Localization/Hybridization Boundary in UPd_2Al_3

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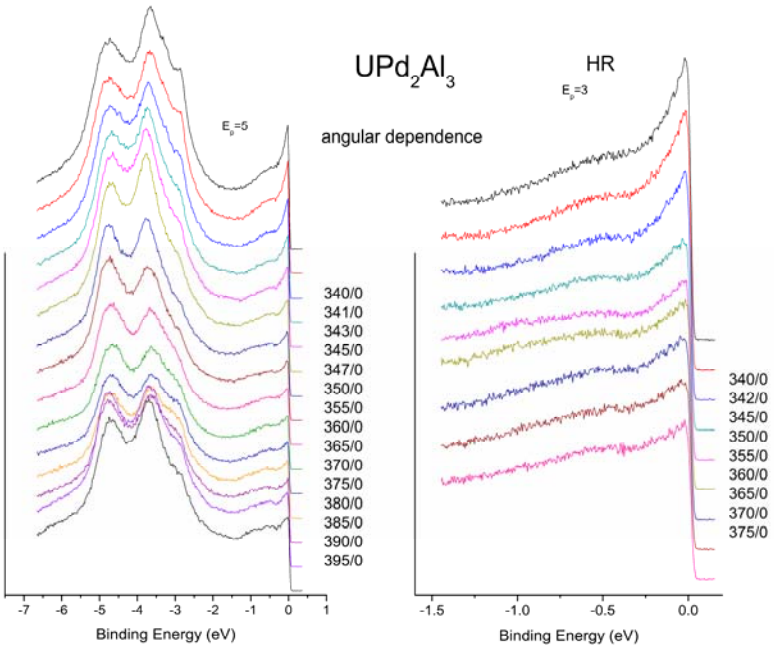
In actinide materials, there is a boundary between treatment of the 5f electrons as localized or bonding. Given the inter-actinide separations in many compounds, the 5f bonding configuration is equated with hybridization of the 5f levels with conduction electrons. On this threshold of localization, 5f electrons exhibit many interesting phenomena attributed to electron-electron interactions which include magnetism, superconductivity and enhanced mass. Many interesting actinide materials will exhibit one or more of these correlated electron phenomena. In rare cases, all of these correlated electron properties are manifest in the same material at ambient pressure. UPd_2Al_3 is such a material with T_N=14 K, T_C=2.0 K and γ=145 mJ/mole K^2.



We have measured the electronic structure of single crystal UPd_2Al_3 by means of angle-resolve photoelectron spectroscopy (ARPES). The ARPES data show two regions of interest in the valence band. The deeper binding energy region extends from 2.5 eV to 6 eV and is associated, in part, with the Pd 4d states (left frame of figure). The feature at the Fermi level (right frame) is of predominant U 5f character, consists of two peaks, and shows small but measurable dispersion.

We explore the possibility that the two 5f-related peaks near the Fermi level are a manifestation of the dual nature (localized/hybridized) of the 5f electrons in this material. We are able to access both the enhanced mass and the antiferromagnetic states in UPd_2Al_3 although the superconducting state remains inaccessible to ARPES. We discuss the ARPES results in terms of more general systems of heavy fermion superconductivity including lanthanide and actinide systems.

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