MAR12-2011-004172

Abstract for an Invited Paper
for the MAR12 Meeting of
the American Physical Society

Correlated Electron State in $Ce_{1-x}Yb_xCoIn_5$ Stabilized by Cooperative Valence Fluctuations[1]

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Heavy fermion superconductivity has continuously attracted broad scientific attention. One of the important issues in this study is the relationship between quantum criticality, non-Fermi-liquid behavior (NFL), and unconventional superconductivity. It is generally thought that critical fluctuations associated with a magnetic quantum critical point (QCP) can provide a mechanism for NFL behavior and unconventional superconductivity in a narrow dome around the QCP. However, the precise nature of the relationship between these phenomena remains to be understood, particularly since many compounds have been reported where the NFL behavior persists over an extended region of the phase diagram in the absence of any identifiable QCP. Recently, intermediate valence phenomena has been found in the heavy fermion superconductor system $Ce_{1-x}Yb_xCoIn_5$. X-ray diffraction, electrical resistivity, magnetic susceptibility, and specific heat measurements reveal that many of the characteristic features of the x = 0 correlated electron state are stable for $0 \leq x \leq 0.775$, and that phase separation occurs for $x > 0.775$. The stability of the correlated electron state is apparently due to cooperative behavior of the Ce and Yb ions, involving their unstable valences. Low temperature NFL behavior is observed which varies with x, even though there is no readily identifiable quantum critical point. The NFL state is tuned by valence fluctuations. The strongly intermediate-valence state of Yb in $Ce_{1-x}Yb_xCoIn_5$ has recently been verified by angle-resolved photoemission spectroscopy, extended x-ray absorption fine structure, and x-ray absorption near-edge structure measurements.

[1]This research was sponsored by the U.S. DOE under Research Grant No. DE-FG02-04ER46105 (crystal growth) and the NSF under Grant No. 0802478 (low temperature measurements).

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