

Preface

This book is based on a course on “Soft Matter,” which I teach for first-year graduate students in the Chemical Physics Interdisciplinary Program at the Liquid Crystal Institute of Kent State University. Students come into this program from several undergraduate majors—including physics, chemistry, materials science, chemical, or electrical engineering—and from many countries. The purpose of my course is to teach this diverse group of students about the statistical physics aspects of liquid crystals and other soft materials. At the same time, other professors teach the students about other aspects of these materials—including chemistry, optics, and design of devices. The students can then combine all of these scientific disciplines in their Ph.D. dissertation research.

In teaching this course, I have found that there are several excellent undergraduate-level books that describe the experimental phenomena of soft materials. There are also many excellent graduate-level books on the theoretical physics of these materials. However, I believe that students need a guide to help them make the transition between these levels—a basic introduction to theoretical physics, explaining the concepts of symmetry, broken symmetry, and order parameters; phases and phase transitions; mean-field theory; and the mathematics of variational calculus and tensors.

I have written this book to meet that need. In particular, I have tried to make it useful for two types of students: First, there are students going into theoretical research. This book will help them to progress toward studying more advanced topics and reading more advanced books on theoretical physics. Second, there are students going into other disciplines, such as experimental physics, chemistry, and engineering. These students may never plan to study more advanced theory, but this book will prepare them to understand theoretical seminars, read theoretical articles, and collaborate with theoretical colleagues.

To serve this diverse audience of students, I have taken two steps. First, I have intentionally written the book in an informal, conversational style. I find that this style is accessible to students from a wide range of backgrounds—from different scientific fields as well as different nationalities.

Second, as a technological innovation, the book is accompanied by a set of “interactive figures” (available at http://www.springer.com/cda/content/document/cda_downloadaddocument/Selinger+Interactive+Figures.zip?SGWID=0-0-45-1509169-p177545420). Some of these figures allow readers to change parameters and see what happens to a graph, some allow readers to rotate a plot or other graphics in 3D, and some do both. The interactive figures help students to develop their intuition for the physical meaning of equations. I strongly urge all readers to download and try them while reading the book. They are in a Wolfram Computable Document Format (CDF) file, which can be opened with Mathematica or with Wolfram’s free CDF player (available at <https://www.wolfram.com/cdf-player>). The player has versions for Windows, Mac, and Linux (although unfortunately not for iOS or Android).

I would like to thank all the students in my classes, as well as my research students, for their feedback as I developed the concepts for this book. I particularly thank Thanh-Son Nguyen for his careful reading of the first draft.

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