

<<场的统计物理学>>

图书基本信息

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前言

Many scientists and non-scientists are familiar with fractals, abstract self-similar entities which resemble the shapes of clouds or mountain landscapes. Fewer are familiar with the concepts of scale-invariance and universality which underlie the ubiquity of these shapes. Such properties may emerge from the collective behavior of simple underlying constituents, and are studied through statistical field theories constructed easily on the basis of symmetries. This book demonstrates how such theories are formulated, and studied by innovative methods such as the renormalization group. The material covered is directly based on my lectures for the second semester of a graduate course on statistical mechanics, which I have been teaching on and off at MIT since 1988. The first semester introduces the student to the basic concepts and tools of statistical physics, and the corresponding material is presented in a companion volume. The second semester deals with more advanced applications - mostly collective phenomena, phase transitions, and the renormalization group, and familiarity with basic concepts is assumed. The primary audience is physics graduate students with a theoretical bent, but also includes postdoctoral researchers and enterprising undergraduates. Since the material is comparatively new, there are fewer textbooks available in this area, although a few have started to appear in the last few years. Starting with the problem of phase transitions, the book illustrates how appropriate statistical field theories can be constructed on the basis of symmetries. Perturbation theory, renormalization group, exact solutions, and other tools are then employed to demonstrate the emergence of scale invariance and universality. The final two chapters deal with non-equilibrium dynamics of interfaces, and directed paths in random media, closely related to the research of the author. An essential part of learning the material is doing problems; and in teaching the course I developed a large number of problems (and solutions) that have been integrated into the text. Following each chapter there are two sets of problems: solutions to the first set are included at the end of the book, and are intended to introduce additional topics and to reinforce technical tools. There are no solutions provided for a second set of problems which can be used in assignments.

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内容概要

Introduction、The Landau-Ginzburg Hamiltonian、Saddle point approximation, and mean-field theory
、Continuous symmetry breaking and Goldstone modes、Discrete symmetry breaking and domain walls
、Fluctuations、Scattering and fluctuations、Correlation functions and susceptibilities、Lower critical
dimension、Comparison to experiments、Gaussian integrals等等。

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The underlying microscopic Hamiltonian for the interactions of particles is usually quite complicated, making an ab initio particulate approach to the problem intractable. However, there are many common features in the macroscopic behavior of many such systems that can still be fruitfully studied by the methods of statistical mechanics. Although the interactions between constituents are quite specific at the microscopic scale, one may hope that averaging over sufficiently many particles leads to a simpler description. (In the same sense that the central limit theorem ensures that the sum over many random variables has a simple Gaussian probability distribution function.) This expectation is indeed justified in many cases where the collective behavior of the interacting system becomes more simple at long wavelengths and long times. (This is sometimes called the hydrodynamic limit by analogy to the Navier-Stokes equations for a fluid of particles.) The averaged variables appropriate to these length and time scales are no longer the discrete set of particle degrees of freedom, but slowly varying continuous fields. For example, the velocity field that appears in the Navier-Stokes equations is quite distinct from the velocities of the individual particles in the fluid. Hence the appropriate method for the study of collective behavior in interacting systems is the statistical mechanics of fields.

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