

Quantum criticality without tuning in the intermediate valence material β -YbAlB₄

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A number of nontrivial phenomena have been found in itinerant magnets in the vicinity of a quantum critical point, such as unconventional superconductivity and non-Fermi liquid. Spin liquid is another emergent quantum state, which has recently attracted much attention.

In the family of heavy-fermion intermetallics, all the quantum critical materials reported so far are known to have an almost integral valence which stabilizes the local moments. By contrast, departures from integral valence associated with valence fluctuations have been regarded to promote screening of local moments, suppressing the critical phenomena.

In this talk, we present our recent discovery of quantum criticality without tuning in the ultrapure intermediate valence material β -YbAlB₄. This compound superconducts below $T_c = 80$ mK, which is highly sensitive to impurity. Above T_c , it exhibits pronounced non-Fermi liquid phenomena at zero field and local-moment behavior despite its strongly mixed valency. We discuss the possible mechanisms of localization process of moments and associated zero field quantum criticality, including valence instability and formation of spin liquid phase on the distorted honeycomb lattice of Yb $4f$ moments. This is the work performed in collaboration with Y. Karaki (Ryukyuu), T. Sakakibara, Y. Shimura, Y. Uwatoko (ISSP), A.H. Nevidomskyy (Rice), and P. Coleman (Rutgers).