Magnetic excitations in the normal state of the non-centrosymmetric superconductor $CeRhSi_3$

Aso N.[A], Suzuki S.[B], Yoshizawa H.[B], Hiess A.[C], Steffens P.[D], Kimura N.[E], Iida H.[E], Aoki H.[E]

[A]*Univ. of Ryukyus*, [B]*ISSP-NSL, Univ. Tokyo*, [C]*ESS*, [D]*ILL*, [E]*Tohoku Univ.*

Various types of superconductors have been discovered. Among them, in non-centrosymmetric superconductors in heavy fermion systems, new phenomena due to its lack of inversion center, were reported and extensively examined. $CeRhSi_3$, with a non-centrosymmetric tetragonal $BaNiSn_3$-type crystal structure (with space group *I*4*mm* #107), exhibits not only the heavy-fermion antiferromagnetic (AFM) ordered state below T_N = 1.6 K at ambient pressure but also superconductivity (SC) under pressure. While T_N gradually decreases with pressure, superconducting transition temperature increases. We believe that an investigation of the spin dynamics of this compound helps understanding the novel superconducting properties. The magnetic structure of $CeRhSi_3$ was determined by our previous study. The magnetic moments, with the magnetic moment of μ_{ord} = 0.13 μ_B/Ce, lie in the *c* plane and form a longitudinal spin-density (LSDW) wave with a propagation vector τ = (±0.215 0 1/2), being consistent with a picture that the Ce 4f electrons are itinerant.

To examine the origin of the SC occurance, we studied a detailed *Q*- and *E*-dependent magnetic fluctuations for $CeRhSi_3$, especially the low-energy magnetic excitations in low-temperature antiferromagnetic and paramagnetic phases under ambient pressure. Inelastic neutron scattering experiments have been performed at a cold-neutron triple-axis spectrometer IN14, ILL by using the FlatCone equipment with 31 multi-channel detectors. 8 pieces of single crystals were aligned in the (*h* 0 *l*) scattering plane and cooled down below 100 mK using a dilution refrigerator.

We started with the elastic scattering and successfully confirmed the magnetic Bragg reflections at incommensurate positions. We also found no other magnetic reflections in the plane and very weak streaks along c^* at the nuclear Bragg reflection (0 0 2). The latter implies the inperfect stacking along *c*-axis in the tetragonal crystal structure.

The upper figure shows the scattering intensity map at ΔE = 0.6 meV and T = 80 mK. The white crossings (×) correspond to the incommensurate magnetic wave vector positions where there is some magnetic scattering intensities. Since the color scale is adjusted so as to have a good view in the scattering near $l = 2 \sim 3$, you can recognize weak-intensity streaks along c^* at the incommensurate reflections. The lower figure is the cut plot along the (*h* 0 2.5) line taken at both 80 mK (blue) and 5K (red), where you can clearly find the well-defined magnetic peak structures near $h \sim \pm 0.2$. We first found that the weak magnetic fluctuation has weak c^*-wave vector dependence, strongly indicating the 2-dimensional fluctuation in the *a*-*b* plane for this compound. The lower figure also indicates that there is amount of magnetic fluctuation even at 5K (three times bigger than T_N).

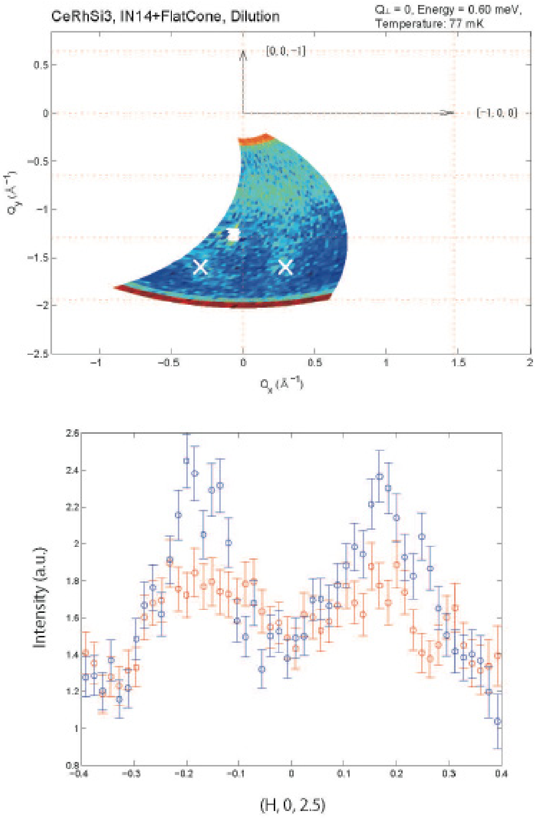

Fig. 1. (upper) Low-energy excitations at ΔE = 0.6 meV for $CeRhSi_3$. (lower) Cut plot along the (h 0 2.5) line. Blue and red symbols are data taken at 80 mK and 5K, respectively.