Elucidation of the origin of the quasi-elastic scattering in a valence-fluctuating rare-earth compound

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YbPd has a simple structure, a CsCl-type structure, but undergoes successive transitions driven by various degrees of freedom [1]. The phase transitions observed at 120 and 105 K are structural transitions: the transition at 120 (105) K is an incommensurate (commensurate) structural transition [2, 3]. The phase transition observed at 1.9 and 0.5 K are magnetic [4]. In addition, the Yb valence state are fluctuating between divalent and trivalent states [1]. Furthermore, the resonant X-ray diffraction experiment [3] also suggested that the structural transitions is accompanied by Yb valence degrees of freedom.

Phonon dispersion relations in YbPd were already revealed by inelastic X-ray scattering (IXS) [5]. The lowest phonon branch is softened at $\boldsymbol{q}$ = (0.5, 0.0, 0.0) and $\boldsymbol{q}$ = (0.5, 0.1, 0.1) just above 120 K. These behaviors support the structural transitions at 120 and 105 K, respectively. In addition, broadened of the phonon excitations at $\boldsymbol{q}$ = (0.5, 0.0, 0.0) is also observed at 300 K and exhibits temperature dependence like that of quasi-elastic scattering contribution. A theory proposes that this broadening is originated from a valence-lattice interaction [6].

Nowadays, two experimental techniques, inelastic neutron scattering (INS) and IXS, are available for investigating dynamical structure factor related to phonon excitations. These techniques are complemental but contain different scattering cross sections to detect phonon excitation signals. To reveal the nature of softened and broadened phonon excitations, therefore, we performed inelastic neutron scattering in YbPd.

Figure 1 shows temperature dependence of INS spectra at (3.5, 0.0, 0.0) in low energy region to observe phonon contribution more clearly than the previous experiment [7]. Detailed analyses are in progress to compare the reported results of IXS [5].

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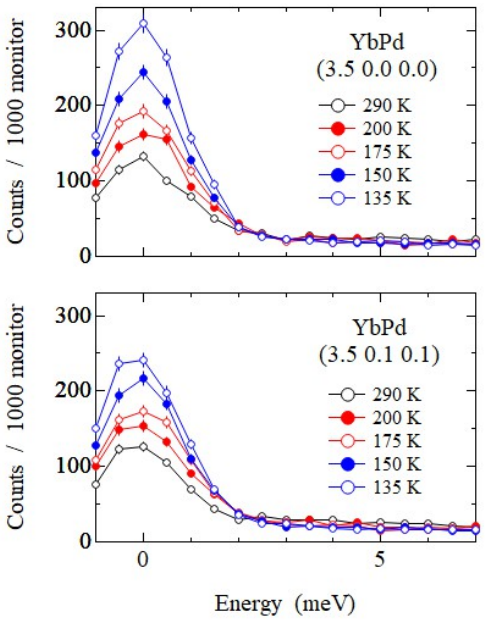

Fig. 1. Inelastic neutron scattering spectra at (3.5, 0.0, 0.0) and (3.5, 0.1, 0.1) and their temperature dependence.