<<凝聚态物理学中的量子场论>>

图书基本信息

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作者：泰斯韦利科

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前言

The objective of this book is to familiarize the reader with the recent achievements ofquantum field theory （henceforth abbreviated as QFT）. The book is oriented primarilytowards condensed matter physicists but， I hope， can be of some interest to physicists inother fields. In the last fifteen years QFT has advanced greatly and changed its languageand style. Alas， the fruits of this rapid progress are still unavailable to the vast democraticmajority of graduate students， postdoctoral fellows， and even those senior researchers whohave not participated directly in this change. This cultural gap is a great obstacle to thecommunication of ideas in the condensed matter community. The only way to reduce thisis to have as many books covering these new achievements as possible. A few good booksalready exist; these are cited in the select bibliography at the end of the book. Havingstudied them I found， however， that there was still room for my humble contribution. Inthe process of writing I have tried to keep things as simple as possible; the amount offormalism is reduced to a minimum. Again， in order to make life easier for the newcomer， Ibegin 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 thecorresponding chapters are intended to refresh the memory. I would recommend those whoare just starting their research in this area to read the first chapters in parallel with someintroductory course in QFT. There are plenty of such courses， including the evergreen bookby Abrikosov， Gorkov and Dzyaloshinsky. I was trained with this book and thoroughlyrecommend it. Why study quantum field theory？ For a condensed matter theorist as， I believe， for otherphysicists， there are several reasons for studying this discipline. The first is that QFT providessome wonderful and powerful tools for our research， The results achieved with these toolsare 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 theprocess of scientific research very pleasant indeed. I do not think that this is an accidentalcoincidence; it is my strong belief that aesthetic criteria are as important in science asempirical ones. Beauty and truth cannot be separated， because beauty is truth realized（Viadimir Solovyev）. The history of science strongly supports this belief： all great physicaltheories are at the same time beautiful.

内容概要

This book is a course in modern quantum field theory as seen through the eyes of a theoristworking in condensed matter physics. It contains a gentle introduction to the subject andcan therefore be used even by graduate students. The introductory parts include a deriva-tion of the path integral representation, Feynman diagrams and elements of the theory ofmetals including a discussion of Landau Fermi liquid theory. In later chapters the discus-sion gradually turns to more advanced methods used in the theory of strongly correlatedsystems. The book contains a thorough exposition of such nonperturbative techniques as1/N-expansion, bosonization （Abelian and non-Abelian）, conformal field theory and theoryof integrable systems. The book is intended for graduate students, postdoctoral associatesand 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 generalwords, 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 thisremains one of the biggest unsolved problems in condensed matter physics. The only part ofit which is well understood concerns a situation where localized electrons are representedby a single local magnetic moment （the Kondo problem）. In this case we know that thelocal moment is screened at low temperatures by conduction electrons and the ground stateis a singlet. The formation of this singlet state is a nonperturbative process which affectselectrons very far from the impurity. The relevant energy scale （the Kondo temperature） isexponentially small in the exchange coupling constant. It still remains unclear how conduc-tion and localized electrons reconcile with each other when the local moments are arrangedregularly （Kondo lattice problem）. Empirically, Kondo lattices resemble metals with verysmall Fermi energies of the order of several degrees. It is widely believed that conductionand localized electrons in Kondo lattices hybridize at low temperatures to create a singlenarrow band （see the discussion in Chapter 21）. However, our understanding of the detailsof this process remains vague. The most interesting problem is how the localized electronscontribute to the volume of the Fermi sea （according to the large-N approximation, they docontribute）. The most dramatic effect of this contribution is expected to occur in systemswith 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 thispoint of view: all compounds with an odd number of conduction electrons per spin areinsulators （Aeppli and Fisk, 1992）. At low temperatures they behave as semiconductorswith very small gaps of the order of several degrees. The marked exception is FeSi wherethe size of the gap is estimated as——,700 K （Schlesinger et al., 1993）.