented as $E = E(S, V, N)$ rather than the more physical statement $\delta E = \text{đ}Q + \delta W$, where $\text{đ}Q$ is the inexact differential of heat and δW is the differential of work.

It is in the last section of Part I, Chapter 3 – Statistical Physics, that a comparison is made between microscopic (mechanical) descriptions of members of an ensemble and the macroscopic parameters (the thermodynamics) of the entire ensemble. The basic elements of statistics are introduced through their application and it is here that the Thermodynamic Limit and the notion of Equilibrium are made (although not in the traditional sense). Here again, the pace is rapid and, although presented with a tone of rigorous exposition, it is likely that an undergraduate would require several passes to be sure of this material. All the chapters of Part I would require supplementary material for a typical undergraduate student.

The remaining parts of the text have a much slower pace and allow for a much clearer presentation of many physical systems. Here is where the real strength of this book lies. The discussions of ideal classical and quantum systems are good and would serve most students well. Parts III and IV (Non-ideal Systems and Advanced Topics) are especially useful, although the standard expansion techniques for interacting systems are not as clearly explained as in other more traditional texts. The one exception is the presentation of the Order Parameter and the Landau expansion as it pertains to liquid crystals. Here, the text is quite clear and contains many useful nuggets that can be incorporated into either a class on Statistical Mechanics or one on Liquid Crystals.

Given the presentation style and approach, the better intended audience of this book is graduate students and researchers working in phases and phase transitions in condensed matter and used as a reference text. It is not configured for adoption as the primary text of a course but can serve reasonably well as a complimentary book, especially in the areas important to liquid crystal research.

Germano Iannacchione
Department of Physics
Worcester Polytechnic Institute
Worcester, MA, USA