Nesting features and the superconducting mechanism in Ce(Co,Rh)In_5

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In strongly correlated electron systems, many unconventional superconductors, such as high-T_c cuprates, organic superconductors, iron-arsenide, and heavy fermion superconductors, have been discovered. Their superconductivity arises in proximity to a magnetically ordered state, and it expected that magnetic spin fluctuations play an important role in Cooper pairing. While the mechanisms of superconductivity in these systems have been extensively studied, both theoretically and experimentally, no definitive conclusions have been presented in the literature. Further study of the significant connections between magnetism and unconventional superconductivity is needed. $CeCoIn_5$ is a heavy fermion superconductor with T_c=2.3K and quasi two-dimensional electronic structure. It has been reported that this system has d-wave gap symmetry, and the superconductivity is mediated by antiferromagnetic (AFM) fluctuations [1]. Neutron scattering experiments have revealed that overdamped magnetic excitations exist near q = (1/2 1/2 1/2), exhibited by a resonance peak at 0.6meV at temperatures below T_c [2]. In addition, Ce(Rh,Co)In_5 is a mixed crystal system exhibiting an interesting phase diagram, and it is important to check where the q-position of the resonance peak is located as a function of composition through neutron scattering experiments. In this study, we confirm how the resonance peak observed in pure $CeCoIn_5$ shifts in $CeRh_{0.2}Co_{0.8}In_5$. This yields important information about the relationship between magnetism and superconductivity in $CeCoIn_5$.

We prepared a co-aligned mosaic of the single crystals of $CeRh_{0.2}Co_{0.8}In_5$ with a total mass of 0.6339 g and oriented in the (H H L) scattering plane. We performed low Q, low energy measurements to search for a resonance peak around q = (1/2 1/2 L), and an energy transfer of 0.5~0.6 meV. We carried out inelastic neutron scattering measurements at 4G using a 1K refrigerator.

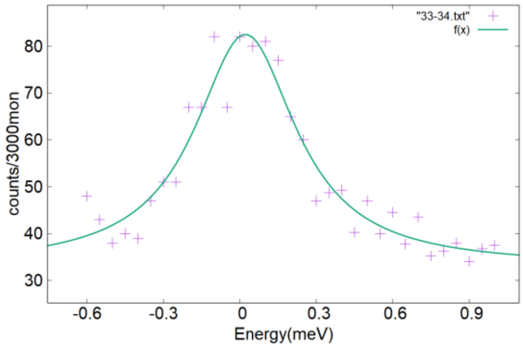

Fig.1.Neutron scattering at (0.5 0.5 0.4). The f(x) is the result of fitting with Laurentian.

$$f(x) = \frac{ad^2}{(x - b^2) + d^2} + c$$

(a=49.512, b=0.022, c=33.02, d=0.242)

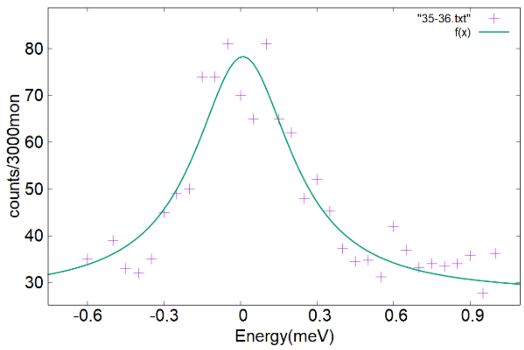

Fig.2.Neutron scattering at (0.5 0.5 0.3). The f(x) is the result of fitting with Laurentian. (a=50.866, b=0.01, c=27.433, d=0.231)

In this measurement, background in the normal state was obtained. Figure 1 and 2 show that there is no signal in the region around E=0.6meV, where the resonance peak is expected to be observed in the superconducting state.

[1] K. Izawa et al., Phys. Rev. Lett. 87, 057002 (2001)
[2] C. Stock et al., Phys. Rev. Lett. 100, 087001 (2008)