Instability of three-band Luttinger liquids: renormalization group analysis and possible application to K$_2$Cr$_3$As$_3$

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(3:30~4:00pm, Tea, Coffee, and Cookie)

Venue: Conference Hall 322, Science Building, Tsinghua University

Abstract

Motivated by recently discovered quasi-one-dimensional superconductor K$_2$Cr$_3$As$_3$ with D$_{3h}$ lattice symmetry, we study one-dimensional three-orbital Hubbard models with generic electron repulsive interaction described by intra-orbital repulsion $U$, inter-orbital repulsion $U'$, and Hund’s coupling $J$. As extracted from density functional theory calculation, two of the three atomic orbitals are degenerate and the third one is non-degenerate, and the system is presumed to be at incommensurate filling. With the help of bosonization, we have usual three-band Luttinger liquids in the normal state. Possible charge density wave (CDW), spin density wave (SDW) and superconducting instabilities are analyzed by one-loop renormalization group. The ground state depends on the ratio $J/U$. For the physical relevant parameter region, $0<J/U<1/2$, the ground states are superconducting states. When $0<J/U<1/3$, spin singlet superconducting state is favored. While spin triplet superconductor will be favored when $1/3<J/U<1/2$. The spin density wave state can be achieved only in the unphysical parameter region $J/U>1/2$. 

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