Anisotropic magnetic correlations and a magnetic field annealing effect in a helical magnet ErNi2Ge2

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A rare earth intermetallic compound ErNi2Ge2 with a tetragonal ThCr2Si2-type structure is a proper-helical magnet with TN =3.0K and magnetic wave vector km=(0,0,0.75). From the recent neutron scattering experiments by using single crystalline samples, we found that an anomalous anisotropic magnetic diffuse scattering coexists with the magnetic Bragg scattering in the magnetic ordered phase [1]. Anomalously, a strong widespread diffuse-scattering is found along the [100]- and the [110]-directions, whereas, no diffuse scattering is found along the [001]-direction. The results indicates that the long-range and the short-range orders coexist in the antiferromagnetic region and the short-range order consists of 1-dimensional long-range helices along the c-axis. A helix has a degree of freedom of its phase, being the same as a XY-spin, and the correlations between helices in ErNi2Ge2 is ferromagnetic. Consequently, we speculate that ErNi2Ge2 is a mimic system of the ferromagnetic XY spin system and the coexistence of the short-range and the long-range orders is an emergence of the Kosterlitz-Thouless (KT) like phase.

In 2009, we performed a neutron scattering experiment under magnetic field on the triple-axis spectrometer T11 installed at JRR-3M reactor to investigate magnetic field effects to the anisotropic short-range order in ErNi2Ge2. The magnetic field is applied along the [110]-direction, being the magnetic easy axis. The magnetic Bragg scattering disappears at Hc = 0.6 T, being consistent with the result of macroscopic magnetization measurements, however, the diffuse scattering remains up to 1.2 T. Surprisingly, when decreasing magnetic field from the field above Hc, the magnetic Bragg scattering appears no longer and only the diffuse scattering was observed down to zero field. And also, in the H-decreasing process, the correlation length shows divergent behavior as shown in Fig. 1. The magnetic state after the "magnetic field annealing" is more similar to the KT phase and the coexistent-state of the short-range and the long-range orders in zero-field-cooling may be a failure of the KT phase.

[1] Y. Tabata et al., J. Phys. Conf. Series 145, 012078 (2009).

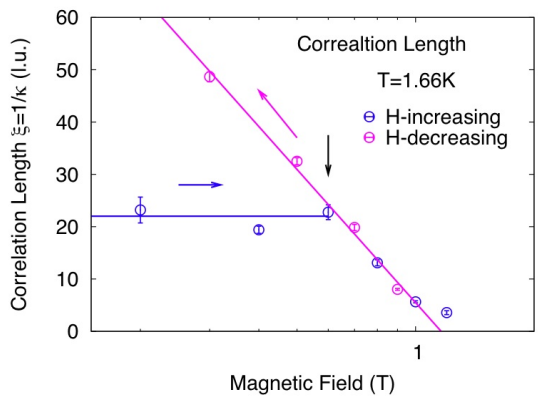

Fig. 1. Field-dependence of the correlation length of the short-range order.