Superconductivity and Magnetism of Spinel Superconductor (Cu,Zn)Ir_2S_4

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We have investigated the magnetic ground state of a spinel superconductor $(Cu_{1-x}Zn_x)Ir_2S_4$, with muon spin relaxation (μSR) which provides the highest sensitivity to test the singlet ground state proposals [1,2]. The undoped $x = 0$ composition, which was proposed to have the singlet ground state, a component of muon spin relaxation start to gain the amplitude below $\sim$ 100K, and the relaxation shows a signature of static and dilute spin freezing at $T \sim$ 30K. The ground state is clearly a magnetic one, with the magnetic volume fraction of approximately 1/3 of the entire sample volume (Fig.1a).

After the electron doping by substitution of Zn^{2+} for Cu^{+}, however, the magnetism vanishes at very small doping. The doping as small as $x = 0.002$ is significant to diminish the muon spin relaxation from the magnetic regions. This result suggests that the observed magnetism at $x = 0$ is easily destroyed by the carrier doping of $Cu^{+} \rightarrow Zn^{2+}$ substitution (Fig.1b and c).

The magnetic penetration depth λ of superconductivity which appears above $x > 0.25$ was investigated by muon spin precession measurement. There was an enhancement of muon spin relaxation below T_c, in accordance with the superconductivity, however, the magnitude of the relaxation enhancement was small, suggesting a long penetration depth ($\lambda >$ 300nm).

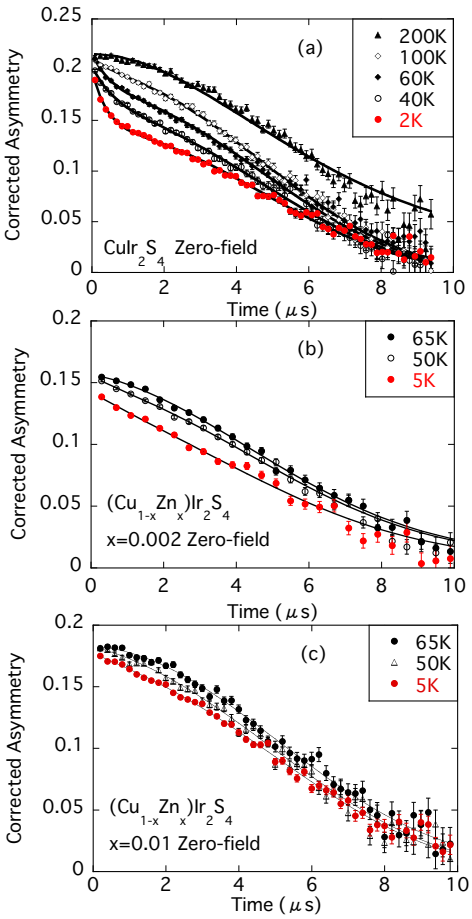

Fig.1 Muon spin relaxation of (Cu,Zn)Ir_2S_4 in zero-magnetic field.

[1] G. Cao *et al.*, Phys. Rev. B 64, 214514 (2001).

[2] P. G. Radaelli *et al.*, Nature 416, 155 (2002).