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Kondo Physics at the Nanoscale[1]

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Recent experimental advances have made it possible to study the Kondo effect in nanoscale structures. These achievements are of great importance because they do not only allow us to manipulate the Kondo screening of single magnetic impurities, but also provide us with the unique opportunity to study how Kondo screening and coherence evolve on different lengthscales from a single Kondo impurity to the Kondo lattice. In this talk, I present two examples of novel Kondo physics emerging in nanostructures. First, I demonstrate that the presence of electronic eigenmodes in a nanostructure gives rise to unconventional properties of a Kondo screened magnetic impurity [1]. In particular, the Kondo temperature, T_K, of a magnetic impurity located inside the nanostructure varies with the impurity's location and is determined by the eigenmodes' spatial structure. Moreover, the modes' frequency dependence leads to a linear relation between T_K and the local density of states, in stark contrast to the conventional Kondo effect. Second, I discuss Kondo screening and the onset of coherence in finite size Kondo lattices, so-called *Kondo droplets*. I show that in such Kondo nanostructures, the hybridization and the coherent coupling of the Kondo resonances can be resonantly enhanced or suppressed via changes in the droplet's geometry and lattice constant. Moreover, I demonstrate how these properties of the Kondo droplet evolve with increasing droplet size. Finally, I discuss how the ability to manipulate the properties of Kondo droplets might provide novel insight into the origin of quantum criticality, which is a central point in understanding the unconventional non-Fermi liquid properties of Kondo lattice systems, such as the heavy-fermion materials.

[1]This work was done in collaboration with E. Rossi. [1] E. Rossi and D. K. Morr, Phys. Rev. Lett. **97**, 236602 (2006).