Detecting quantum critical fluctuations in the distorted kagome Kondo compound CeRhSn

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Geometrically frustrated spin systems have been studied extensively for decades because of many intriguing phenomena, exemplified by the non-magnetic quantum disordered states. Also studied are non-magnetic ground states originating from Kondo-lattice-effect, such as those observed in Ce- and Yb-based intermetallic heavy-fermion compounds. Recently, a combination of the Kondo-effect and geometrical frustration becomes a new topic, both enhancing quantum fluctuations in different routes. This opens a new playground for the solid state physicists, and hence attracts special attention.

In this work, we study the heavy-fermion compound CeRhSn, which has a distorted kagome-lattice structure, a distorted version of a typical geometrically frustrated lattice. Recently, it has been reported that CeRhSn is indeed quite close to the quantum critical point, where divergence of quantum critical fluctuations were found below 1 K [1]. To elucidate the origin of this quantum critical behavior, we have performed neutron inelastic scattering experiment in this energy range ($E < 0.1$ meV) using the backscattering spectrometer IRIS at ISIS. The experiment was performed using PG 002 reflections as analyzer, resulting in the energy resolution of 19 ueV at the elastic position. The sample was loaded in the dilution refrigerator with which the lowest attainable temperature was approximately 30 mK. To reduce the neutron absorption effect (of mainly Rh), the sample was cut in a thin plate shape.

We have measured the magnetic excitation spectra at the base temperature (˜ 30 mK) and high temperature (500 mK) on several representative loci in the Q-space. Fig. 1 shows the result at the base temperature on the Q-locus passing through Q = (1, 0, 0) and (1, 1, 0) at the elastic position. In addition to the single straight line observed at 0.25 meV, which is apparently the prompt pulse contamination, we see weak excitation intensity at 0.13 meV and Q ˜ (1, 0, 0). This inelastic intensity disappears at 500 mK, suggesting that it is indeed related to the quantum critical fluctuations. However, since the observed inelastic intensity is too weak to conclude its existence, we are planning to perform further experiments in future.

[1] Y. Tokiwa, C. Stingl, M.-S. Kim, T. Takabatake and P. Gegenwart, Sci. Adv. 2015;1 e1500001 (2015).

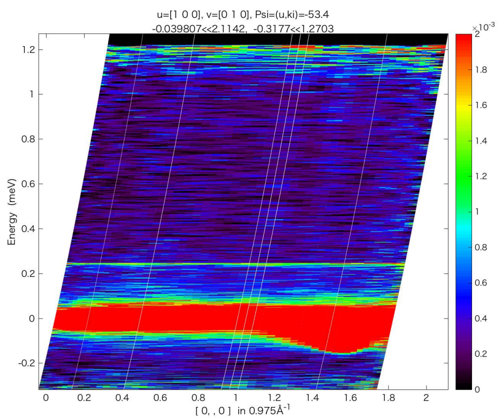

Fig. 1. Inelastic spectrum measured using the backscattering spectrometer IRIS at ISIS. The temperature was ˜ 30 mK. The locus at the elastic position was set to pass through both the Q = (1, 0, 0) and (1, 1, 0) positions.