MA 58: Surface magnetism II

Time: Friday 9:30–11:00 Location: EB 202

MA 58.1 Fri 9:30 EB 202

Magnetic structure of MnO_2 and FeO_2 chains on Ir(100) investigated by spin-polarized STM — •Martin Schmitt, Matthias Vogt, Ryan Cotsakis, Jeannette Kemmer, and Matthias Bode — Physikalisches Institut, Experimentelle Physik II, Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

Low-dimensional systems are known to behave different from bulk properties. In particular, for monatomic 3*d* transition metal chains unconventional magnetic ground states have been theoretically predicted [1]. Recently, a new self-organized growth method of transition metal oxide (TMO) chains with a structural (3×1) unit cell on Ir(100) has been reported [2]. DFT calculations predict a rather strong antiferromagnetic (AFM) coupling along MnO_2 and FeO_2 chains, but only a weak AFM interaction across the chains. We performed low-temperature spin-polarized scanning tunneling microscopy (SP-STM) to unravel the spin structure of various TMO chains on Ir(100) at 5 K. Our results confirm an AFM coupling for MnO_2 and FeO_2 along the stripes. Surprisingly, we also find pronounced magnetic order in between adjacent chains. Whereas a ferromagnetic (FM) inter-stripe coupling leading to a (3×2) magnetic unit cell is found for FeO_2, MnO_2 chains show a complicated non-collinear ground state with a (9×2) magnetic unit cell. Potential ordering mechanisms which may lead to this spin structure will be discussed.

[1] M. Tanveer *et al.*, Phys. Rev. B **94**, 094403 (2016); further references therein.
[2] P. Ferstl *et al.*, Phys. Rev. Lett. **117**, 046101 (2016).

MA 58.2 Fri 9:45 EB 202

Spin-Resolved Spectroscopy of the Yu-Shiba-Rusinov States of Individual Atoms — Lasse Cornils[1], Anand Kamlapure[1], Lihui Zhou[1,3], Saurabh Pradhan[2], Alexander A. Khajetoorians[1,4], Jonas Fransson[2], •Jens Wiebe[1], and Roland Wiesendanger[1] — [1]Department of Physics, Hamburg University, D-20355 Hamburg, Germany — [2]Department of Physics and Astronomy, Uppsala University, Uppsala SE-751 21, Sweden — [3]Max Planck Institute for Solid State Research, D-70569 Stuttgart, Germany — [4]Institute for Molecules and Materials (IMM), Radboud University, Nijmegen 6525 AJ, Netherlands

A magnetic atom in a superconducting host induces so-called Yu-Shiba-Rusinov (YSR) bound states inside the superconducting energy gap. By combining spin-resolved scanning tunneling spectroscopy with simulations we demonstrate that the pair of peaks associated with the YSR states of an individual Fe atom coupled to an oxygen-reconstructed Ta surface gets spin polarized in an external magnetic field [1]. As theoretically predicted, the electron and hole parts of the YSR states have opposite signs of spin polarizations which keep their spin character when crossing the Fermi level through the quantum phase transition. The simulation of a YSR state right at the Fermi level reveals zero spin polarization which can be used to distinguish such states from Majorana zero modes in chains of YSR atoms.

[1] L. Cornils, A. Kamlapure, L. Zhou, S. Pradhan, A. A. Khajetoorians, J. Fransson, J. Wiebe, and R. Wiesendanger, Phys. Rev. Lett. **119**, 197002 (2017).

MA 58.3 Fri 10:00 EB 202

Tuning a Yu-Shiba-Rusinov state across a quantum phase transition — •Laëtitia Farinacci, Gelavizh Ahmadi, Gaël Reecht, Michael Ruby, Benjamin W. Heinrich, and Katharina J. Franke — Freie Universität Berlin, Arnimallee 14, 14195 Berlin

Magnetic impurities on superconductors induce an exchange scattering potential that locally perturbs the pairing of the superconductor's electrons. This leads to the presence of Yu-Shiba-Rusinov (YSR) states within the gap of the superconductors whose energy depends on the coupling strength between the impurity and Cooper pairs. In particular, upon increase of this coupling strength, the ground state of the system undergoes a quantum phase transition from a free to a screened spin state.

Here, we investigate YSR states induced by Fe-porphin molecules on Pb(111). Upon tip approach we are able to continuously tune their energy across the Fermi energy and thus study, on the single impurity level, such a quantum phase transition.

MA 58.4 Fri 10:15 EB 202

Valence and magnetism of samarium single atoms and clusters on noble metal surfaces — •Alessandro Barla[1], César Moreno[2], Miguel Angel Valbuena[2], Sanjoy K. Mahatha[1], Luca Persichetti[3], Corneliu Nistor[3], Sylvie Godey[2], David Coffey[5], José Ignacio Arnaudas[5], Pierluigi Gargiani[4], Pietro Gambardella[3], Aitor Mugarza[2,6], and Carlo Carbone[1] — [1]Istituto di Struttura della Materia, CNR, Trieste, Italy — [2]Catalan Institute of Nanoscience and Nanotechnology (ICN2), Cerdanyola del Vallès, Spain — [3]Department of Materials, ETH Zürich, Zürich, Switzerland — [4]ALBA Synchrotron Light Source, Cerdanyola del Vallès, Spain — [5]Instituto de Nanociencia de Aragón, Universidad de Zaragoza, Zaragoza, Spain — [6]Institució Catalana de Recerca i Estudis Avançats (ICREA), Barcelona, Spain

There is currently strong interest in the magnetic properties of individual rare-earth atoms, after the discovery of magnetic remanence of Ho adatoms adsorbed on the MgO surface [1]. We present our results on the electronic and magnetic properties of samarium individual atoms and small clusters adsorbed on noble metal surfaces [Cu(111), Ag(111) and Ag(100)]. Our combined XMCD and STM investigations show that Sm atoms and small 2D clusters are in a divalent state characterized by van Vleck paramagnetism. A magnetically almost isotropic trivalent component appears as soon as the second Sm layer starts growing. From the third Sm layer the growth becomes three-dimensional and larger clusters exhibit superparamagnetism with a strong out-of-plane magnetic anisotropy. [1] F. Donati et al., Science 352, 318 (2016)

MA 58.5 Fri 10:30 EB 202

Scanning tunneling spectroscopy of 3d transition metal atoms on superconducting Re(0001) — •Lucas Schneider, Manuel Steinbrecher, Levente Rózsa, Jens Wiebe, and Roland Wiesendanger — Department of Physics, Hamburg University, 20355 Hamburg, Germany

Yu-Shiba-Rusinov (YSR) bands in chains of magnetic atoms on s-wave superconductors can host Majorana bound states at their ends [1,2]. For the realization of braiding of these states, which is ultimately needed for their usage in quantum computation, the building of controlled nanostructures of chains and an understanding of the coupling of the magnetic atoms to the substrate, are essential ingredients. In this study, different 3d transition metal adatoms were deposited on a superconducting Rhenium substrate which enables atom-by-atom assembly of nanostructures using the tip of a scanning tunneling microscope as a tool to move the atoms on the surface. The YSR states and spin-excitations of the atoms were investigated by inelastic scanning tunneling spectroscopy in comparison to theoretical *ab-initio* calculations revealing that the YSR state formation crucially depends on the species of atom and its adsorption site.

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[1] S. Nadj-Perge *et al.*, Science **346**, 6209 (2014). [2] M. Ruby *et al.*, Nano Letters **17**, 4473, (2017).

MA 58.6 Fri 10:45 EB 202

Spin-resolved dispersion relation of a single Co island — •Hirofumi Oka and Tadahiro Komeda — Institute of Multidisciplinary Research for Advanced Materials, Tohoku University, Katahira 2-1-1, Aoba-ku, Sendai 980-8577, Japan

Scanning tunneling microscopy and spectroscopy (STM/STS) are powerful tools to study on the nanometer (nm) scale spatial modulations of the electronic local density of states (LDOS), which are caused by quantum interference between electron waves scattered off nanostructure boundaries. The analysis of modulation patterns gives the dispersion relation of electronic states. When electrons are confined to magnetic nanostructures, spin-dependent quantum interference occurs and spatial modulations of the LDOS become spin-polarized [1]. Here we report on the observation of spin-polarized modulations of the LDOS within a single Co island on Cu(111) using spin-polarized STM/STS (SP-STM/STS). We show that the spin-resolved dispersion relation of surface states of a nm-small Co island can be obtained by analyzing the spin-polarized LDOS modulations.

[1] H. Oka, P.A. Ignatiev, S. Wedekind, G. Rodary, L. Niebergall,

V.S. Stepanyuk, D. Sander, and J. Kirschner, Science 327, 843 (2010).
*Present address (H.O.): Advanced Institute for Marerials Research (AIMR), Tohoku University, Katahira 2-1-1, Aoba-ku, Sendai 980-8577, Japan.