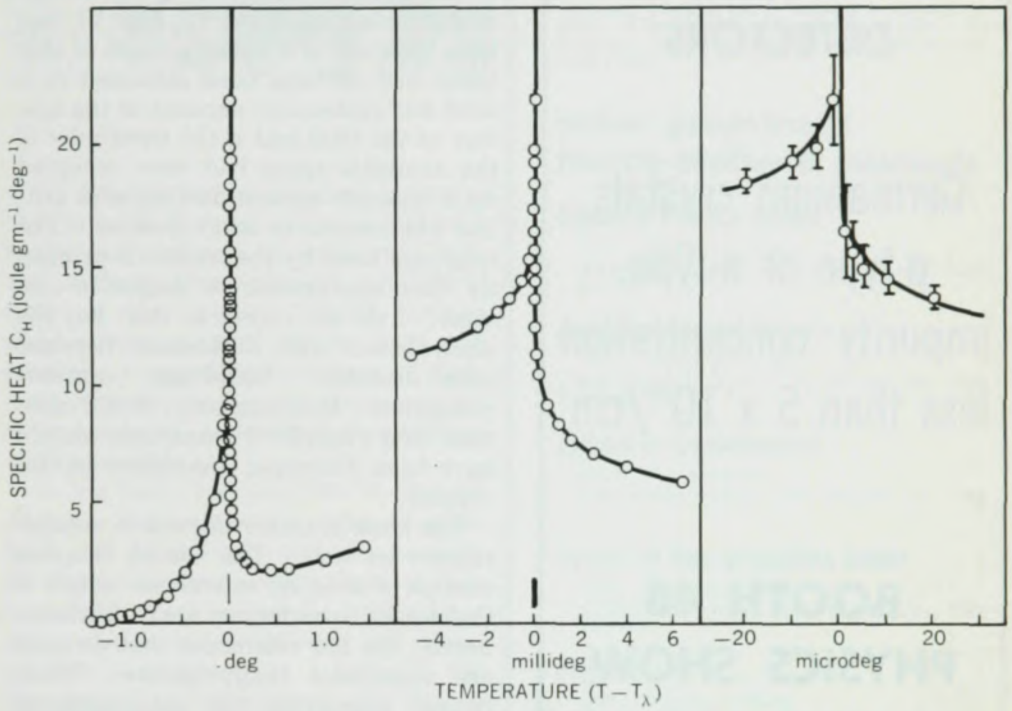
books

Phase transitions for beginners

Introduction to Phase Transitions and Critical Phenomena

H. Eugene Stanley
Oxford U. P., New York, 1971.
$9.50

Reviewed by Guenter Ahlers



High precision measurements of a critical phenomenon. Experimental data by Buckingham, Fairbank and Kellers for the specific heat of the superfluid transition in He.[4] The width of the small vertical line above the origin indicates the portion of the diagram that is expanded in the figure directly to the right. The fact that the shape of the curve does not change on successive expansions illustrates that phase transitions are sharp.

Without question, a need existed for a book of this type. There has been a virtually complete lack of texts devoted exclusively to phase transitions, although over the last decade or so research in this area has grown rapidly. By now, many graduate students are being introduced to the field, and courses devoted exclusively to this subject matter should be and are being taught. Nonetheless the novice in the field, as well as the student with the more casual interest of an outsider, has been forced to depend almost entirely upon a few review articles that address themselves to a more expert audience and are thus too condensed in language and too detailed in subject matter. Eugene Stanley's monograph is a substantial step towards filling this void and as such is most welcome and bound to be a success.

Much of the book is written at a fairly elementary level and assumes virtually no previous acquaintance with the field. The volume is well executed, and some useful devices are employed to make it very readable. For instance, the more important equations are labeled by arrows, and are easily recognized. The summary of thermodynamic relations and critical exponent definitions inside the cover, as well as the rather extensive notation guide, are convenient. For the most part the language is extremely clear and quite precise. Most of the figures are well chosen and contribute appreciably to a better understanding of the text. Unfortunately, however, the book does not contain any problems to be solved by students.

Although my overall opinion of the book is quite high, it is not difficult to find some fault with it. My most serious objection pertains to the very uneven choice of material. Perhaps unavoidably, even at this relatively elementary level, the text seems to overemphasize some of the author's personal interests and totally neglects some other important aspects of the field. The book is essentially limited to liquid-gas and ferromagnetic transitions, according to the author, for the sake of simplicity. One could perhaps sympathize more with this approach if the book remained very elementary throughout its entirety; but it does not. The first several chapters are indeed written at a level that is consistent with this approach, and they provide as clear and elementary an introduction to the subject as one could desire. Parts I and II present a review of the pertinent thermodynamics, proceed to the definitions of the critical point exponents and derive the rigorous exponent inequalities. Next, "classical" theories of critical phenomena are discussed. Here I was very pleased with the author's instructive effort to point out where apparently different approaches to the same problem, such as van der Waals and mean-field theories, are largely equivalent. Likewise, a little later, Stanley very successfully demonstrates how the homogeneous-function and the Kadanoff-construction approaches to scaling have much in common. But alas, before we arrive at this very clear and reasonably brief Part V that deals primarily with static scaling, we are faced with 57 pages of Part IV devoted to model systems. No doubt much of this material is useful to some, and even an introductory text should convey the flavor of this aspect of the field; but the novice should not be burdened with excessive details. For instance, he really does not need to know much about procedures of extrapolation to the limiting behavior of

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power series, and he can learn about Padé approximants when and if he specializes in the field. My first reaction to the material on "graphology" in Part IV was that this also went beyond the scope of the book; but it is presented well and does illustrate some important physics. Much of Part VI, dealing primarily with transport properties, is likewise too detailed to be consistent with the remainder of the book. It is drawn in part from very recent research that has not yet stood the test of time, and that to some extent is already outdated.

I would have been even more pleased than I am with this book if a considerable fraction of Parts IV and VI had been omitted, if a small portion of this space had perhaps been allocated to a brief but systematic account of the history of the field and if the remainder of the available space had been occupied by a separate section dealing with critical phenomena in other systems. The language used by the author is primarily that appropriate to magnetic systems. I do not object to this; but the equivalences and differences between order-disorder, liquid-gas, antiferromagnetic, ferromagnetic, liquid mixture, and superfluid transitions should have been discussed somewhere in this volume.

The book is rather uneven in another respect as well. The initial chapters contain almost no references, which is fine for an introductory text. Unfortunately, the few references that do exist are sometimes inappropriate. Thus, figures displaying the measurements by J. Anthony Tyson and David H. Douglass, Jr of the superfluid density of He II and the specific heat results for cobalt chloride of J. Skalyo and S. A. Friedberg are labeled "after Kadanoff *et al.*" This reference pertains to a review article, and no credit is given to the experimentalists responsible for the data. In Parts IV and VI, original literature citations are extremely plentiful; this is unnecessary in an elementary text and not in keeping with the earlier chapters.

It is not clear to me what audience the author primarily had in mind. Because of its uneven character, the book is perhaps more suitable for beginning graduate students who wish to specialize in this field than it is for a formal course given to a more general audience. However, for the latter purpose it still contains much well written material; but it omits some that should be included and includes some that should be omitted.

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Invisible Colleges: Diffusion of Knowledge in Scientific Communities

Diana Crane
The Univ. of Chicago Press, Chicago, Illinois, 1972. $9.00

Much of Diana Crane's work over the past decade of so has dealt with the communication system in science and more generally with various aspects of the sociology of science. Her central focus in this volume is on scientific communities and how scientific knowledge is produced. For her, the problem is to identify these communities, to determine whether there are truly communities or invisible colleges or "social circles"—each implying quite different connections among the scientists. Crane does this directly through a sociometric analysis of who says they are influenced by whom, and, indirectly through an analysis of citation patterns in the literature of a given field. Thus a tightly knit cluster of papers is taken to reflect a tightly knit group of scientists engaged in producing new knowledge.

Taking off from Thomas S. Kuhn's work on normal and revolutionary science and the role of the paradigm, Crane seeks to combine stages in the growth of knowledge with differing characteristics of scientific communities. Thus when a paradigm first appears in a given field, she postulates that there is little or no social organization. But as the paradigm becomes adopted and normal science progresses, groups of collaborators and even invisible colleges develop. Major problems are getting solved. Eventually anomalies appear. Scientists have become increasingly specialized, and at the same time there is more controversy. Finally, there is exhaustion and crisis and a concomitant decline in community membership. The curve of publications flattens out after having taken off in the second stage and crested in the third. Many people presumably go off to work in greener fields.

In developing this model of scientific growth, Crane is not wholly unaware of the role of cognitive and substantive differences among scientific subfields. But her emphasis is on the role of social organization (a factor often neglected or ignored) as it promotes the development of subfields, aids in the diffusion of knowledge and even in the choice of problems. The interrelations of patterns of growth and patterns of social organization are explored. And the whole communication system within science is examined not only in terms of internal efficiency but in terms of the model she has developed.

In the final chapter, Crane takes