

<<凝聚态物理学中的量子场论>>

图书基本信息

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前言

The objective of this book is to familiarize the reader with the recent achievements of quantum field theory (henceforth abbreviated as QFT). The book is oriented primarily towards condensed matter physicists but , I hope , can be of some interest to physicists in other fields. In the last fifteen years QFT has advanced greatly and changed its language and style. Alas , the fruits of this rapid progress are still unavailable to the vast democratic majority of graduate students , postdoctoral fellows , and even those senior researchers who have not participated directly in this change. This cultural gap is a great obstacle to the communication of ideas in the condensed matter community. The only way to reduce this is to have as many books covering these new achievements as possible. A few good books already exist; these are cited in the select bibliography at the end of the book. Having studied them I found , however , that there was still room for my humble contribution. In the process of writing I have tried to keep things as simple as possible; the amount of formalism is reduced to a minimum. Again , in order to make life easier for the newcomer , I begin the discussion with such traditional subjects as path integrals and Feynman diagrams. It is assumed , however , that the reader is already familiar with these subjects and the corresponding chapters are intended to refresh the memory. I would recommend those who are just starting their research in this area to read the first chapters in parallel with some introductory course in QFT. There are plenty of such courses , including the evergreen book by Abrikosov , Gorkov and Dzyaloshinsky. I was trained with this book and thoroughly recommend it. Why study quantum field theory ? For a condensed matter theorist as , I believe , for other physicists , there are several reasons for studying this discipline. The first is that QFT provides some wonderful and powerful tools for our research , The results achieved with these tools are innumerable; knowledge of their secrets is a key to success for any decent theorist. The second reason is that these tools are also very elegant and beautiful. This makes the process of scientific research very pleasant indeed. I do not think that this is an accidental coincidence; it is my strong belief that aesthetic criteria are as important in science as empirical ones. Beauty and truth cannot be separated , because beauty is truth realized (Vladimir Solovyev) . The history of science strongly supports this belief : all great physical theories are at the same time beautiful.

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内容概要

This book is a course in modern quantum field theory as seen through the eyes of a theorist working in condensed matter physics. It contains a gentle introduction to the subject and can therefore be used even by graduate students. The introductory parts include a derivation of the path integral representation, Feynman diagrams and elements of the theory of metals including a discussion of Landau Fermi liquid theory. In later chapters the discussion gradually turns to more advanced methods used in the theory of strongly correlated systems. The book contains a thorough exposition of such nonperturbative techniques as $1/N$ -expansion, bosonization (Abelian and non-Abelian), conformal field theory and theory of integrable systems. The book is intended for graduate students, postdoctoral associates and independent researchers working in condensed matter physics.

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章节摘录

The related problem is a long-standing problem of the Kondo lattice or, in more general words, the problem of the coexistence of conduction electrons and local magnetic moments. We have discussed this problem very briefly in Chapter 21, where it was mentioned that this remains one of the biggest unsolved problems in condensed matter physics. The only part of it which is well understood concerns a situation where localized electrons are represented by a single local magnetic moment (the Kondo problem). In this case we know that the local moment is screened at low temperatures by conduction electrons and the ground state is a singlet. The formation of this singlet state is a nonperturbative process which affects electrons very far from the impurity. The relevant energy scale (the Kondo temperature) is exponentially small in the exchange coupling constant. It still remains unclear how conduction and localized electrons reconcile with each other when the local moments are arranged regularly (Kondo lattice problem). Empirically, Kondo lattices resemble metals with very small Fermi energies of the order of several degrees. It is widely believed that conduction and localized electrons in Kondo lattices hybridize at low temperatures to create a single narrow band (see the discussion in Chapter 21). However, our understanding of the details of this process remains vague. The most interesting problem is how the localized electrons contribute to the volume of the Fermi sea (according to the large- N approximation, they do contribute). The most dramatic effect of this contribution is expected to occur in systems with one conduction electron and one spin per unit cell. Such systems must be insulators (the so-called Kondo insulator). The available experimental data apparently support this point of view: all compounds with an odd number of conduction electrons per spin are insulators (Aeppli and Fisk, 1992). At low temperatures they behave as semiconductors with very small gaps of the order of several degrees. The marked exception is FeSi where the size of the gap is estimated as ~ 700 K (Schlesinger et al., 1993).

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