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Non-thermal lattice disorder in UCu$_{5-x}$Pd$_x$

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Although Pd/Cu site interchange in UCu$_4$Pd has been observed, the relationship between this disorder and the non-Fermi liquid (NFL) behavior remains unclear. Even within the simplest NFL model, namely the single-impurity Kondo disorder model (KDM), the measured site interchange is insufficient to explain the observed logarithmic divergences in the magnetic susceptibility. If lattice disorder is the sole microscopic origin of the NFL behavior, the KDM then requires that some other kind of local lattice disorder exist around the uranium sites. We have performed detailed, temperature-dependent x-ray absorption fine structure (XAFS) experiments on the UCu$_{5-x}$Pd$_x$ series ($x = 0–2.2$) at temperatures between 15–300 K that determine the non-thermal contribution to the local bond distribution widths around the uranium, palladium and copper sites. All data fit a site-interchange model very well. The degree of site interchange is always above the nominal value. However, there appears to be relatively more site interchange in the NFL materials. Most importantly, the amount of non-thermal disorder in the nearest-neighbor U-Cu bonds is smaller than the amount estimated to be necessary within the KDM for all samples measured. These results are therefore strong evidence that, although lattice disorder appears to be important for generating NFL behavior, the KDM model does not contain all of the necessary physics. These results are, however, consistent with the Griffiths’ phase models, either based on a quantum critical point or on Anderson localization.

**Keywords**: non-Fermi liquids, lattice disorder, XAFS

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