Powder diffraction study on the ternary compound $Ce_5Ni_2Si_3$

T. J. Sato, K. Iida, H. Kitazawa[1], and Y. S. Kwon[2]
ISSP-NSL, University of Tokyo, Tokai, Ibaraki 319-1106, Japan
[1] *NIMS, Tukuba, Ibaraki 305-0047, Japan*
[2] *Department of Physics, Sung Kyun Kwan University, Suwon 440-476, Korea*

Effect of geometrical frustration in the localized spin systems has been intensively studied to date. A number of novel low-temperature phenomena have been reported there, exemplified by the spin freezing, spin liquid and spin ice, to note a few. Geometrical frustration may also bring about non-trivial magnetic ordering in the metallic system at low temperatures. In particular, competition/interplay between the strong electron correlations and geometrical frustration is an intriguing issue to study.

The ternary compound $Ce_5Ni_2Si_3$ crystallizes in the hexagonal Ce_2NiSi-type structure with the space group $P6_3/m$. The Ce Atoms are at the corners of trigonal prisms, forming a locally triangular lattice net [1]. The linear Sommerfeld coefficient γ is about 300 mJ/Ce mol K^2, which is a sign of heavy fermion formation in this compound. An antiferromagnetic order was observed at $T_N = 7.3$ K, whereas the Weiss temperature $\theta = -61.3$ K, resulting in the frustration index $f \sim 8$. Although macroscopic magnetic properties have been reported to a large extent, spin structure in the ordered phase has not been determined yet.

In this study, we performed the powder neutron diffraction experiments to determine the crystal as well as the spin structure at low temperatures in $Ce_5Ni_2Si_3$. The experiments have been performed at IMR-HERMES powder diffractometer. A powdered sample (about 4 grams) was loaded in the vanadium cell with the diameter of 7 mm, and then attached to the closed cycle refrigerator. The powder diffractgrams were recorded at 2 K, 15 K, and 300 K.

Figure 1 shows the resulting powder diffraction patterns at the low temperatures 2 K and 15 K. The overall diffraction patterns are mostly the same for two temperatures, inferring absence of the structural transition. At the lowest temperature 2 K, however, there appear several weak Bragg peaks [see arrows in Fig. 1(b)]; since this temperature is well below T_N, they are most likely the magnetic Bragg peaks associated to the macroscopically observed antiferromagnetic ordering. Magnetic as well as crystallographic structure analysis is now in progress using homemade Rietveld analysis code with the group theoretical representation analysis for the magnetic structure determination [2].

References:
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[2] I. Nakanowatari *et al.*, Phys. Rev. B **76** (2007) 184427.

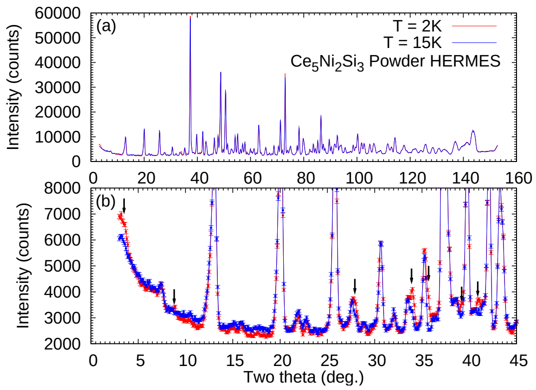

Fig. 1. Neutron powder diffraction patterns at $T = 2$ K (red) and 15 K (blue) measured at IMR-HERMES.