DIRECTION DES SCIENCES DE LA MATIERE, INSTITUT RAYONNEMENT MATIÈRE DE SACLAY
SERVICE DE PHYSIQUE ET DE CHIMIE DES SURFACES ET DES INTERFACES

SEMINAIRE

Mercredi 15 Janvier à 11h00

Bâtiment 466, salle 111 - CEA Saclay, 91191, Gif sur Yvette

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Inelastic tunneling spectroscopy for magnetic atoms and the Kondo resonance

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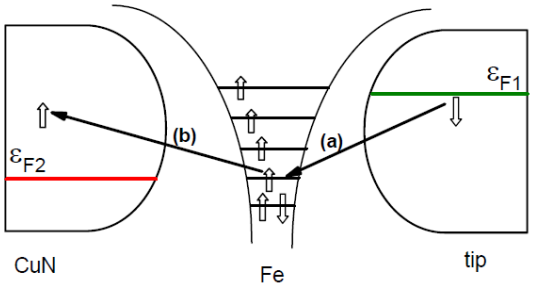
(invité par Yannick DAPPE)

Electron inelastic tunneling spectroscopy has been recently used to explore the intrinsic spin properties of single magnetic atoms and molecular magnets [1]. In the single atom case, Fe, Mn or Co have been deposited on a CuN surface, so that electrons injected with a STM-tip across the magnetic atom interact with the atomic spin, creating spin-flip processes that reveal themselves in the tip-metal tunneling conductance measured as a function of the bias voltage.

These experiments have been analyzed by different groups combining an atomic crystal-field effect with an effective interaction between the tunneling electron and the atomic spin, as described by means of an exchange coupling, a spin-assisted Hamiltonian or using strong-coupling theory [2]. We revisited this problem [3] by introducing a new ionic Hamiltonian for describing the d-electrons of the magnetic atom, and analyzed the tunneling electron current for a metal/atom/tip configuration using a Green-function Equation of Motion method. I will show how this new ionic Hamiltonian describes electron inelastic processes and Kondo resonances associated with magnetic atoms like Fe, Mn or Co.

In this new approach, the inelastic interaction between the incoming electron and the atomic spin is described by means of a co-tunneling process, in which one electron jumps from the tip into a d- orbital, and one electron of spin up jumps from the same orbital to CuN. In this process for Fe, the atomic spin changes from S=2, M=2 to S=2, M=1, the intermediate state being S=3/2, M=3/2 (see the figure).

I will show some theoretical results for the differential conductance of a Fe atom on CuN for increasing magnetic fields, and compare them with the experimental evidence. Our results reproduce well in those curves the steps associated with the inelastic spin flip processes, and the asymmetries found with respect to the applied bias. Furthermore, the case of Co is also considered and shown to present a resonance at the Fermi energy associated with a Kondo temperature of 6K .



We conclude that the new ionic Hamiltonian introduced in this work describes well the electron inelastic processes and the Kondo resonances associated with magnetic atoms like Fe, Mn or Co.

[1] Hirjibehedin C F et al. 2007 Science 317 1199; Otte A F et al. 2008 Nature Physics 4 847; Otte A F et al 2009 Phys. Rev. Lett. 103 107203

[2] Persson M 2009 Phys. Rev. Lett. 103 050801; Fernández-Rossier J 2009 Phys. Rev. Lett. 102 256802; Lorente N and Gauyacq J P 2009 Phys. Rev. Lett. 103 176601

[3] Goldberg E C and Flores F 2008 Phys. Rev. B 77 125121; Goldberg E.C. and Flores F. 2013, J Phys C 25, 225001; Romero M. A. et al 2013, Phys Rev B 87, 195419