Process of a thermally induced martensitic transformation of a Heusler-type off-stoichiometric Ni$_2$MnGa single crystal was investigated. A triple-axis neutron spectrometer, AKANE, was used. The composition of the alloy was Ni$_{2.16}$Mn$_{0.78}$Ga$_{1.06}$, having a martensitic transformation temperature around room temperature (293 K) coincident with a Curie temperature. It is ferromagnetic in the martensitic phase and paramagnetic in the mother phase and is expected as a magnetic field-induced shape memory alloy. Change of a cubic (020) peak on (hk0) reciprocal-plane (h=-0.36 - 0.36, k=1.76 - 2.36), where the cubic structure is in the mother phase, was observed with decreasing temperature from 293 K to 100 K. The result was compared with magnetic field dependence of the pattern measured by TAS-2, where the field was changed up to 10 T at 293 K. The diffraction patterns projected on (hk0)-plane at typical temperatures, 279 K and 100 K, under no magnetic field and the pattern under 10 T at 293 K are shown in Fig. 1. At 279 K peaks belonging to orthorhombic structure in the martensitic phase$^1$), are seen. Two peaks near k=2.1 due to orthorhombic (002), a peak at k=2.0 due to orthorhombic (020) and two peaks near k=1.9 due to orthorhombic (200) are observed. Other four peaks on the corner of the (hk0)-plane, the intensity of which are very weak, indicate that there are some long period in the orthorhombic structure. The origin of this long period is not yet analyzed. Peaks near (0 2.3 0) and (0 1.72 0) were found to be the foot of (0 2.3 0.3) and (0 1.72 0.26). At 100K the structure changed to a tetragonal structure in the martensitic phase$^1$). Peaks near k=2.12 belong to tetragonal (200) and the peaks near k=1.78 belong to tetragonal (002). Under the magnetic field of 10 T at 293 K, the observed orthorhombic structure was quite similar to that at 279 K under no field. It is suggested that temperature decrease of 14 K in this alloy causes the same effect of magnetic field of 10 T. The magnetic field as high as 10 T is not enough to cause the tetragonal structure, which is the equilibrium martensitic structure at low temperature. However, these experimental results show that magnetic field-induced shape memory effect becomes promising, because we already know that the addition of small amount of boron to the alloy or making a foil of the alloy improve the brittleness of the material and make the transformation easier.

Fig. 1. Temperature dependence and magnetic field dependence of cubic (020) peak on (hk0) reciprocal plane.