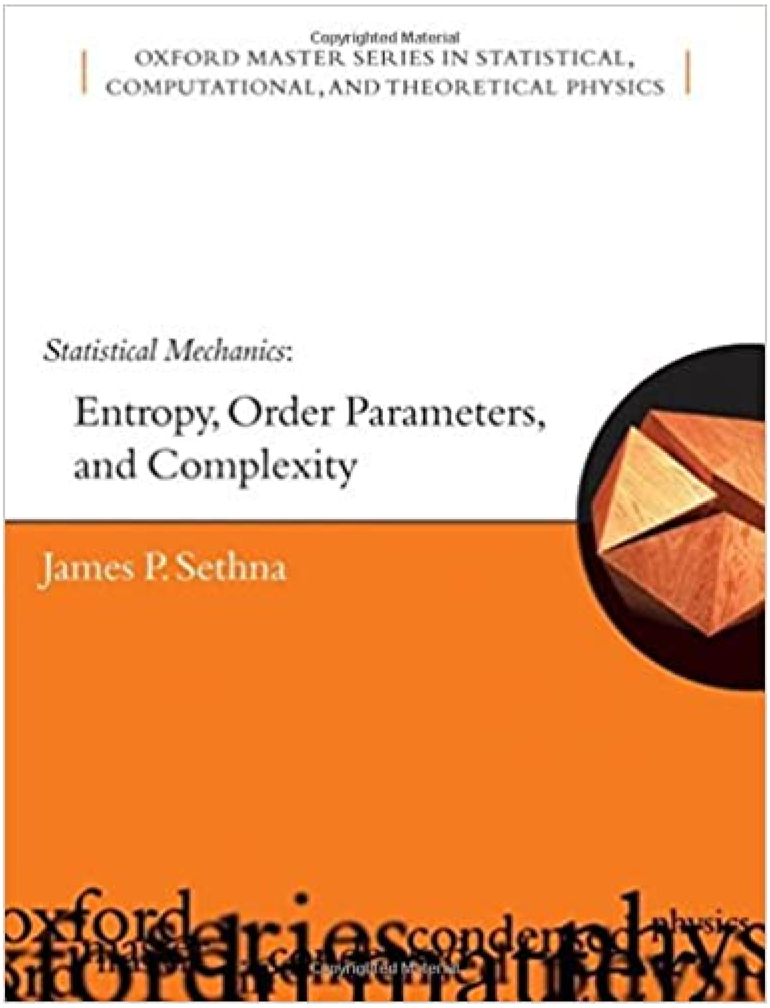
Statistical Mechanics: Entropy, Order Parameters And Complexity (Oxford Master Series In Physics)



Synopsis

In each generation, scientists must redefine their fields: abstracting, simplifying and distilling the previous standard topics to make room for new advances and methods. Sethna’s book takes this step for statistical mechanics--a field rooted in physics and chemistry whose ideas and methods are now central to information theory, complexity, and modern biology. Aimed at advanced undergraduates and early graduate students in all of these fields, Sethna limits his main presentation to the topics that future mathematicians and biologists, as well as physicists and chemists, will find fascinating and central to their work. The amazing breadth of the field is reflected in the author’s large supply of carefully crafted exercises, each an introduction to a whole field of study: everything from chaos through information theory to life at the end of the universe.

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Customer Reviews

"It would take quite a long time to list all the interesting subjects treated in this textbook, but overall, this is a very good starting point for an undergraduate student who is interested in pursuing a career in research and wants to have a global idea of the different problems that are currently developed in laboratories."--Mathematical Reviews"Sethna’s book provides am important service to students who want to learn modern statistical mechanics."-- Physics Today"An extremely intelligent and elegant introduction to fundamental concepts, well suited for the beginning graduate level."--William Gelbart, University of California at Los Angeles"The author’s style, although quite concentrated, is simple to understand, and has many lovely visual examples to accompany formal ideas and concepts, which makes the exposition live and intuitively appealing."--Journal of Statistical Physics

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This is not a very good textbook to learn statistical mechanics.My major complaints are as follows:- The problems at the end of the book are only generally connected to the content of that chapter. In my opinion there is too much that the author assumes the reader already knows. The information needed to complete some problems is often found in the chapters succeeding the questions. Not only that, but many of the questions are not clear, despite the paragraphs of explanation preceding them; they're just poorly worded. Often key points of the chapter are left as exercises for the students. This is particularly difficulty because of the next complaint.- Far too often the author defines important words and concepts through examples. It is not helpful for the students to say, "This system can be considered _________," and use that as the definition of the word. If you cannot write a clear definition of a word without using it in context or in an example, it is going to be confusing for the student.- Far too many footnotes that really don't enhance the text. They're distracting, and with so much background noise it is difficult to filter out what is important. It really breaks up the flow and diminishes the student's understanding of the main points of the paragraphs.- Inconsistent assumptions of the reader. The author generally assumes the reader to have a very deft mathematics knowledge, and at other times assumes the student has never taken a mechanics class.- There's often phrases in the text that are incorrect, and the author even mentions so in the footnotes. There's so much fluff and not enough content that it doesn't even feel like I'm reading a physics book, it reminds me more of an economics text in terms of its presentation.I'm five chapters in to the text, and so far don't think I've learned anything useful that I hadn't already seen in thermodynamics. I will update this review if my opinion changes as I progress through the book, but so far I find it very unfulfilling and not helpful.

Seems to be a decent text book so far.The author also makes a electronic pdf version of this available for free, just so you know.I bought this anyway, because I prefer to have the hard copy.

I haven't yet had a chance to read this book from cover to cover. However, after several hours with it, some of its strengths and weaknesses became evident. Many of these complement each other.It covers an exciting range of contemporary applications -- take a look at the table of contents. The problems are long, discursive, and even more intriguing than the main text, covering topics like the cosmic microwave background, origami microstructures, Langevin equations, snowflakes, biochemical reaction rates and NP-completeness. The book is rich in illustrations, and in footnotes that give an informal commentary on the main text.One downside is that, being so wide, the coverage is also a bit thin in places. Many of the most interesting contemporary topics, such as the statistical mechanics of networks, are covered *only* in exercises. Thermodynamics is dismissed in less than 10 pages in the middle of the book, owing to that subject's being "cluttered" with a "zoo of partial derivatives, transformations and relations."The exercises look to be more fun and tempting than usual in books on this subject. So it's a definite bummer that the book neither includes answers or hints, nor states problems in closed form ("Show that this stuff = X"). The book's web site contains only some hints for computational exercises, plus a bunch of additional problems (again, without answers). If you're interested in self-study, this tease is frustrating - an automatic one-star deduction.There's more good news/bad news with the author's aim to be relevant to fields outside traditional physics -- e.g. in econophysics and social science. This certainly makes the book up-to-date and attractive, and was one of the reasons I bought it. But applying physics to social science is a tricky business. There's a couple hundred years of failed attempts, because people blithely modeled stuff without thinking enough about the limits within which such an analogy might be appropriate. And many who do think about those limits when deriving a model often forget about them when applying it.An example is the Black-Scholes model of option pricing. The model's results are "simply wrong" (B. Mandelbrot). Its assumptions about volatility and the structure of the option contract aren't empirically justified. Its blind application contributed to the 1987 stock market break. And the investment fund run by one of its Nobel-laureate inventors went bust in flames in 1998. In this book, there's an exercise that walks you through some of the underlying concepts of Black-Scholes (pp. 32-33). But the author only praises the model, without so much as a footnote mentioning its darker side.Even when doing "traditional" physics, one ignores philosophical issues at one's peril. A lot of the great physicists of the past century weren't being stupid to fret over them. On the other hand, there are lots of folks like my QM professor in the 1970s, who explained that the only reason Bohr, Heisenberg and Einstein discussed philosophy was that they didn't understand QM, "but today we understand it very well, so we don't need to worry about that stuff."Unfortunately, this book continues that gung-ho, what-me-worry tradition. A disappointing example is the discussion of information and entropy (pp. 85 ff). The author states that interpreting entropy "not as a property of the system, but of our knowledge of the system ... cleanly resolves many otherwise confusing issues" (@ 85). This "cleanly" is a bit disingenuous, since plenty of people wouldn't agree with this interpretation (see, e.g., J. Bricmont's 1995 paper "Science of Chaos, or Chaos in Science?", available on the arXiv). The discussion of the arrow of time (pp. 80-81) does mention a couple of nuggets of relevant history, but the level of treatment is more suitable for a pre-med physics survey class than for a graduate course in stat mech.A couple of pages later (pp. 87-90), the author slides from a discussion of Shannon entropy to discussing an algorithm for helping your roommate find her keys by asking her questions. Without acknowledging it, he introduces the notion of meaning into "information" -- but meaning wasn't relevant for Shannon. Indeed, the historical background for why Shannon called his quantity "entropy" -- John von Neumann advised him to use the term because "nobody understands entropy" -- suggests one should be very cautious about mashing up the various scientific and colloquial meanings of "information".It's just this kind of unreflective enthusiasm when applying physics techniques outside their usual domain that leads to so many junk "Physics and Society" papers on the arXiv. At least one-half star deduction, for an upper bound of 3.5 stars.NOTE ADDED 2007/03/27: I recently received a very gracious email from the author addressing some of the above comments. I wasn't convinced by him about Black-Scholes or entropy (which he claimed to understand "in the broad context" better than Claude Shannon or J. Bricmont), but I do appreciate his engaging me on those points. He's also prepared an answer key to the exercises, though you'll need to write to him and convince him that you aren't taking the course for credit before he'll send them to you. (In my case my review apparently was credible evidence enough; not sure what it might take in yours, but from his note it sounds like it's not an impossible task.) I can't say that this materially changes my rating of the book, but I certainly give five stars to the author for his sincerity.

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