Present Status of Tohoku University Triple-Axis Spectrometer TOPAN (6G)

Kazuaki Iwasa
Department of Physics, Tohoku University

Up to the beginning of FY2006, the control system of TOPAN has been replaced to the LabVIEW PXI environment common for the spectrometers owned by ISSP. The stepping motors and the encoders were also renewed, and the automatic diaphragms and attenuators were installed. These upgrades were based on the financial supports of Grant-in-Aid for Scientific Research from MEXT and of Yamada Science Foundation.

Hereafter, some research subjects using the IRT beam time will be reviewed.

(1) Search for electronic ordering under high pressure: Phase transitions of electron orbital or multipolar degrees of freedom have been topics in condensed matter physics. Collaborators of Tohoku University have studied the ordering of vanadium 3*d* electron orbital in RVO_3 under high pressure (D. Bizen *et al.*: J. Magn. Magn. Mater. in press (Proceedings of ICM)). In addition, collaborators of Tokyo Metropolitan University have been interested in the drastic change of transport properties in filled skutterudite $PrFe_4P_{12}$ under high pressure, which is expected to correlate with switch of the order parameter of Pr-ion 4*f* electrons (D. Kawana *et al.*: J. Phys. Soc. Jpn. 75 (2006) 113602). In order to understand the ordering mechanisms under high pressures in these systems, we established collaborations with JAEA group that has recently developed a compact anvil-type high-pressure apparatus (T. Osakabe *et al.*: J. Magn. Magn. Mater. in press (Proceedings of ICM)). We have succeeded in detecting magnetic ordering in $TbVO_3$ up to 4.3 GPa and $PrFe_4P_{12}$ up to 3.9 GPa. We obtained the stable experimental condition with this high pressure cell and the cryomagnet of ISSP producing magnetic field up to 5.8 T.

(2) Detection of the magnetic polarization of Ce ions due to octupolar ordering in $Ce_{0.7}La_{0.3}B_6$: Higher rank multipolar ordering has been recently observed in several *f*-electron systems. One of the most attractive systems is CeB_6 and La substituted ones. CeB_6 has been well known for the antiferro-quadrupolar ordering owing to the quartet crystal-field ground state of Ce^{3+} $J = 5/2$ multiplet. On the other hand, $Ce_{0.7}La_{0.3}B_6$ shows a so-called phase IV below 1.5 K, in which antiferro-type octupolar ordering was suggested from the resonant x-ray scattering result (D. Mannix *et al.*: Phys. Rev. Lett. 95 (2005) 117206, H. Kusunose and Y. Kuramoto: J. Phys. Soc. Jpn. 74 (2005) 3139). Such ordering is accompanied by the magnetic polarization within the Ce ion without net magnetic dipole moment, and the diffraction peaks are expected to appear in the large scattering vectors. The experiment for $Ce_{0.7}La_{0.3}B_6$ based on the collaboration with Tokyo Metropolitan University and ISSP was carried out, and we succeeded in detecting antiferromagnetic reflections whose intensities become larger in the higher scattering angles. This result is consistent with the octupolar ordering scenario.

(3) Application of PSD to polarized neutron experiments: We have examined the installation of position sensitive detectors (PSD) in TOPAN for observing reflections in the wide scattering-angle. Although the background level is high when it is used with the cryomagnet, we found that it can be applicable in polarized neutron spin-flipping measurement at Bragg reflection points. Now we are trying to install neutron polarization option together with PSD in the LabVIEW system, to accomplish the search for electron ordering phenomena in the near future.

The description of TOPAN is seen in the

web site: http://sheat.phys.tohoku.ac.jp/~iwasa/TOPAN/index-j.html. The operation of TOPAN is based on the IRT of Tohoku University shown in the web site.