Coupling adatoms or molecules to magnetic surfaces:
a scanning tunneling spectroscopy study

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The understanding of the coupling between discrete electronic states and a continuum is the key issue of transport through nanometer size conductors in general and for molecular electronics in particular. Up to now, this coupling has been mainly studied, especially at the nanometer scale, with non spin polarized continuums. However, the interaction of ultimate nano-objects like single atoms or molecules with a spin-polarized electronic bath (i.e. magnetic material) can be of particular interest both to better understand this coupling and for spintronics applications. In this talk, I will show two examples of such systems, studied by scanning tunneling spectroscopy.

Firstly, I will describe the Kondo resonance induced by a single cobalt adatom interacting with a ferromagnetic iron nanocluster, measured by low-temperature scanning tunneling microscopy. The persistence of the Kondo resonance is evidenced along with the predicted splitting of the spectral density peak for a Kondo impurity surrounded by a spin-polarized electron bath. Reversible quenching of the split feature is observed using atom manipulation between adjacent adsorption sites. Using a Green's-function formalism, we model a double Fano resonance leading to a quantitative insight of our observations [1].

Secondly, I will present spin-polarized scanning tunneling microscopy of the antiferromagnetic Cr(001) surface [2], discussing by comparison with ab initio calculations the origin of its different magnetic surface states. In a next step, I will show how, coupling state-of-the-art spin-polarized scanning tunneling spectroscopy and spin-resolved ab initio calculations, we have demonstrated the first experimental evidence of the spin splitting of a molecular orbital on a single non magnetic C_{60} molecule in contact with the magnetic surface states of the Cr(001) surface (cf. Fig. 1) [3]. This hybridized molecular state is responsible for an inversion of sign of the tunneling magnetoresistance depending on energy. This result opens the way to spin filtering through molecular orbitals.

References

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Figures

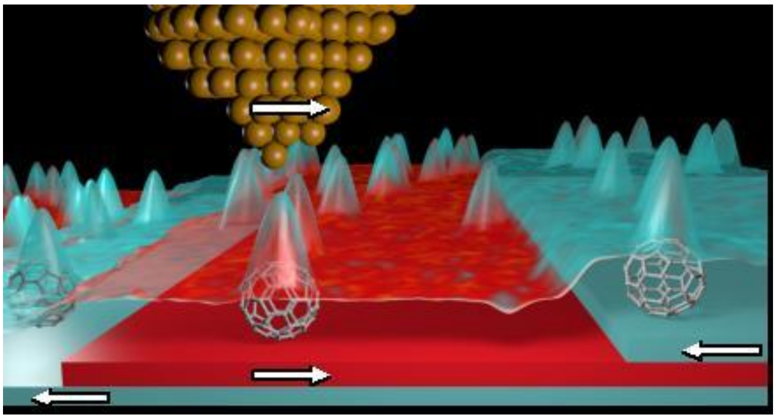

Fig. 1. *3D STM image of single C60 molecules deposited on a chromium surface. The color scale indicates the local tunnel magneto-conductance. The tip of the microscope, the chromium surface and buckyballs are also schematized for clarity.*