Experimental mapping of the quantum phase diagram for the two-impurity Kondo effect

Juhn-Jong Lin*[2,1]

[2]Institute of Physics, National Chiao Tung University (IOP, NCTU) – No.1001, Daxue Rd., East Dist., Hsinchu City 30010, Taiwan

[1]Department of Electrophysics, National Chiao Tung University – No.1001, Daxue Rd., East Dist., Hsinchu City 30010, Taiwan

Abstract

Quantum phase transitions are governed by competing interaction parameters in the Hamiltonian of a physical system. They are of fundamental conceptual interest but nontrivial to realize experimentally. The two-impurity Kondo (2IK) effect provides an appealing system to verify theoretical predictions of an interesting and nontrivial quantum phase transition. In a conduction electron Fermi sea containing dilute spin- magnetic moments, the local magnetic moments can be fully screened by the spins of conduction electrons, leading to the Kondo-screened ground state at zero temperature. The local magnetic moments can also interact with each other, leading to a RKKY-coupled (e.g., local spin-singlet) ground state. Theory predicts that a quantum critical point separates these two ground states and evolves into a quantum critical regime at finite temperatures. We demonstrate that the experimental mapping of the quantum phase diagram for the 2IK effect is possible by using an Al/AlOx/Y tunnel junction system. In our design, a few yttrium atoms situating at the AlOx/Y interface can serve as spin- magnetic moments and cause the exotic Kondo effect with an induced magnetic quantum phase transition.

*Speaker