武汉物数所理论交叉学术交流系列报告

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Unconventional p-wave pairing from electric and magnetic dipolar interactions

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频标楼4楼报告厅

About the speaker:

2011- Associate Professor, Department of Physics, UCSD.

2007-2011 Assistant Professor, Department of Physics, UCSD.

2005-2007 Postdoctoral Research Associate, Kavli Institute for Theoretical Physics, UCSB.

RESEARCH AREA: My research focuses on the theoretical study of new states of matter in condensed matter systems, including unconventional magnetism and superconductivity, orbital physics, spin-orbit coupling and spintronics, excitons, quantum phase transitions and criticality, strongly correlated bosonic and fermionic systems with cold atoms, and numerical algorithms for two dimensional quantum systems.

Abstract:

Electric and magnetic dipolar interactions have become an important research effort in ultra-cold atom physics. Both of them give rise to a natural and robust p-wave Cooper pairing in fermionic systems to first order in the interaction strength. In the two-component electric dipolar systems, we found the competition between the p_z-wave spin triplet and the $s+d$-wave spin singlet pairings. If they coexist, a relative phase of $\pi/2$ develops, thus spontaneously breaking time-reversal symmetry. Unlike the classic electric-dipoles, atomic magnetic dipoles are quantum-mechanical matrix operators proportional to the hyperfine-spin of atoms, thus provide even richer opportunities to investigate exotic many-body physics. Unpolarized magnetic dipolar systems are isotropic under simultaneous spin-orbit rotation. This spin-orbit coupled nature gives rise to the orbital p-wave (L = 1) spin triplet (S = 1) pairing with total angular momentum of the Cooper pair J = 1. This pairing is markedly different from both the 3He-B phase in which J = 0 and the 3He-A phase in which J is not conserved. To our knowledge, it has not been studied in condensed matter systems before. The Fermi liquid properties also exhibit spin-orbit coupled nature. We found a topological zero sound-like mode identified as spin-orbit coupled Fermi surface oscillations in which spin distribution on the Fermi surface exhibits a topologically hedgehog configuration.

Ref: 1) Yi Li, Congjun Wu, "The J-triplet Cooper pairing with magnetic dipolar interactions", Scientific Report 2, 392 (2012). 2) Yi Li, Congjun Wu. "Spin-orbit coupled Fermi liquid theory with magnetic dipolar interaction," Phys. Rev. B 85, 205126 (2012). 3) Congjun Wu, J. E. Hirsch "Mixed triplet and singlet pairing in ultracold multicomponent fermion systems with dipolar interactions", Phys. Rev. B 81, 020508 (R) (2010).

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