

Scanning Tunneling Microscopy and Spectroscopy on the Heavy Fermion Compounds CeCoIn₅ and URu₂Si₂

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A remarkable variety of collective electronic phenomena have been discovered in compounds with partially filled f-orbitals, where electronic excitations act as heavy fermions (HF). In many of these materials, it is believed that screening of the localized heavy f-moments by the Kondo effect begins at relatively high temperatures resulting in the formation of a heavy fermion Kondo lattice, whose detailed microscopic understanding is still lacking. At sufficiently low temperatures, these hybridized many body states form exotic quantum phases such as unconventional superconductivity and the so-called “hidden order” phase in URu₂Si₂. We use atomic scale imaging and spectroscopy with the scanning tunneling microscope (STM) to examine the different electronic states in the heavy fermion compounds CeCoIn₅ and URu₂Si₂ [1]. We image the first direct observation of the heavy fermion band hybridization and the formation of a coherent Kondo lattice state below the coherence temperature T*. We further visualize the different electronic signatures of the enigmatic phase transition in URu₂Si₂ at 17.5 K from the Kondo lattice state to the “hidden order” phase, whose order parameter is still a mystery.

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[1] P. Aynajian, et al. *Proc. Natl. Acad. Sci. USA* 107, 10383 (2010).