复旦大学物理系物质科学报告

Physics Department Colloquium

Inelastic neutron scattering and μSR investigations of an anisotropic hybridization gap in the Kondo insulators: CeT_2Al_{10} (T=Fe, Ru and Os)

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Abstract: Recently the Kondo semiconductors CeT_2Al_{10} (T=Fe, Ru and Os) possessing a c-f hybridization gap have received considerable attention because of the unexpected high magnetic ordering temperature of CeRu2Al10 (T_N=27 K) and $CeOs_2Al_{10}$ (T_N=28.5 K) and the Kondo insulating behaviour observed in the valence fluctuating compound $CeFe_2Al_{10}$ with a paramagnetic ground state down to 50 mK. We are investigating this family of compounds using inelastic neutron scattering and muon spin rotation (μSR) techniques to understand the role of anisotropic c-f hybridization on the spin gap formation as well as on their magnetic properties. Our inelastic neutron scattering studies on single crystals of $CeRu_2Al_{10}$ and $CeOs_2Al_{10}$ revealed dispersive spin wave excitations below T_N. Analysis of spin wave reveal the presence of strong anisotropic exchanges, stronger along the c-axis than in the ab-plane. These anisotropic exchanges govern the direction of the magnetic moment compare to that of the single ion crystal field anisotropy. In the polycrystalline sample of $CeFe_2Al_{10}$, we have observed a spin gap (or hybridization gap) of 12 meV at 5 K which transforms into quasi-elastic scattering on heating to 100 K. In order to investigate the anisotropic nature of the hybridization gap in $CeFe_2Al_{10}$, we have carried out single crystal time-of-flight (TOF) inelastic neutron scattering measurements using the MERLIN spectrometer at the ISIS Facility. Our study clearly reveals the opening of an anisotropic hybridization gap in the ab-plane (at [±1 0 L] and [0 ±1 0 L]) with a gap energy of 10 (±1) meV and a maximum energy of 13 (±1) meV at 5 K. Further, at 100 K the inelastic excitations evolve into quasi-elastic excitations, in agreement with the reported study on the polycrystalline sample as well as with the recent single crystal study on $CeFe_2Al_{10}$. It was observed that the gap type excitations have stronger intensity when L is an integer, while weaker intensity when L is a half integer. We will discuss the origin of the anisotropic spin gap in $CeFe_2Al_{10}$ based on a theoretical model of nodal heavy-fermion semiconductors first introduced by Ikeda and Miyake and the magnetic excitations. Further the effect of electron- and hole-doping on the magnetic properties of CeT_2Al_{l0} compounds will be discussed.

Time：2:00 pm, Tuesday, 2014.4.22

Location：Physics Building, Room 221B

(Cookies and coffee are served from 1:30 pm)