Experimental report

22/06/2016

Proposal: 4-02-449 **Council:** 4/2015

Title: Probing the spin resonance mode insuperconducting K2Cr3As3 single crystals

Research area: Physics

This proposal is a new proposal

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Samples: K2Cr3As3

Instrument	Requested days	Allocated days	From	To
THALES	0	6	27/07/2015	02/08/2015
IN12	6	0		

Abstract:

K2Cr3As3 is a recently discovered novel quasi-1D superconductor TC ≈ 6.1 K. The unconventional superconducting nature has been revealed by both experimental and theoretical investigations. Previously we have carried out neutron diffraction on K2Cr3As3 powder sample and did not observe any signal of static magnetic order. As theoretical calculations have pointed out that K2Cr3As3 is near an in-out co-planar magnetic order and superconductivity is relevant to strong spin fluctuations, we proposal to carried out inelastic neutron scattering experiment to probe the spin resonance mode in the superconducting state. Such an experiment will determine the low energy spin excitation spectrum and give the key information of the nature of superconductivity.

Experimental report of proposal 4-02-449

Probing the spin resonance mode in superconducting $K_2Cr_3As_3$ single crystals

In this proposal, we proposed to search for the low energy spin fluctuations and probe the spin resonance mode in the recently discovered quasi-one dimensional (Q1D) superconductor, $K_2Cr_3As_3$ (T_c ~6.1 K). For this experiment, we prepared ~ 200 pieces of single crystal with a total mass of 0.11g. The single crystals were co-aligned in the *ac* plane.

The energy scan was performed at the theoretically predicted magnetic wavevector **Q** = (0 0 1) at 1.5 K and 10 K. A clear enhancement of intensity was observed in at ~ 1 meV below T_c which resembles the behavior of a spin resonance mode (Fig 1). However, the detailed temperature dependence shows a kink at 4 K instead of T_c and then we realized that it could cause by the helium recoil. After pumping out the helium exchange gas, the signal disappeared and our conjecture was confirmed.

Then we performed a series of constant energy scans through the theoretically predicted magnetic wavevectors **Q** = (0 0 1) and (1.414 0 0) at E=2.5 meV below and above T_c. However, after a long counting time, no clear spin response was observed and the scattering intensity shows no temperature difference (Fig 2). Our experimental results therefore suggest that the spin fluctuations in $K_2Cr_3As_3$ could be very weak or there are no spin fluctuations in this compound.

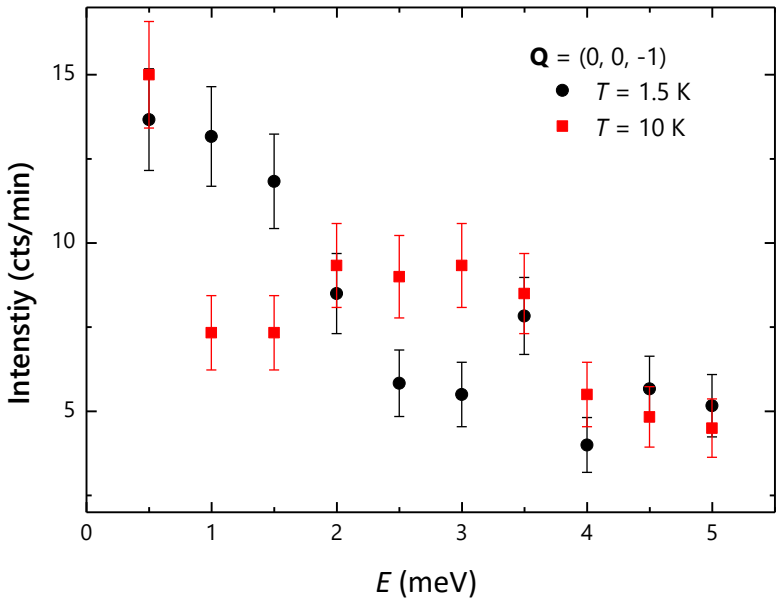

Fig 1. Energy scan at Q = (0, 0, -1) at 1.5 and 10 K before the helium exchange gas was pumped out. The temperature difference was caused by helium recoil.

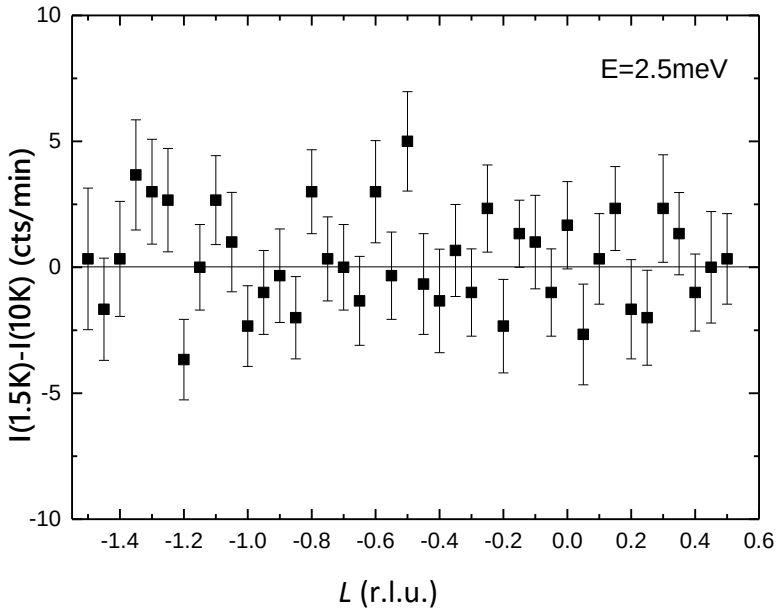

Fig 2. Intensity difference of constant energy scan at **Q** = (0, 0, *L*) between 1.5 and 10 K. No clear temperature difference was observed.