The neutron determination of the order parameters in $YbCu_4Au$

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Recently, exotic quantum phases induced by multiple criticality has been attracted. For instance, in U-based compounds, a tri-critical point known as a "wing structure" has been reported in the phase diagram. In this phase diagram, superconductivity coexists with ferromagnetic fluctuations, and the symmetry of the Cooper pairs is spin triplet. However, due to the scarcity of candidate materials for quantum criticality with multiple critical points, material exploration is still ongoing.

$YbCu_4Au$ shows field-induced quantum criticality. Recently, we successfully synthesized a single crystal. From heat capacity and muon spin relaxation (μSR) measurements, we observed double magnetic transitions below 1 T, and a multiple critical point at 1 T. No hysteresis was observed in either phase transition. However, in thermodynamics, it is not allowed for two second-order transition lines to coincide. To resolve this issue, we observed the magnetic reflection signal through neutron diffraction experiments.

The sample was synthesized by the method described in reference [5]. The obtained single crystals were crushed to obtain total of 2 g. The powder was sealed in a vanadium cell with helium gas. The experiments were performed at the T1-2 AKANE beamline using a ^{3}He refrigerator and cooled down to 0.4 K.

Figure 1 shows the powder neutron and X-ray diffraction patterns at room temperature. We determine the assigns of all the signals.

Figure 2 shows the temperature dependence of the intensity of the (422) signal. The transition temperatures were determined to be 0.66 and 0.48 K by heat capacity measurements [5]. The intensity of the (422) signal changes discontinuously at 0.5 K, suggesting that the intermediate and low-temperature phases undergo a first-order transition. Therefore, the temperature-magnetic field phase diagram of $YbCu_4Au$ is consistent with thermodynamic.

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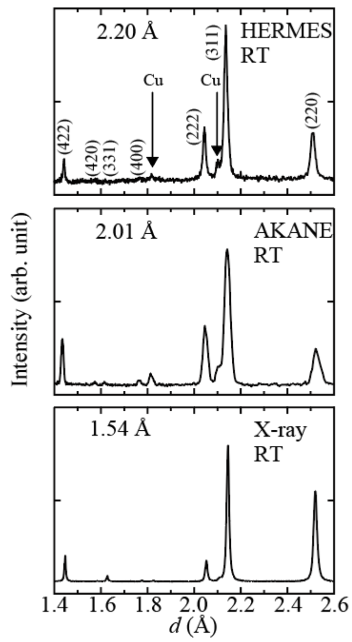
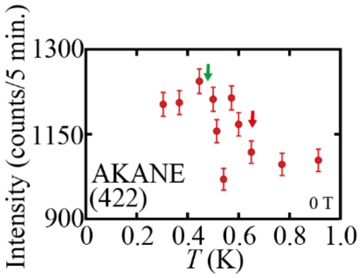


Fig. 1. Powder neutron and X-ray diffraction patterns of $YbCu_4Au$ by HERMES, AKANE, and MiniFrex [5].



Fig, 2. Temperature dependence of intensity of (422) in $YbCu_4Au$ [5].