<<场的统计物理学>>

图书基本信息

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作者：卡达

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前言

Many scientists and non-scientists are familiar with fractals, abstract self-similarentities which resemble the shapes of clouds or mountain landscapes. Fewer arefamiliar with the concepts of scale-invariance and universality which underliethe ubiquity of these shapes. Such properties may emerge from the collectivebehavior of simple underlying constituents, and are studied through statisticalfield theories constructed easily on the basis of symmetries. This book demon-strates how such theories are formulated, and studied by innovative methodssuch as the renormalization group. The material covered is directly based on my lectures for the second semesterof a graduate course on statistical mechanics, which I have been teaching onand off at MIT since 1988. The first semester introduces the student to thebasic concepts and tools of statistical physics, and the corresponding materialis presented in a companion volume. The second semester deals with moreadvanced applications - mostly collective phenomena, phase transitions, andthe renormalization group, and familiarity with basic concepts is assumed. Theprimary audience is physics graduate students with a theoretical bent, but alsoincludes postdoctoral researchers and enterprising undergraduates. Since thematerial 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 theproblem of phase transitions, the book illustrates how appropriate statisticalfield theories can be constructed on the basis of symmetries. Perturbation the-ory, renormalization group, exact solutions, and other tools are then employedto demonstrate the emergence of scale invariance and universality. The finaltwo chapters deal with non-equilibrium dynamics of interfaces, and directedpaths in random media, closely related to the research of the author. An essential part of learning the material is doing problems; and in teachingthe course I developed a large number of problems （and solutions） that havebeen integrated into the text. Following each chapter there are two sets ofproblems：solutionsto the first set are included at the end of the book, and areintended to introduce additional topics and to reinforce technical tools. Thereare no solutions provided for a second set of problems which can be used inassignments.

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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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章节摘录

The underlying microscopic Hamiltonian for the interactions of particles isusually quite complicated, making an ab initio particulate approach to the prob-lem intractable. However, there are many common features in the macroscopicbehavior of many such systems that can still be fruitfully studied by the meth-ods of statistical mechanics. Although the interactions between constituentsare quite specific at the microscopic scale, one may hope that averaging oversufficiently many particles leads to a,simpler description. （In the same sensethat the central limit theorem ensures that the sum over many random variableshas a simple Ganssian probability distribution function.） This expectation isindeed justified in many cases where the collective behavior of the interact-ing system becomes more simple at long wavelengths and long times. （Thisis sometimes called the hydrodynamic limit by analogy to the Navier-Stokesequations for a fluid of particles.） The averaged variables appropriate to theselength and time scales are no longer the discrete set of particle degrees offreedom, but slowly varying continuous fields. For example, the velocity fieldthat appears in the Navier-Stokes equations is quite distinct from the velocitiesof the individual particles in the fluid. Hence the appropriate method for thestudy of collective behavior in interacting systems is the statistical mechanicsof fields.

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