The surge of a Kondo lattice in atomic scale structures

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Nanomagnets of atomic scale are promising devices for future technology [1]. In the development of the spin-based technology, the understanding of the interactions between magnetic impurities and the conduction electrons of the substrate is of crucial importance. The magnetic properties of single magnetic atoms on metals are inherently connected with many body interactions between the localized magnetic moment and the supporting surface. The Kondo effect is the one most frequently found. Using scanning tunneling microscopy we have developed a method to perform 2D-imaging of the Kondo resonance over Co magnetic impurities on Ag(111). Starting with a single atom (Kondo screening length, ξ_k=0.7 nm) we have characterized the Kondo cloud as a function of the number of nearest neighbors and their separation with atomic-scale control. We have observed a transition in the overall magnetic coupling between atoms separated by three Ag(111) interatomic distances (0.87nm) to impurities separated two atomic distances (0.58nm) where the corresponding Kondo clouds interfere owing to the interaction [2,3] through the conduction electrons of the metal host (Ruderman-Kittel-Kasuya-Yosida interaction).
We have further addressed the competition between RKKY interactions and the Kondo liquid regime of such artificial structures. In linear atomic chains, scanning tunneling spectroscopy shows that the Kondo resonance of atoms with two neighbors is broadened by 1.3 meV (15K). In the RKKY mediated antiferromagnetic regime this broadening has been theoretically predicted [4], and experimentally assigned to a spin splitting of the otherwise degenerated doublet responsible for the Kondo phase [5] (fig.1). In contrast, for atoms with the same number of neighbors but with topographically frustrated spin, the Kondo temperature does not show the same behaviour.

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[2] Y. Jiang et al. *Science* 333, 324 (2011)
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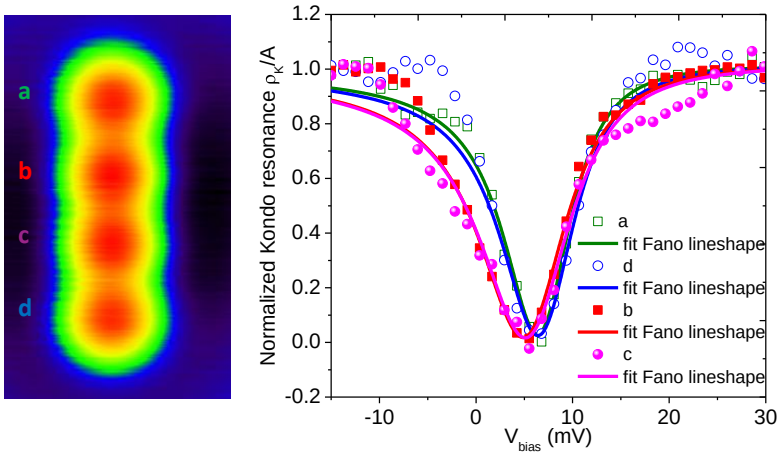

Fig.1: Left: Topography image (V_{bias}=-20 mV, I_t=15 pA) of a four Co atoms chain separated two Ag(111) interatomic distances(0.58nm). Right: STS performed in the atoms reveal a 1.5 meV broadening of the Kondo resonance.