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Widely ranging Kondo phenomena and magnetism in nanostructured quantum materials

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A theme of our research is to use nanostructures as building blocks to fabricate materials with the aim of exploiting nanoscale control to tailor materials behaviour –potentially even quantum behaviour - from the nanoscale up. As a testbed, we study strong interactions between localized, unpaired spins and delocalized electrons. Such interactions play a key role in phenomena ranging from the Kondo effect to high Tc superconductivity. Using short (therefore, conducting) butanedithiol (HS(CH2)4SH) molecules as crosslinkers and Au (metal) nanoparticles, we have observed for the first time a Kondo effect in this nanostructured material. Leveraging nanoscale control and using Au nanoshells, which are more insulating, we observe the Kondo temperature-scale increases 10-fold, to >250K. Interestingly, the metallic and insulating systems, respectively, exhibit magnetism consistent with paramagnetism and antiferromagnetism. These results point to molecule linker-nanoparticle assemblies as a versatile means to generate materials exhibiting a range of strong electron-electron interactions.

Keyword-1

quantum materials

Keyword-2

nanostructures

Keyword-3

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