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Scanning Tunneling Microscopy and Spectroscopy of the Heavy Fermion Compounds URu_2Si_2 and $CeCoIn_5$[1]

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Heavy electronic states originating from the f atomic orbitals underlie a rich variety of quantum phases of matter. We use atomic scale imaging and spectroscopy with the scanning tunneling microscope (STM) to examine the novel electronic states that emerge from the uranium f states in URu_2Si_2 [1]. We find that as the temperature is lowered, partial screening of the f electrons' spins gives rise to a spatially modulated Kondo-Fano resonance that is maximal between the surface U atoms. At T=17.5 K, URu_2Si_2 is known to undergo a 2^{nd} order phase transition from the Kondo lattice state into a phase with a hidden order parameter. From tunneling spectroscopy, we identify a spatially modulated, bias-asymmetric energy gap with a mean-field temperature dependence that develops in the hidden order state. Spectroscopic imaging further reveals a spatial correlation between the hidden order gap and the Kondo resonance, suggesting that the two phenomena involve the same electronic states. We further study the behavior of the Kondo lattice in a model heavy fermion compound $CeCoIn_5$ as a function of temperature and establish a direct comparison between the two heavy fermion compounds.

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

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