Magnetic structure at lowest temperatures of exotic valence-ordered YbPd

A. Mitsuda[A], R. Nakashima[A], K. Tasaka[A], K. Ohoyama[B], K. Kinjo[C], K. Nawa[C], T. J. Sato[C]

[A]Kyushu Univ. , [B]Ibaraki Univ., [C]Tohoku Univ.

To approach the mechanism of the valence order and the accompanying exotic phenomena in YbPd from the viewpoint of magnetic structure, we have carried out neutron diffraction. Recently, we have clarified an incommensurate sinusoidal magnetic structure with $\boldsymbol{k}_1$ = (0.080 0 0.32) and the amplitude of the magnetic moments of 0.3μ_B aligned along the a-axis at T = 0.59 K (< T_3 = 1.9 K) by time-of-flight powder neutron diffraction at BL-20 of J-PARC. It was also manifested that only Yb^{3+} ions have a magnetic moment and $Yb^{2.6+}$ ions no moment. Besides, the magnetic moment of 0.3μ_B is smaller than that expected for a localized Yb^{3+} ion, which strongly suggests the Kondo effect of Yb^{3+} site [1]. Our next aim is to investigate the ground-state magnetic structure at $T < T_4$ (= 0.5 K), where suppression of thermal fluctuation of Yb^{3+} moments is anticipated to produce a commensurate magnetic structure. The simpler magnetic phase makes it easier to discuss correlation between the valence order and the magnetic order. In the present study, we have carried out neutron diffraction of a single crystal in the temperature ranges from 0.3 K to 2.7 K within the 2-dimensional reciprocal lattice spaces with axes of $\boldsymbol{a}^*$-$\boldsymbol{b}^*$, $\boldsymbol{b}^*$-$\boldsymbol{c}^*$and $\boldsymbol{a}^*$-$\boldsymbol{c}^*$ using 4G beamline and a ^{3}He refrigerator at JRR-3. In addition to the magnetic Bragg peak of $\boldsymbol{k}_1$, we have discovered a commensurate magnetic Bragg peak of $\boldsymbol{k}_2$ = (-2/3 0 0) at T = 0.3K. The $\boldsymbol{k}_2$ peak decreases in intensity gradually with temperature but survives at $T > T_4$ and disappears at T_3, as shown in Fig. 1(a). On the other hand, T- dependence of the intensity of $\boldsymbol{k}_1$ peak has a minimum at around T_4, as shown in Fig. 1(b), which is a sign of the magnetic phase transition. However, we could not find $\boldsymbol{k}$-vector appearing only below T_4. The coexistence of incommensurate $\boldsymbol{k}_1$ and commensurate $\boldsymbol{k}_2$ vectors is mysterious. Since the phase transition at T_4 is of first order, an influence of the higher-temperature incommensurate phase might survive even at $T < T_4$ due to a thermal hysteresis. It is necessary to perform neutron diffraction at sufficiently lower temperatures than T_4 by a dilution refrigerator.

[1] K. Oyama *et al*., J. Phys. Soc. Jpn. **87**, 114705 (2018).

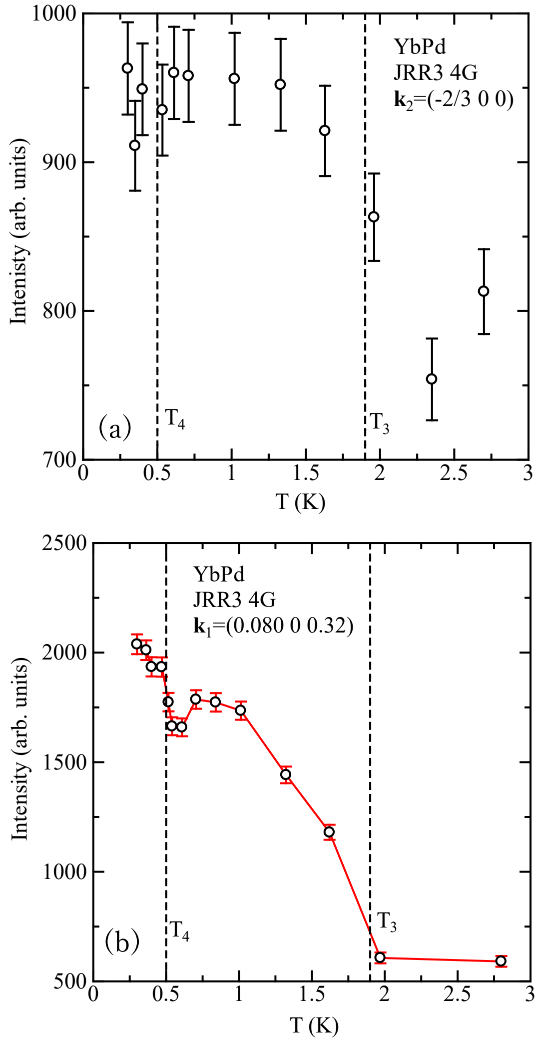

Fig. 1 Temperature dependence of the intensity of magnetic Bragg peaks of (a) $\boldsymbol{k}_2$=(-2/3 0 0) and (b) $\boldsymbol{k}_1$=(0.080 0 0.32).