Journal of Statistical Physics, Vol. 105, Nos. 1/2, October 2001 (© 2001)

Book Review: *Introduction to the Replica Theory of Disordered Statistical Systems*

Introduction to the Replica Theory of Disordered Statistical Systems. Victor Dotsenko, Cambridge University Press, 2000.

This book is a concise collection of a selected set of topics on spin glasses and disordered systems in general. The level of the book is introductory, and is accesible to graduate students in physics who want to learn the elements of the theory of spin glasses. The book is very well written, concise and clear, and the selection of topics is a good one. The book succeeds in explaining the power of the replica method by applying it to a large variety of physical systems throughout the book. Moreover, despite the introductory character of the book, the reader will learn about the state of the art as pertains to open problems. For these reasons I find this to be a modest (around 200 pages) but excellent book for students interested in the general area of statistical field theory applied to disordered systems.

The book is divided into three parts. The first part contains a basic revision of mean-field theory. The main content of this section is based on results obtained for the infinite-range spin glass or Sherrington–Kirkpatrick model. The book explains the physical meaning of the order parameter, the notion of pure states, and the somewhat mysterious concept of replica symmetry breaking as encoded in the Parisi ansatz. The only topic I find missing in this part is a discussion of subjects such as the TAP equations and metastability which have been so useful in understanding physical properties of the spin glass phase.

The second third of the book is devoted to one of the most controversial subjects in spin glass theory. That is, how the concepts of the previous chapters can be extended to realistic short-ranged systems. For this difficult and unsolved question, the author concentrates on the analysis of critical phenomena and the possible extension of standard renormalization group ideas to disordered systems. This is done for the simplest case of non-frustrated diluted systems. However, an analysis of the nature of the low-temperature phase in spin glasses is omitted. This part of the book serves to

0022-4715/01/1000-0403$19.50/0

give the idea of the difficulty of the subject. I only missed a discussion about some phenomenological approaches to the low-temperature phase of spin glasses such as the domain wall scaling ideas introduced by MacMillan or the droplet model by Fisher and Huse. Possibly some of the efforts by De Dominicis and Kondor that go beyond the Gaussian approximation could have been reported. In fact, Chapter 9 remains obscure and unclear and could have been replaced by more general considerations on the items discussed above.

Finally, the third section of the book deals with other models for disordered systems. The author analyzes the random field, the directed polymer, and some zero-dimensional models. These issues turn out to be instructive and useful for the general reader to learn more about other models in which the replica method can be succesfully applied. In general, I find the book by Dotsenko to be an important contribution to the existing collection of books on the statistical physics of disordered systems. Although modest in contents and pages (nearly no mention is made about dynamics in the book which, nevertheless, is said to be one of the most important subjects in the Conclusion) nevertheless it is a good introduction for those wanting to learn about this fascinating modern subject.

Felix Ritort
Physics Department
Faculty of Physics
University of Barcelona,
Diagonal 647, 08028 Barcelona, Spain