Inelastic neutron scattering of YbPd using defocused beam

S. Tsutsui[A], C. H. Lee[B], K. Nawa[C], A. Mitsuda[D], H. Wada[D]

[A]*JASRI*, [B]*AIST*, [C]*Tohoku Univ.*, [D]*Kyushu Univ.*

Inelastic neutron scattering (INS) and inelastic X-ray scattering are complementary techniques to investigate dynamical structure factor related to phonon dispersion relations in materials. On the other hand, the scattering cross sections related to the phonon dispersion relations are different between INS and IXS, because neutrons (X-rays) are scattered by nuclei (electrons). Therefore, cooperation use of neutrons and X-rays is useful to understand whether phonon and magnetic excitations coexist or are coupled. In particular, cooperation use of INS and IXS is helpful to distinguish electronic excitations from phonon excitations when electronic and phonon excitations may couple among them.

YbPd contains various degrees of freedom such as valence fluctuation, magnetic ordering, structural instabilities and so forth, in spite of its simple structure of a CsCl-type one [1]. Recent researches clarified that the successive phase transitions at 120 and 105 K are caused by structural transitions [2, 3]: the phase transition at 120 (105) K is an incommensurate (a commensurate) structural transition. In addition, recent IXS study of YbPd clarified that temperature dependence of the softened phonon modes related to the phase transition at 120 K differs from that of the softened mode related to the phase transition at 105 K [4]: the former (latter) softening occurs at the longitudinal X point of $\boldsymbol{q}$ = (0.5, 0.0, 0.0) (around (0.5, 0.1, 0.1)). Furthermore, a theoretical prediction suggested that the softened mode related to the phase transition at 120 K correlated with a valence-lattice interaction [5]. To reveal the nature of the softened phonon modes related to the successive phase transitions, INS is a helpful tool.

We have performed INS of YbPd at 4G (GPTAS) of JRR-3 in 2021 with the focused neutron beam. However, uncertainty of the momentum transfer makes it difficult to discuss the phonon dispersion relations in YbPd because the phonon dispersion relations around the longitudinal X point are complicated. Then, we have performed INS of YbPd with defocused neutron beam in this experiment to improve the resolution of the momentum transfer.

Figure 1 demonstrates that the INS spectra of YbPd at (1.5 -0.1 -0.1) and (1.5 0.0 0.0) exhibit different temperature dependence. Detailed analyses of these spectra and comparison of these spectra with the IXS spectra are in progress.

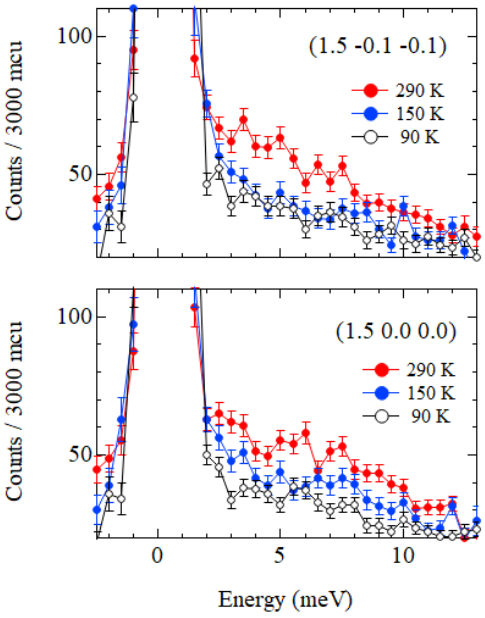

Fig. 1. Inelastic neutron scattering spectra at $\boldsymbol{q}$ = (1.5 -0.1 -0.1) and (1.5 0.0 0.0) at various temperatures.

[1] R. Pott *et al.*, Phys. Rev. Lett. **54**, 481 (1985).
[2] A. Mitsuda *et al.*, J. Phys. Soc. Jpn. **82**, 084712 (2013).
[3] R. Takahashi *et al.*, Phys. Rev. B **88**, 054109 (2013).
[4] S. Tsutsui *et al.*, Phys. Rev. B **102**, 245150 (2020).
[5] T. Hasegawa *et al.*, J. Phys.: Conf. Proc. **592**, 012061 (2015).