<<强关联电子系统中的量子场论>>

图书基本信息

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前言

Research on electronic systems in condensed matter physics is at present developing very rapidly, where the main focus is changing from the "single-particle problem" to the "many-particle problem". That is, the main research interest changed from phenomena that can be understood in the single particle picture, as, for example, in band theory, to phenomena that arise owing to the interaction between many electrons.As examples of the latter case, we mention superconductivity and magnetism; in both cases the research has a long history. New developments in these fields are the studies on phenomena that are beyond the scope of mean field theories such as BCS theory and mean field theory of the spin densitywave - and are related to research on so-called electronic correlation. Electronic correlation effects arise owing to strong quantum as well as thermal fluctuations. When fluctuations are large, the interaction between different degrees of freedom becomes important; for example, the interplay between magnetism and superconductivity in high temperature superconductors.The best framework to describe strongly interacting degrees of freedom - which is nothing but the "field" itself- is quantum field theory. In this volume, applications of quantum field theory to the problem of strongly correlated electronic systems are presented in a - hopefully - systematic way in order to be understandable to the beginner. Knowledge of the basic topics discussed in Quantum Field Theory in Condensed Matter Physics, written by the same author, is presumed.

内容概要

Research on electronic systems in condensed matter physics is at present developing very rapidly, where the main focus is changing from the "single-particle problem" to the "many-particle problem". That is, the main research interest changed from phenomena that can be understood in the single particle picture, as, for example, in band theory, to phenomena that arise owing to the interaction between many electrons.

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章节摘录

插图：On the other hand, there exist modes that are only contributed by a limited area of the Fermi surface, being local in k-space (individual excitation). These excitations build up a continuum spectrum, and are not very much influenced by the effect of the interaction. Putting it the other way round, also without interaction, individual excitations; that is, electron-hole pair creations emerges. In the higher-dimensional case, because both modes exist and the ratio of the individual excitations is larger, the excitation spectrum does not change drastically when no interaction is present. This corresponds to the Fermi liquid. However, in the one-dimensional case, the 'Fermi surface' consists only of the two points kF and ——kF, and therefore only the collective excitation modes exist. Therefore, the effect of the correlation is drastically visible. For this reason, the one-dimensional system is a non-Fermi liquid. We conclude that from the point of view where the Fermi surface is considered to be a dynamic variable, the Tomonaga Luttinger liquid and the Fermi liquid can be described using almost the same physical picture.However, in higher dimensions it is not easy to treat the Umklapp scattering by the bosonization scheme. In the Mott insulator, Umklapp scattering certainly occurs, and for this reason, in the vicinity of the Mott insulator state, perhaps a non-Fermi liquid arises. This problem is related to thehigh temperature superconductors, and is at present being intensively investigated.

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