UNIVERSITY of HOUSTON

TcSUH

Superconductivity and Related Subjects in Strongly Correlated Electron Systems

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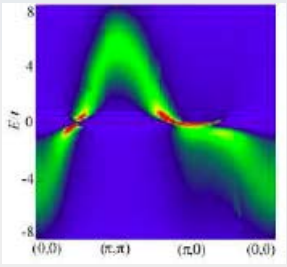
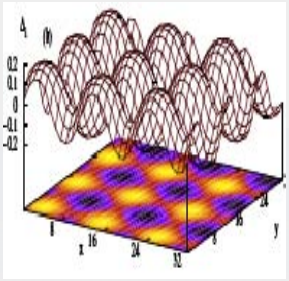
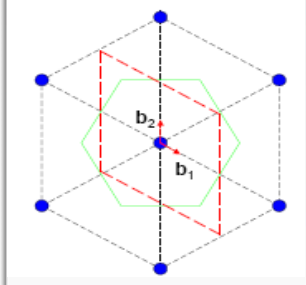


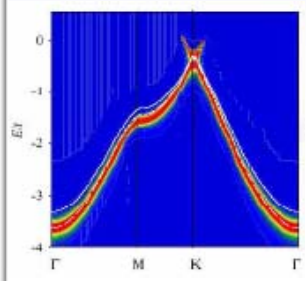
Spectral density for electron doped cuprates



FFLO state in heavy fermion superconductors $CeCoIn_5$



Reciprocal lattice space of graphene



Spectral density of Dirac fermions in graphene

Current Projects/Achievements:

Fluctuation-Exchange Study of Superconductivity in Cuprate Superconductors: The interplay of superconductivity and antiferromagnetism in these compounds will be studied by the Hubbard model, taking into account the spin and pairing fluctuations plus the charge fluctuations due to the long-range Coulomb interactions. We are working to obtain the experimentally observed phase diagram for this system.

Local Tunneling Spectroscopy of Vortex Structure of the FLLO State in Two-Dimensional Heavy Fermion Superconductors: Recently, a d-wave heavy fermion superconductor, $CeCoIn_5$, has shown evidence of realization of FFLO state when a magnetic field is applied parallel to its conducting plane. When the magnetic field has component perpendicular to the conducting plane of the two-dimensional superconductor, vortex-lattice structure of a FFLO state may arise. We will study the local density of states (LDOS) of the vortex and its images.

Probing the Doping Evolution of the LDOS Around a Unitary Impurity in Electron-Doped Cuprate Superconductors: The LDOS will be calculated by both T-matrix Green's function approach and Bogoliubov-de Gennes numerical diagonalization. Impurity-induced states and their change with doping are expected, which will be of great significance to characterize the different SC states at different dopings. The theoretical predictions can be measured by STM.

Electronic States in Superconductors with Rashba Spin-Orbit Couplings: Recently many experiments have revealed that superconductivity exists in a series of noncentrosymmetric materials such as the heavy fermion compound $CePt_3Si$ and the nonmagnetic compounds Li_2Pd_3B and Li_2Pt_3B. Due to Rashba spin-orbit couplings, these materials possess two sub-bands, in which electrons with spin up and down mix together. Therefore, it is a unique opportunity to observe the spin-triplet Cooper pairing in such superconductors without inversion symmetry. However, there is no consensus about the pairing symmetry. In this project, we shall investigate a). the local density of states induced by a unitary impurity in order to determine the order parameter symmetry; b). the supercurrent and its effect on the impurity states; and c). conductance characteristics between a normal metal and a Rashba superconductor.

Study of Transport Property of Electrons in Graphene: We study the transport properties of Dirac fermions using the current-current correlation function in the self-consistent Born approximation due to charged impurities. In addition, the weak localization effect in this system will also be investigated. The theoretical studies should be of great interest to experi-mental investigations.

Spin Polarized Kondo Effect in A Magnetic Quantum Dot: The project is to re-investigate Kondo effect within an equation of motion (EOM) approach at zero temperature and finite temperature when a magnetic quantum dot is imbedded in a spin polarized electron system, and study the I-V curve across the quantum dot using spin polarized current using time ordered Green's function approach.

Personnel

Dr. Yunong Qi, Postdoctoral Fellow; Dr. Degang Zhang, Postdoctoral Fellow; Dr. Wonkee Kim, Research Associate; Dr. Xin-Zhong Yan, Research Associate; Dr. Li Sheng, Research Associate (Part Time)