VISUALIZING THE 2D QUANTUM CRITICAL KONDO LATTICE STEMMING FROM 4F-ELECTRONS

DIRECTEURS DE THESE : JEAN-PIERRE BUCHER ET MARIO RUBEN
IPCMS, UNIVERSITE DE STRASBOURG, 23 RUE DU LOESS, 67034 STRASBOURG
TEL: 03 88 10 70 96 ; E-MAIL : BUCHER@UNISTRA.FR

In lanthanide (Ln) compounds, the localized *4f*-electrons usually interact both, with the itinerant *spd* electrons as well as with each other, leading to a rich variety of unusual properties [1]. Spin-flip scattering of conduction electrons from these *4f* local moments may result in their collective magnetic screening below a characteristic temperature called the Kondo temperature T_K. In materials, where local moments are arranged in dense periodic arrays, forming a "Kondo lattice" the deconfinement of localized orbitals through their hybridization with the conduction electrons results in composite low energy excitations. Tuning the hybridization between *f* orbitals and itinerant electrons can destabilize the Fermi-liquid state towards an antiferromagnetically ordered ground state at a quantum critical point (QCP) [1,2]. However, the emergence of a coherent band of quasiparticles near the Fermi energy in a Kondo lattice system is still not well understood. Additionally, the vast majority of studies have been conducted on 3D bulk materials [1,2]. This PhD project therefore aims at studying quantum criticality in lower dimensions, where potentially larger fluctuations are expected. The scattering of quasiparticles, visualized by spectroscopic Fourier transform of STM conductance maps is used to detect the emergence of quantum entanglement of itinerant substrate conduction and *4f*-electrons as a function of temperature in a family of 2D compounds made of arrays of self-organized *Ln*-atoms on metal substrates.

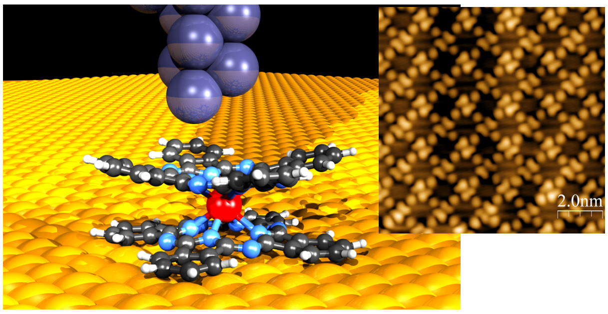

Figure 1. Schematic view of a $LnPc_2$ molecule in the gap between the STM tip and the surface, the lanthanide ion is shown in red. Inset: STM image of a two dimensional network of Terbium complexes on Au(111).

The possibility of building a 2D lattice of *Ln*-atoms by monolayer deposition of atoms dressed by ligands, as well as their manipulation with the tip of the STM has been demonstrated by our team [3]. The lanthanide complexes with appropriate ligands are synthesized in the group of M. Ruben (KIT & IPCMS). For this project a dedicated low temperature (LT)-STM equipped with a vector magnetic field is used. The measurements are carried out in ultrahigh vacuum to ensure a clean and reproducible experimental environment [3,4]. The candidate will participate in an ambitious multi-partner project including theoretical support from both, IPCMS and KIT.

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[3] A. Amokrane, S. Klyatskaya, M. Boero, M. Ruben, J.P. Bucher, *ACS Nano*, **11**, 10750 (2017).
[4] R. Tuerhong, F. Ngassam, S. Watanabe, J. Onoe, M. Alouani, J.P. Bucher, *J. Phys. Chem. C* 122, 20046 (2018).