

<<非平衡态量子场论>>

图书基本信息

## 前言

The purpose of this book is to provide an introduction to the applications of quantum field theoretic methods to systems out of equilibrium. The reason for adding a book on the subject of quantum field theory is two-fold: the presentation is, to my knowledge, the first to extensively present and apply to non-equilibrium phenomena the real-time approach originally developed by Schwinger, and subsequently applied by Keldysh and others to derive transport equations. Secondly, the aim is to show the universality of the method by applying it to a broad range of phenomena. The book should thus not just be of interest to condensed matter physicists, but to physicists in general as the method is of general interest with applications ranging the whole scale from high-energy to soft condensed matter physics. The universality of the method, as testified by the range of topics covered, reveals that the language of quantum fields is the universal description of fluctuations, be they of quantum nature, thermal or classical stochastic. The book is thus intended as a contribution to unifying the languages used in separate fields of physics, providing a universal tool for describing non-equilibrium states. Chapter 1 introduces the basic notions of quantum field theory, the Bose and Fermi quantum fields operating on the multi-particle state spaces. In Chapter 2, operators on the multi-particle space representing physical quantities of a many-body system are constructed. The detailed exposition in these two chapters is intended to ensure the book is self-contained. In Chapter 3, the quantum dynamics of a many-body system is described in terms of its quantum fields and their correlation functions, the Green's functions. In Chapter 4, the key formal tool to describe non-equilibrium states is introduced: Schwinger's closed time path formulation of non-equilibrium quantum field theory, quantum statistical mechanics. Perturbation theory for non-equilibrium states is constructed starting from the canonical operator formalism presented in the previous chapters. In Chapter 5 we develop the real-time formalism necessary to deal with non-equilibrium states; first in terms of matrices and eventually in terms of two different types of Green's functions. The diagram representation of non-equilibrium perturbation theory is constructed in a way that the different aspects of spectral and quantum kinetic properties appear in a physically transparent and important fashion for non-equilibrium states. The equivalence of the real-time and imaginary-time formalisms are discussed in detail. In Chapter 6 we consider the coexistence regime between equilibrium and non-equilibrium states, the linear response regime. In Chapter 7 we develop and apply the quantum kinetic equation approach to the normal state.

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### 内容概要

The purpose of this book is to provide an introduction to the applications of quantum field theoretic methods to systems out of equilibrium. The reason for adding a book on the subject of quantum field theory is two-fold : the presentation is , to my knowledge , the first to extensively present and apply to non-equilibrium phenomena the real-time approach originally developed by Schwinger , and subsequently applied by Keldysh and others to derive transport equations. Secondly , the aim is to show the universality of the method by applying it to a broad range of phenomena. The book should thus not just be of interest to condensed matter physicists , but to physicists in general as the method is of general interest with applications ranging the whole scale from high-energy to soft condensed matter physics. The universality of the method , as testified by the range of topics covered , reveals that the language of quantum fields is the universal description of fluctuations , be they of quantum nature , thermal or classical stochastic. The book is thus intended as a contribution to unifying the languages used in separate fields of physics , providing a universal tool for describing non-equilibrium states.

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