FROM HEAVY FERMIONS TO RANDOM–LOCALIZED-SITE f– ELECTRONIC AND MAGNETIC BEHAVIOR VIA ANDERSON LOCALIZATION

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9.7 cm

Anderson localization of the $5f$ electrons for some of the light actinide atoms on a lattice can be self–induced when they provide sufficiently strong scattering of the intinerant 5f electrons originating from the remaining light actinide sites. These remaining atoms have fluctuating $5f$ configuration. In the absence of magnetic ordering, the transition temperature to this solid–state–solution–like phase is determined through overcoming the loss of bonding energy by maximizing entropy by exact bifurcation. Thus as hybridization weakens so this solid–state–solution–like phase appears, there is a phase transition between strongly–correlated extremely–narrow (enhanced mass) band behavior and spatially–disordered 5f localization or, as correlated–band bonding weakens further, to strong spatially–disordered localized ferromagnetism. Recent muon spin rotation/relaxation (μSR) measurements on $U_xLa_{1-x}S$ by Grosse, Kalvius et al., showing a moment collapse at 55% uranium, from a ferromagnetic moment of well over $1\mu_B$ to an antiferromagnetic moment of about $0.1\mu_B$, confirms this prediction (which includes the correct absolute prediction of ferromagnetic moment and critical concentration). This mechanism also explains the transition in elemental plutonium to the low-density δ fcc phase at $592K$, and the substantial depression of melting temperature with respect to neighboring elements.

13.4 cm

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