Quantum Criticality and Crystal Structure of $YbCu_4Ni$

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The quantum criticality due to spin fluctuations is one of the most extensively studied topics in solid-state physics. In particular, the relationship between electronic states and spin fluctuations near the quantum critical point has been widely discussed. Many reported cases of *f*-electron intermetallic compounds have demonstrated that spin fluctuations can lead to attractive interactions between electrons near the quantum critical point, resulting in anisotropic superconductivity.

However, it is quite surprising that recent μSR measurements revealed that the high-quality YbCu4Ni, exhibiting three-fold rotational symmetry and successfully synthesized by the applicant in 2021, actually exhibits a quantum criticality. Additionally, dynamical mean-field calculations have indicated that the ground state might be a spin-liquid state when significant spin fluctuations arising from geometrical frustration and the Kondo effect coexist [1]. Furthermore, it has been suggested that the spin glass state can be realized by altering the electronic state with parameters such as pressure.

The objective of this study is to determine the crystal structure of YbCu4Ni, which exhibits quantum criticality, using HERMES. Moreover, the study aims to explore any anomalous physical properties, such as large electronic specific heat coefficients, which can also be influenced by the Kondo disorder effect, where the Kondo temperature T_k is widely distributed due to disordered crystal structures and other factors. UCu_4Pd is an example of a material that has been successfully identified as having anomalous properties due to Kondo disorder [2]. This disorder may be responsible for the large electronic specific heat coefficient observed. Specifically, given that Cu and Ni have adjacent atomic numbers, it is expected that $YbCu_4Ni$ may exhibit site mixing. On the other hand, $YbCu_5$, located near the quantum critical point, has a large electronic specific heat coefficient $\gamma_e \sim 0.55$ J/mol K^2[3]. Therefore, there are two potential explanations for the reported giant electronic specific heat coefficient $\gamma_e \sim 7.5$ J/mol K^2[4] in $YbCu_4Ni$: Kondo disorder and quantum criticality. To distinguish between these two possibilities, we determined the crystal structure through powder neutron diffraction experiments and will investigate the local magnetism through additional μSR experiments.

The HERMES powder neutron diffraction profiles indicate a site mixing model of Cu and Ni, as shown in the figure. Thus, we cannot exclude the possibility of Kondo disorder. Further μSR experiments will help to differentiate between Kondo disorder and quantum criticality.

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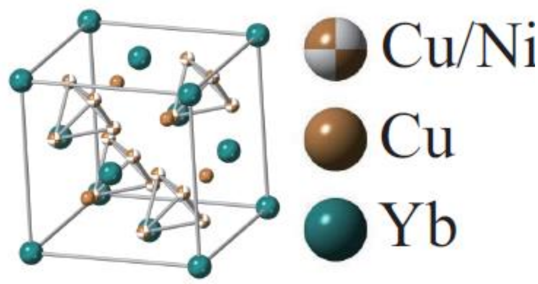

Fig. 1. Crystal structure of $YbCu_4Ni$ determined by powder neutron diffraction measurement..