

T_cSUH Bi-Weekly Seminar

Texas Center for Superconductivity at the University of Houston

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Pseudogap State of High-Temperature Superconductors

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Room 102, University of Houston Science Center
12:00 noon– 1:00 p.m.

Abstract

One of the most defining features of high-temperature superconductors is the pseudogap state. It is important not only because high-temperature superconductors are significantly different from conventional superconductors above the superconducting transition temperature (T_c) but also because it is related with the natures of the superconducting transition of cuprate superconductors. In this talk, I briefly review experimental observations of the pseudogap state of high- T_c superconductors. Various experiments seem to indicate that the pseudogap state exists in all high- T_c superconductors regardless of the doping level. This is an important fact for the phase diagram of the cuprates. There are two commonly believed phase diagrams. These phase diagrams lead to quite different theoretical models for the pseudogap state of high- T_c superconductors. In general, the theoretical models can be categorized into two pictures. One is the preformed-pair scenario and the other the competing gap model. I compare the two scenarios based on the basic ideas of the models. Nonetheless, the emphasis in the talk goes to the preformed-pair model because growing experimental evidence appears to favor this picture. The preformed pair model is partially motivated by a two-dimensional nature of copper-oxide planes. Unlike the conventional BCS theory, this model does not assume that the Cooper pair formation and the phase coherence take place at the same time. The pairs form above T_c while the phase is locked in via the Kosterlitz-Thouless (KT) transition at the KT transition temperature. Consequently, this temperature is identified as T_c . Since the KT phenomenon can be described within the classical XY model, I explain it pictorially. Recent experiments on spatial variations of the order parameters visualized in topographic images reveal local structures of the order parameters in the pseudogap state of cuprate superconductors. Within the preformed-pair scenario (also known as phase fluctuation model), we incorporate the phase fluctuations generated by the classical XY model with the Bogoliubov-de Gennes formalism utilizing a field-theoretical method. This picture delineates the inhomogeneous characteristics of local order parameters observed in high- T_c superconductors above T_c . I also present the local density of states near a non-magnetic impurity with a strong scattering potential computed based on the model. The resonance peak smoothly evolves as temperature increases through T_c as observed in a recent experiment. Possible application of the theoretical framework would be discussed.

Bio

Dr. Wonkee Kim is a research associate working at the theory group led by Prof. Ting. He studied optical properties of strontium ruthenate superconductors, pseudogap models of high- T_c superconductors, and local density of states in the vortex state of high- T_c superconductors, in particular, resonance peaks in the pinned vortex cores. Currently, Dr. Kim is working on phase fluctuation effects in the vortex states, vortices in the pseudogap state, and possible enhancement of T_c induced by interlayer coupling between a normal layer and a superconducting layer.

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