9.7 cm

Theoretical description of the high-temperature phase of Yb and Eu intermetallics

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A number of different Yb and Eu intermetallic compounds (such as $YbInCu_4$ and $EuNi_2(Si_{1-x}Ge_x)_2$) display anomalous behavior as a function of temperature. At high temperature, the systems possess local moments with a Curie-like susceptibility and show no signals of the Kondo effect. They appear to be "dirty" metals with unscreened local moments and large thermopower. As the temperature is lowered, these systems undergo a transition to an intermediate-valence state, where the local moments are screened, and the number of charge carriers is increased.

One way to describe these systems is via a combined periodic Anderson and Falicov-Kimball model. The system has the f-levels lying just above the chemical potential at zero temperature. In the high-temperature phase, the Kondo effect renormalizes to zero, and the local moments appear due to thermal activation. The system becomes more resistive due to the presence of a gap in the single-particle density of states. As temperature is lowered, a transition occurs to an intermediate-valence state with fully screened local moments.

When we restrict the analysis to consider only the Falicov-Kimball model, then a finite-temperature crossover occurs between the high-temperature phase with many local moments to a low-temperature phase with no local moments. Much of the physics of these systems seems to be accounted for within this scenario, even though it does not properly capture the quantum-mechanical intermediate-valence low-temperature phase.

13.4 cm

Subject category :

1. Correlated Electrons and High Temperature Superconductors

Presentation mode :
oral

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