Two-dimensional magnetic excitations in $CeRhIn_5$

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The interplay between magnetism and superconductivity (SC) is the interesting and important issue on condensed matter physics. Although it has been considered to be exclusive over quantum critical point (QCP), it is now widely accepted that both SC and antiferromagnetism (AFM) coexist in the vicinity of QCP in the systems of the pressure (P)-induced superconductor $CePd_2Si_2$, $CeIn_3$, and $CeRhIn_5$ [1, 2] and so on after a lot of energetic investigations. Since it, however, was very difficult to establish the coexistence of both two phases under P because of the inhomogeneity of the P, there was open to argument if the coexistence is intrinsic. Very recently G.G. Chen et al. [3] reported that high-quality single crystalline $CeRhIn_5$ display the SC at $T_{SC} \sim 90$ mK even under ambient P and its P-temperature (T) phase diagram is drastically renewed. These findings indubitably indicate that the identical f electron plays both roles of SC and AFM. Therefore $CeRhIn_5$ is a very important material for the investigations on the coexistence of SC and AFM. To elucidate the coexistence mechanism of both SC and AFM, it is very useful to perform inelastic neutron scattering which is a very powerful tool to directly observe the dynamical spin susceptibility (DS) of the system. The main goal of our study is to determine the wave vector dependence and its energy scale of the DS in $CeRhIn_5$, and to find out the connection between SC and the DS.

On the other hand, since the Rh and In nuclei are strong neutron absorbers, there has been little information on low-energy magnetic excitations by inelastic neutron scattering studies. In the last year, we succeeded in detecting the low energy magnetic excitations at the AFM ordering wave vector Q = (0.5, 0.5, 2.7) by using a lot of large single crystals of $CeRhIn_5$. [4]

This year we have been continuing to study the DS in $CeRhIn_5$ at the ISSP/HER spectrometer in the research reactor JRR-3/JAEA. Figure 1 shows inelastic neutron scattering spectrum at constant energy of $\hbar\omega$ = 0.8 meV in the (h, h, l)-zone at and T = 1.4 K. One can clearly recognize a strong intensity along the (0.5, 0.5, l) line, indicating that the low-energy magnetic excitation is a two-dimensional nature. We are now continuing to study the overview of the low-energy part of its DS in $CeRhIn_5$.

References

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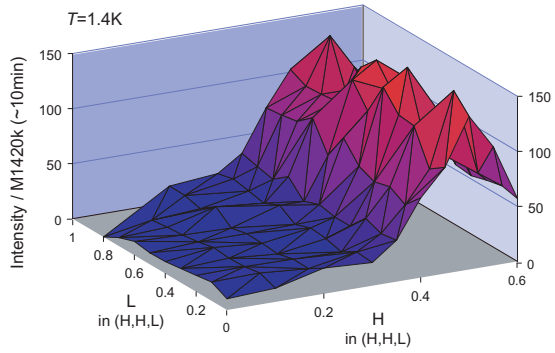

Fig. 1. Inelastic neutron scattering profiles in the (h, h, l)-zone at $\hbar\omega$ = 0.8 meV and T = 1.4 K.