CEA - Saclay 91191 Gif-sur-yvette Cedex

Service de Physique de l'Etat Condensé

SÉMINAIRE

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Mercredi 2 mars 11h15

Orme des Merisiers SPEC Salle Itzykson, Bât.774

Single-molecule transistor : Single-spin detection

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The last two decades have seen the emergence of a new field merging the magnetic and electric properties of materials, leading to new ways in storing and processing the information. The miniaturisation of the devices is pushing toward the investigation of the interaction between transport and magnetic properties at a nanometric scale. It has given rise to molecular quantum spintronics [1], which studies the magnetic moment of a single molecule interacting with electrons flowing through a nanostructure. A possible candidate in building such a device is a Single-Molecular Magnet (SMM) based transistor. The choice of SMMs is motivated by their large spin and anisotropy leading to long coherence time. Furthermore, they are subject to quantum phenomenon such as quantum tunneling or Berry phase interference. The first experiments on a Single-Molecule Transistor (SMT) based on SMMs did not show encouraging results [2,3], due to the loss of the magnetic properties because of a strong interaction with the environment. But recent results [4] have shown that the magnetic properties of SMMs could be kept intact if the spin was well protected as it is the case of a bis-(phthalocyaninato) Terbium(III) molecule. These molecules have been studied in details both in monolayers [5] and crystals [6]. I will then present our measurements performed on two types of protected single magnetic molecules, in two different transport measurement regime. First, for N@C60, I will show that the analysis of the cotunneling regime permits to detect the state of the single Nitrogen. Then, in a SMT based on bis-(phthalocyaninato) Terbium(III), we report for the first time the detection, at the single molecular level, of the quantum tunneling of the magnetization of two entangled spins : the electronic magnetic moment of the Terbium entangled with its nuclear spin. This magnetic characterization of a single magnetic spin is successfully performed using the extreme sensitivity of the Kondo regime and/or the sequential tunneling regime, to its magnetic environment showing how quantum transport and magnetic phenomenon can interact, leading to measurements at the single magnetic molecule level.

[1] L. Bogani & W. Wernsdorfer, Nature Mat., 7, 179 (2008)

[2] M.-H. Jo et al., Nano Letters, 6 (9), 2014 (2006)

[3] H. B. Heersche et al., Phys. Rev. Lett., 96, 206801 (2006)

[4] L. Vitali et al., Nano Letters, 10, 657 (2008)

[5] Margheriti L et al. Advanced materials, 1, 6 (2010)

[6] N. Ishikawa et al., Angewandte Chemie (International ed. in English), 44 (19), 2931 (2005)

The seminar will be given in English. A coffee break will be served at 11h00.

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