Interaction between slow dynamics of nuclear and magnetic domains in relaxor magnet LuFeCoO4

M. Soda and T. Masuda
Neutron Science Laboratory, Institute for Solid State Physics, University of Tokyo, Tokai, Ibaraki 319-1106, Japan

Relaxor ferroelectrics characterized by a huge and broad peak in the dielectric permittivity has attracted considerable interest in the field of basic and applied physics One of the most important concept of relaxor system is " Polar Nanoregions " (PNRs), where ordered polarizations in nanoscale domains are randomly oriented. Previously we studied one of the relaxor ferroelectrics having the magnetic ions (relaxor magnet) LuFeCoO4 in order to clarify the relationships between relaxor property and magnetism. LuFeCoO4 having the triangular lattice is isostructural to LuFe2O4, where Co2+ ions are randomly substituted for Fe ions. This system has a relaxor behavior in the dielectric properties and has the magnetism induced by Fe3+ and Co2+ ions. Thus, this system is the relaxor magnet.[1,2] In our elastic neutron study of LuFeCoO4, the strong coupling between the nuclear and magnetic correlations has been found. The simultaneous change in the nuclear and magnetic diffuse intensities was observed at T~190 K. Furthermore, the magnetic correlation length along (1,1,0) direction at 190 K coincides the size of the PNRs estimated from nuclear diffuse scattering in the c-plane. From these neutron results, we proposed "multiferroic nano region" (MNR) model[2]; At 190 K the correlation of both magnetic moments and electric polarizations are developed inside the MNRs. In the temperature region 70 K $< T <$ 190 K, furthermore, the superparamagnetic behaviour in the magnetization is observed.

In order to study the coupling between the slow dynamics of the dielectric and magnetic properties, we have measured the nuclear and magnetic quasi-elastic neutron scatterings in relaxor magnet LuFeCoO4 by using high resolution spectrometer Osiris installed at ISIS in RAL.

Figure 1 shows the neutron scattering spectra measured at the Q=(1/3,1/3,L) against the transfer neutron energy. The magnetic quasi-elastic neutron scattering was observed at 90 K and 170 K. With decreasing the temperature, furthermore, magnetic quasi-elastic neutron scattering disappears. The temperature dependence of the magnetic quasi-elastic neutron scattering is consistent with the temperature region where the superparamagnetic behaviour in the magnetization is observed.

References

[1] M. Soda et al., J. Phys. Soc. Jpn. 80 043705 (2011).
[2] M. Soda et al., J. Phys. Soc. Jpn. 85 034713 (2016).

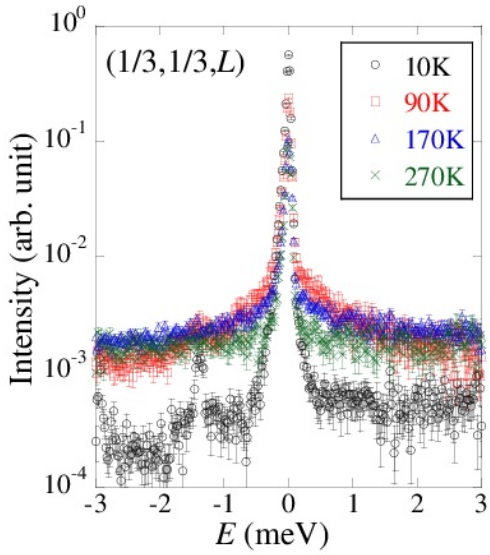

Fig. 1. Magnetic quasi-elastic neutron scattering measured at several temperature points.