Magnetism and Superconductivity in RENi$_2$B$_2$C

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RENi$_2$B$_2$C (RE is a rare earth or Y) exhibits various physical properties such as superconductivity (SC) or magnetic order, by substitution of the rare earth site. In particular, one of them, ErNi$_2$B$_2$C, is known to show the microscopic coexistence of the SC and weak ferromagnetism (WFM). Another system, TbNi$_2$B$_2$C, does not show the SC, while it has a quite similar crystal structure and magnetic property to ErNi$_2$B$_2$C. We have studied the magnetism of this system to understand the coexistence of the SC and WFM by comparison. The system shows a spin density wave (SDW) phase below $T_N = 15$ K and the coexistence of this phase and a weak ferromagnetic phase below $T_{WFM} = 8$ K in the absence of the external magnetic field. We have found that many magnetic ordered phases appear in the external field from the magnetization measurement. In the present study, we investigate the magnetic structures for these phases by the neutron scattering measurement, to complete the phase diagram of this system in the magnetic field.

The experiment was carried out at the 4G spectrometer (GPTAS). A set of a ^{4}He cryostat and a transverse field magnet was used. The single crystal sample of TbNi$_2$B$_2$C was cooled down to 1.6 K. The magnetic field was applied parallel to the a-axis, which corresponds to the easy-axis of the system. ($h0l$) was selected as the scattering plane. Representative fields where each phase appears, $H = 0.9$ T, 1.5 T, 2.1 T and 2.8 T were chosen.

The neutron magnetic scattering profiles in the (h01) direction in various magnetic fields at 1.6 K are shown in Fig. 1. The magnetic Bragg peaks corresponding to the SDW phase are observed at q (=11/20a^*), 3q, 5q and 7q. Their positions are not shifted, as the field increases. On the other hand, the magnetization increases step-by-step, suggesting changes in the spin configuration. This fact implies that the spin is flipped as the magnetic field increases, without changing the modulation of the magnetic structure. It is expected that nesting of a Fermi surface is not so sensitive to the magnetic field.

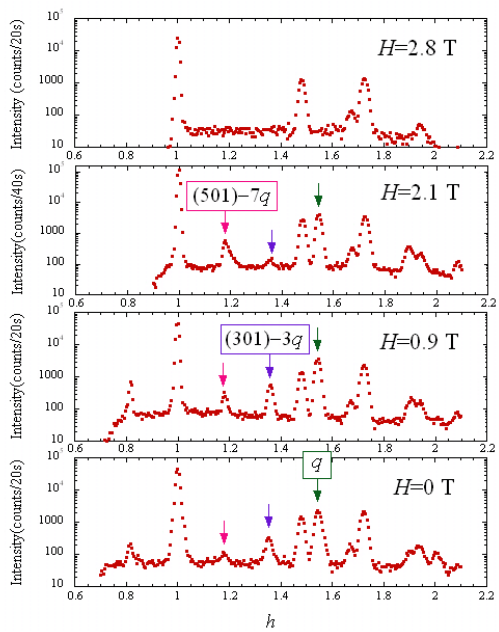

Fig. 1. Neutron magnetic scattering profiles in the (h01) direction in the magnetic fields of 0 T, 0.9 T, 2.1 T and 2.8 T at 1.6 K.