

This book is devoted entirely to the work that has been done on the Sherrington-Kirkpatrick model and to developments that have followed from that work; it does not touch on the problems of real random magnetic systems. The authors give a masterly account of the work on the model in the first 85 pages. Such a summary cannot be found elsewhere, and much of our current understanding of the problem is due to the authors of this book and their collaborators. Twenty-four reprints on the subject follow. The predominant theme of this first part of the book is that the model describes a system that has many equilibrium states at the same temperature, and that these states are organized with an ultrametric structure.

The rest of the book is devoted to two applications of the ideas that were developed to deal with the spin glass model. Both original text and relevant reprints are included. The first application considered is work on optimization problems such as the traveling salesman problem. The relevance of the spin glass work to this famous problem is that multiple equilibrium states are analogous to the many local minima of the traveling salesman problem, and in both cases techniques are needed that will find properties of the global minimum or minima.

The section entitled "Biological Applications," apart from a two-page summary of Philip Anderson's work on prebiotic evolution, is devoted entirely to John Hopfield's model of neural nets and various modifications of it. Here there is a correspondence between the multiple equilibrium states of the spin glass and the multiple memories stored in a neural net.

The first part of the book describes clearly and authoritatively the remarkable properties of the infinite-range spin glass, and the reprints are well chosen to show how the theory developed. The theory is so interesting that I feel it ought to describe real physical systems, but many of us doubt that real spin glasses have more than a small proportion of the model's rich and novel properties. The remainder of the book, on the applications of the theory to other fields, is sketchy rather than comprehensive. I feel that the spin glass experts are like settlers encamped in hostile territory. They have interesting observations to make, but have not learned how to communicate with the earlier settlers. In some of the papers on neural nets there is barely a reference to work by scientists outside the spin glass community.

This is an important book, which every physics library should have. It is also good reading for anyone who wants to know about these aspects of the spin glass problem, and why "replica symmetry breaking" and "ultrametricity" may be important.

DAVID J. THOULESS
University of Washington

Statistical Field Theory

Giorgio Parisi

Addison-Wesley, Redwood City, Calif., 1988. 352 pp.

\$48.50 hc ISBN 0-201-05985-1

The symbiotic relationship between statistical mechanics and quantum field theory has come into much prominence in recent years, particularly since the introduction in 1971 of Kenneth Wilson's renormalization group approach. Just as field theory proved to be the natural language with which to describe and perform computations for critical phenomena, the renormalization group approach led to a clearer notion of such concepts in field theory as the continuum limit. A major character in this interplay between the two areas of theory has been Giorgio Parisi. He has made seminal contributions to both, ranging from his work on Monte Carlo simulation of gauge theories to his extremely original notion of replica symmetry breaking in the theory of spin glasses.

One is always interested in knowing more about the insights such leading figures have into their subject matter. A textbook, where a more leisurely pace prevails than in research papers, is surely one of the most fertile sources of priceless insights. However, rarely do active researchers find the time or the motivation to write up their unique perspectives. Fortunately for us Parisi has chosen to do just that, and I waded into the material most eagerly. It lived up to its promise.

As one may infer from the title, the book contains detailed treatments of a variety of special topics: spin models, path integrals, Euclidean field theory, renormalization group approach, non-equilibrium processes and computer simulations. I am not aware of any other book that covers all these topics or their interrelationships.

The book is self-contained and accessible to any beginning graduate student who is willing to be guided by it. Every idea that is introduced (the ϵ expansion is a notable example) is treated in some depth, with all the 2π 's in place, so that the student can start working on real problems after

going through the material. Several ideas from rigorous statistical mechanics, such as the Osterwalder-Schrader positivity conditions or the theory of symmetry breaking, are explained in the simplest possible terms, but without compromise.

The book does not include any problems, so it probably would not be easy to use as a text, unless the instructor came up with the problems himself. On the other hand, it is ideal for self-study or study by a journal club that wants to master this very fundamental subject and needs just a good introduction, as well as a guide through the literature, or simply for those who work in the field.

I recommend the book without reservation to this audience. It is bound to become a canonical reference in the future. An adviser who is confronted with a student wanting to work in this field and needing an introductory text can now tell the student to get a copy of Parisi's book and call back after finishing it.

RAMAMURTI SHANKAR
Yale University

The Physics of Structurally Disordered Matter: An Introduction

N. E. Cusack

Adam Hilger, Bristol, UK
(US dist. Taylor and Francis,
New York), 1987. 402 pp.

\$162.00 hc ISBN 0-85274-591-5;

\$68.00 pb ISBN 0-85274-829-9

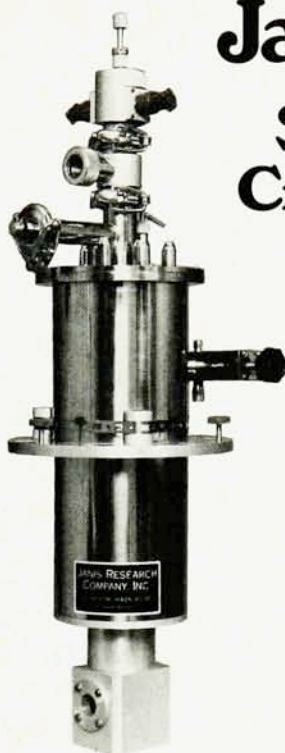
The general topic of structurally disordered matter entered into the mainstream of condensed matter physics roughly two decades ago, although most beginning (and even advanced) texts that one is likely to encounter in a typical university solid-state physics course give the subject short shrift. The reasons aren't too difficult to uncover: Our understanding of "disordered" systems lags far behind that of their "ordered" counterparts; most important issues in the various fields are a long way from being settled; and there are few central unifying theories to lend coherence to the subject. (There is even some disagreement on which problems properly belong to the subject.) As a result, there are few texts that extensively treat both ordered and disordered systems, that is, electrons in periodic and random potentials, crystals and glasses, crystalline and amorphous semiconductors, and so on.

Despite the difficulties posed by writing a pedagogical text on disordered systems, the number of such books has been steadily increasing

over the past decade. These include, among others, John Ziman's *Models of Disorder* (Cambridge U.P., New York, 1979), Richard Zallen's *The Physics of Amorphous Solids* (Wiley, New York, 1983; reviewed in *PHYSICS TODAY*, August 1987, page 69), Giorgio Careri's *Order and Disorder in Matter* (Benjamin, Menlo Park, Calif., 1984) and Debashish Chowdhury's *Spin Glasses and Other Frustrated Systems* (Princeton U.P., Princeton, N.J., 1987). N. E. Cusack's *The Physics of Structurally Disordered Matter: An Introduction* is the most recent, and in some sense, the most comprehensive of these. Potential readers should be aware that the title means what it says: Quenched disorder in magnetic systems, for example, is given only very brief mention, and the reader who wishes to learn about spin glasses or random-field systems will have to look elsewhere.

The book is part of Adam Hilger's Graduate Student Series in Physics, and as such its purpose is mostly pedagogical. It is aimed toward graduate students entering research in structural disorder—aspects such as liquid metals, amorphous semiconductors, glasses and so on. The number of topics treated is quite large, so the book adopts a survey format rather than attempting an in-depth treatment of fewer subjects. The result is a useful, well-referenced, semi-encyclopedia compendium that gives one a taste of the techniques, approaches and current directions in a variety of topics; the book serves more as a jumping-off point than as a place to delve deep into any one area. Nevertheless, as is to be expected, its treatment of some topics is more successful than of others.

Cusack deals with both equilibrium systems whose disorder arises solely from thermal effects, like liquids, and quenched systems out of equilibrium, like glasses. The introduction on order and disorder, which could have been more tightly focused, includes such recent developments as quasicrystals, which are not considered in the remainder of the book. The same is true of local icosahedral order, which should reappear in the last chapter, on metallic glasses, but does not. The shortcomings of the somewhat desultory introduction are remedied in the next two chapters, which provide a useful and readable primer on the basic theoretical and experimental tools and models (Voronoi polyhedra, distribution functions, scattering experiments and so on) used to describe and investigate the actual structure of disordered materials.



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Send nominations with supporting material to:

John S. Rigden
Director of Physics Programs
American Institute of Physics
335 East 45th Street
New York, NY 10017

Deadline for receipt of nominations is 31 December 1988.

An attractive feature of the book is the inclusion of a chapter on numerical techniques, mostly Monte Carlo and molecular dynamics, which have long provided an important avenue of investigation into the structural and thermodynamical properties of disordered matter. The treatment is relatively brief, however, and the results given for a few models (hard sphere, Lennard-Jones, semi-empirical liquid metal potentials and quenched Lennard-Jones glasses) are really only sketches.

The strongest chapters are those on simple liquids and liquid metals (including a chapter on nonlocalized electrons in disordered matter), the latter being the area of Cusack's own research. Theory is presented clearly, and its successes and limitations are spelled out. The coverage of liquid metals is relatively broad, given the limited allocation of space to each chapter; electronic and thermal properties for both simple elemental liquid metals and liquid alloys are discussed, and transport processes are introduced at this time. Comparison with experiment keeps pace with the theory throughout most of the book.

The chapters on percolation and localization are weaker, and illustrate some of the problems inherent in attempting to write a survey. One feels rushed in these chapters. Concepts are partially introduced but not given sufficient development into a coherent exposition; at times they end up somewhat jumbled. The problem seems mostly to stem from the author's attempt to squeeze too much into too little space; in many cases, discussion of a topic proceeds up to a point that leaves the narrative (and central idea) hanging, and then turns the subject over to the references, sometimes without leaving the reader with a clear idea of what exactly is in them. Deficiencies such as this are rather minor, but they leave the reader somewhat unsatisfied.

Similar problems persist in the chapter on insulating glasses, where the choice of topics is rather arbitrary. The only model of the glass transition discussed is the modified free-volume theory; the more recent mode-coupling theories are given only the briefest of mentions and then are consigned to the references.

The last two chapters treat amorphous and liquid semiconductors and metallic glasses. The discussion of the former, which includes treatments of defects and dangling bonds in the tetrahedrals and chalcogenides, electron spin resonance and photoluminescence, and transport, is again quite good and reasonably com-

prehensive. The chapter on metallic glasses is better than that on insulating glasses but exhibits some of the same shortcomings; some of the more recent work, such as that on local icosahedral order, is not mentioned.

Among the book's strongest points are the attention paid to both experiment and theory, and comparison of the two wherever possible. The references are very extensive and should be useful to workers in the field and to beginning graduate students. *The Physics of Structurally Disordered Matter*, despite its shortcomings, should help to introduce beginning researchers to a field in which pedagogically oriented books for graduate students are still scarce.

DANIEL L. STEIN
University of Arizona

New Directions in Solid State Chemistry: Structure, Synthesis, Properties, Reactivity and Materials Design

C. N. R. Rao and
J. Gopalakrishnan
Cambridge U. P., New York,
1986. 516 pp. \$79.50 hc
ISBN 0-521-30192-0

The senior author of this book, C. N. Ramachandra Rao, professor of solid-state chemistry at the Indian Institute of Technology, Bangalore, has made significant contributions to the synthesis and characterization of many solids, mainly but not exclusively inorganic. With his collaborator, Jagannatha Gopalakrishnan, he has covered most of the current activities in solid-state science. The attempt at such broad coverage makes the book too dense, moving quickly from one subject to another. Unfortunately, the bibliography is at the end. This makes finding a reference inconvenient. It would have been better to put each chapter's references after the chapter.

Chapter 3, "Preparative Strategies," should be very useful to physicists. It emphasizes synthetic methods such as decomposition of nitrates, cocrystallization of carbonates and sol-gel methods, which lead to formation of complex phases at low temperatures and to fine particle size, necessary when the product is a catalyst but also permit lower sintering temperatures, and, not incidentally, minimize porosity. The chapter also discusses intercalation, de-intercalation and ion exchange. In the midst of these clever strategies, the authors give a well-deserved nod to

serendipity, citing Charles Torardi and Robert McCarley's accidental discovery of NaMo_4O_6 while attempting to prepare something altogether different. This compound proved to be the prototype of a series of so-called cluster-chain compounds. Another example might be the discovery of $\text{YBa}_2\text{Cu}_3\text{O}_7$ -type compounds, which was made while following the methods in Georg Bednorz and Alex Müller's original report (*Z. Physik B* 65, 189, 1986)—but this book was written before that paper.

Chapter 4, on phase transitions, briefly introduces Landau theory, followed by a quick treatment of soft modes, critical phenomena, mechanisms of phase transitions and so on. The brevity of these discussions makes them hardly adequate to enable the reader to calculate anything. They do serve to convey to chemists the existence of these concepts and to guide them to more detailed treatments.

In the introductory chapters on elementary bonding concepts and structures of solids, the authors cover most of the mandatory material to be found in several books entitled *Solid State Chemistry* or *Structural Inorganic Chemistry*. The book also deals with organic crystals, with examples of charge-transfer salts whose surprising metallic behavior has created much excitement in recent years.

Methods of characterization are briefly discussed, with emphasis on new methods such as EXAFS, XANES, solid-state nmr and various electron spectroscopies, enough detail to illustrate the usefulness of the techniques. Frequent references to reviews and books will help readers to locate more detailed information.

Defects of all types are reviewed in some detail. A case study of defect perovskite oxides shows how particular orderings of defects lead to different structures. Similar case studies are used in chapter 6, on structure-property relationships. A variety of magnetic and electrical properties are covered, from RKKY ferromagnetism and other magnetic orderings to optical and dielectric behavior to superconductivity. Case studies of oxides, sulfides and fluorides are used for illustration. Both band structure and localized bond concepts are used in attempts to understand the phenomena. Some physicists reject this qualitative understanding, but the complexities of most materials preclude the fitting of data to oversimplified models. In any event, the volume under review does not pretend to be a textbook on condensed matter physics. In that spirit, this chapter gives a