Book Review: *Principles of Condensed Matter Physics*

Principles of Condensed Matter Physics. P. M. Chaikin and T. C. Lubensky, Cambridge University Press, Cambridge, England, 1995.

As stated in the preface, this book is intended to bridge a gap in the existing condensed matter literature. There are a number of good textbooks on solid-state and many-body physics, but virtually none that venture into the field of soft condensed matter and presents in a unified format the basic concepts of condensed matter physics. These are exemplified by broken symmetry, critical phenomena, and the role of fluctuations and topological defects in establishing different ordered phases and associated transitions. The present book is especially welcome at a time when we are witnessing vigorous activity in all fields concerned with "soft" matter, starting from the classical examples of liquid crystalline and polymer physics and membrane physics, leading up to "hard" condensed matter, which encompasses quasicrystals, incommensurate crystals, classical fluids, and regular crystals. The book is aimed at a graduate audience and contains a selection of problems following each chapter. It contains a thorough and detailed treatment of all the subjects and is intended also to be suitable as a reference text for active reseachers.

The book starts with two chapters that present introductory material on the basic concepts of condensed matter physics and techniques that are used in analyzing problems in that area. In an overview of the subject the authors choose water as a paradigm to introduce the concepts of order parameters, broken symmetry, fluctuations, critical phenomena, and universality. Since the book deals exlusively with macro and mesoscopic levels of description, the authors choose to introduce the microscopic forces and interactions underlying different phenomena only sketchily. The summary on structure and scattering stands by itself as an illuminating, concise introduction to the multiplicity of ordered phases encountered in condensed matter, encompassing crystalline solids, liquid crystals, incommensurate structures, quasicrystals, liquids, and fractals. It has all the

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indications of an extremely fruitful joint effort of an experimentalist and a theorist, and is a delight to read.

The next set of four chapters is methodological in nature and I tend to view them as a series of formal preparatory steps for the themes in the core of the book. They introduce the topics of thermodynamics and statistical mechanics, mean-field theory, field theories, critical phenomena, and the renormalization group as well as a description of dynamics in terms of correlation and response functions. These are presented at various levels of detail. Some chapters are completely self-contained and exhaustive (e.g., the treatment of the mean-field approximation in its various guises), whereas others tend to read more as an introduction to more specialized literature (e.g., the chapter on field theories, critical phenomena, and the renormalization group). The variety of illustrations of models and the discussion of experimental realizations of various general methodologies is almost encyclopedic. To my way of thinking the chapter on mean-field theory and the phenomenology associated would be difficult to surpass. Again, I think the book is at its best in those parts in which the authors have achieved a balance of experimental breadth and theoretical depth.

The core of the book in my view is contained in the three chapters on generalized elasticity, hydrodynamics, and topological defects. A variety of different model and experimental illustrations are used to exemplify various theoretical points. The elastic theory of mesophases as well as solids is treated exhaustively together with a discussion of x-ray line shapes, scattering in general, and fluctuations of the different order parameters. Hydrodynamic theory is built from the example of rigid rotors on a lattice and advances to the hydrodynamics of mesophases and dynamic critical phenomena. Again the wealth and breadth of different illustrations of general developments is impressive. The elastic theory of topological defects is developed starting from vortex configurations in the xy model and progresses to the phenomenology and energetics of different topological defects in mesophases and defect-mediated phase transitions. It ends with a detailed exposition of the TGB phase.

There is a lot that generally surpasses the graduate level and I am sure that seasoned researchers in different fields of condensed matter physics will find topics of direct relevance to their immediate research interests. In discussing this book with various colleagues I got the impression that all share the feeling that it is destined to become the standard reference work on soft condensed matter physics. This book presents a most fortunate blend of theoretical depth and encyclopedic grasp of phenomenology, while being written in a pedagogically sound and elegant manner. Of course I am not "happy" that it lacks some of my currently favorite systems, but there is simply no room left to cram in even more material.

All in all, this monograph is a well-written, thorough, modern book on soft condensed matter physics that I wholeheartedly recommend to everybody with an interest in this subject.

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