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Kondo Effect and Controlled Spin-Entanglement in Coupled Quantum Dots

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Semiconductor double-quantum dots represent an ideal system for studying the novel spin physics of localized spins. On each quantum dot when the number of electrons is odd and the net spin is 1/2, a strong coupling of this localized spin to conducting electrons in the leads gives rise to Kondo correlation. On the other hand, in the coupled double-quantum-dot if the inter-dot antiferromagnetic interaction is strong, the two spins can form a correlated spin-singlet state, quenching the Kondo effect. This competition between Kondo and antiferromagnetic correlation is studied in a controlled manner by tuning the inter-dot tunnel coupling. Increasing the inter-dot tunneling, we observe a continuous transition from a single-peaked to a double-peaked Kondo resonance in the differential conductance. On the double-peaked side, the differential conductance becomes suppressed at zero source-drain bias. The observed strong suppression of the differential conductance at zero bias provides direct evidence signaling the formation of an entangled spin-singlet state. This evidence for entanglement and the tunability of our devices bode well for quantum computation applications.

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