Neutron scattering study on magnetic quasicrystal Zn-Mg-(Y,Gd)

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Quasicrystals are characterized by sharp Bragg reflections with a point symmetry which is forbidden in a periodic lattice, such as the five-fold symmetry. Quasicrystal can include magnetic ions, called as "magnetic quasicrystals". These magnetic quasicrystals provide us an intriguing playground to experimentally investigate the magnetic ordering and dynamics in the quasiperiodic spin systems.

Macroscopically, the magnetic quasicrystals mostly show the spin-glass-type freezing at low temperatures, as seen in the Zn-Mg-RE (RE: rare-earth) quasicrystals. Nevertheless, the spin dynamics, observed by neutron scattering, is very different from canonical spin-glasses, and sometimes exhibits temperature independent $S(Q,\hbar\omega)$ in the neutron scattering spectrum [1].

The temperature independent $S(Q,\hbar\omega)$ is very unusual. One intriguing mechanism of the temperature independence is the proximity to the quantum critical point (QCP) [2]. On the other hand, the temperature independence may be simply due to distribution of the crystalline electric field (CEF) levels. To conclusively judge which is the case for the magnetic quasicrystal, we have performed neutron inelastic scattering experiment in the Zn-Mg-(Y,Gd) quasicrystal, where the half-filld 4f level of the Gd^{3+} ions do not have CEF splitting in principle.

The neutron inelastic scattering study was performed using the ISSP-GPTAS(4G) and ISSP-HER(C11) triple-axis spectrometers installed at the JRR-3 research reactor. A powdered icosahedral sample of the composition $Zn_{60}Mg_{30}Y_{8.5}{}^{160}Gd_{1.5}$ was prepared in the usual manner. It may be noted that to avoid the huge neutron absorption of natural Gd, we used the stable isotope.

Figure 1 shows the resulting inelastic scattering spectra at several temperatures spanning 1.4 K to 50 K, observed using the ISSP-HER spectrometer with the outgoing neutron energy of 2.75 meV. It is clearly seen that the spectrum for the neutron-energy-loss side exhibits almost temperature-independent behavior. This behavior is indeed exactly the same as what has been observed in the Zn-Mg-Ho quasicrystal. Therefore, we can conclude that the origin of the temperature independence is not due to the accidental distribution of the CEF levels. Instead, a closer relation to the QCP mechanism is highly suggested.

[1] T. J. Sato *et al.*, Philos. Mag 87 (2007) 2939.

[2] M. C. Aronson *et al.*, Phys. Rev. Lett. 75 (1995) 725.

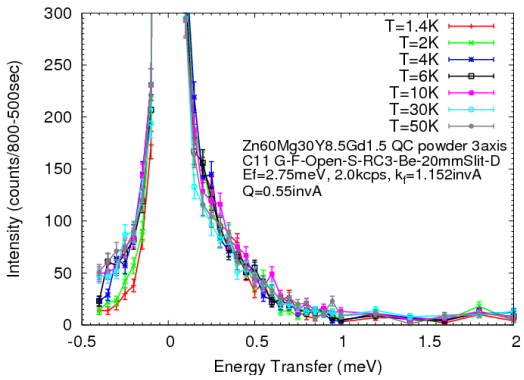

Fig. 1. Inelastic scattering spectrum of Zn-Mg-(Y,Gd)