MA 30: Surface Magnetism

Time: Thursday 9:30–11:30 Location: H48

MA 30.1 Thu 9:30 H48

Interplay of magnetic states and hyperfine fields of iron dimers on MgO(001) — •SUFYAN SHEHADA[1,2,3], MANUEL DOS SANTOS DIAS[4,1], MUAYAD ABUSAA[3], and SAMIR LOUNIS[1,4] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich & JARA, 52425 Jülich, Germany — [2]Department of Physics, RWTH Aachen University, 52056 Aachen, Germany — [3]Department of Physics, Arab American University, Jenin, Palestine — [4]Faculty of Physics, University of Duisburg-Essen, 47053 Duisburg, Germany

Individual nuclear spin states can have very long lifetimes and could be useful as qubits. Progress in this direction was achieved on MgO/Ag(001) via detection of the hyperfine interaction (HFI) of Fe, Ti and Cu adatoms using scanning tunneling microscopy (STM)[1,2]. Previously, we systematically quantified from first-principles the HFI for the whole series of 3d transition adatoms (Sc-Cu) deposited on various ultra-thin insulators, establishing the trends of the computed HFI with respect to the filling of the magnetic s- and d-orbitals of the adatoms and on the bonding with the substrate[3]. Here we take one step further by investigating the impact of the magnetic coupling between the dimer atoms on the HFI of Fe dimers on MgO(001) and its dependence on where the Fe atoms are located on the surface[4]. –Work funded by (BMBF–01DH16027).

[1] Willke *et al.*, Science **362**, 336 (2018); [2] Yang *et al.*, Nat. Nano. **13**, 1120 (2018); [3] Shehada *et al.*, Npj Comput. Mater. **7**, 87 (2021). [4] Shehada *et al.*, *arXiv.* **2202.00336** (2022).

MA 30.2 Thu 9:45 H48

Low-energy end states in proximitized antiferromagnetic nanowires — •LUCAS SCHNEIDER[1], PHILIP BECK[1], THORE POSSKE[2,3], LEVENTE RÓZSA[4], JENS WIEBE[1], and ROLAND WIESENDANGER[1] — [1]Department of Physics, Universität Hamburg, D-20355 Hamburg, Germany — [2]I. Institute for Theoretical Physics, Universität Hamburg, D-20355 Hamburg, Germany — [3]The Hamburg Centre for Ultrafast Imaging, Luruper Chaussee 149, 22761 Hamburg, Germany — [4]Department of Physics, University of Konstanz, D-78457 Konstanz, Germany

Magnetically ordered nanowires coupled to a superconducting surface have been proposed to host Majorana modes (MMs) at their ends, which form a single, highly non-local fermionic state together. While multiple experiments claim the observation of MMs via a zero-bias resonance in tunneling conductance at the ends of nanowires, this is not a unique signature of MMs. In this work, we study the emergence of low-energy end states in artificially crafted antiferromagnetic nanowires on two different superconducting surfaces using scanning tunneling spectroscopy. While some of the end states are observed close to zero energy, we find that they can be split into two non-degenerate components localized on the left and right ends by local defects - in clear contrast to expectations for a single non-local state. The phenomenology of these trivial bound states can be explained by simple toy-model calculations. We propose that similar perturbations by local defects could be used on other sample systems to probe the stability of candidate topological edge modes against local disorder.

MA 30.3 Thu 10:00 H48

Spin-resolved Fermi Surface of "Half-Metallic" FePd Alloy Monolayers — •XIN LIANG TAN[1,2], KENTA HAGIWARA[1,2], YING-JIUN CHEN[1,2], VITALIY FEYER[1], CLAUS M. SCHNEIDER[1,2], and CHRISTIAN TUSCHE[1,2] — [1]Forschungszentrum Jülich, Peter Grünberg Institut, Jülich — [2]Fakultät für Physik, Universität Duisburg-Essen, Duisburg

Magnetism in reduced dimensions is one of the preconditions for the realization of nanoscale spintronics. Despite the recent discovery of ferromagnetism in monolayers of two-dimensional materials, tunability and engineering on such systems are challenging. Here we present the electronic structure of ultrathin ferromagnetic iron-palladium alloy films using spin-resolved momentum microscopy. Momentum microscopy enables the two-dimensional detection of photoelectrons with an in-plane crystal momentum over the full Brillouin zone. By employing an imaging spin filter, spin-resolved momentum maps of the iron-palladium alloy were acquired. Breaking of time reversal symmetry by the remanent magnetization of the film manifests in a pronounced anisotropy of the electron states in the Fermi surface. In particular, the competition between exchange interaction and strong spin-orbit coupling in the FePd alloy leads to the formation of wave-vector dependent local gaps in the Fermi surface. Moreover, the spin-resolved maps recorded by the momentum microscope give evidence for a non-collinear spin texture of the electron states at the Fermi surface, where the local spin polarization vector points orthogonal to the remanent magnetization of the sample.

MA 30.4 Thu 10:15 H48

Real-time MOKE measurements of CoTMPP on magnetic Ni/Cu(110)-(2x1)O — •GIZEM MENDIREK[1], ALEKSANDER BROZYNIAK[2], MICHAEL HOHAGE[1], ANDREA NAVARRO-QUEZADA[1], and PETER ZEPPENFELD[1] — [1]Institute of Experimental Physics, Johannes Kepler University Linz, Altenberger Str. 69, 4040 Linz, Austria — [2]Christian Doppler Laboratory for Nanoscale Phase Transformations, Johannes Kepler University Linz, Altenberger Str. 69, 4040 Linz, Austria

In this work, we report the detailed analysis employing a fitting algorithm on a setup consisting of a combination of a sinusoidal modulation of the magnetic field with the synchronous detection of the reflectance difference spectroscopic MOKE (RD-MOKE) signal. This setup allows recording hysteresis loops continuously revealing relevant magnetic properties like magnetization amplitude, remanent magnetic signal and coercive field as a function of coverage, time or temperature with high precision in real-time. The capabilities of our setup and our analysis algorithm is demonstrated for Ni thin films grown on a Cu(110)-(2×1)O reconstructed surface with a sharp spin reorientation transition at 9 ML. Subsequently, the deposition of cobalt tetramethoxyphenylporphyrin (CoTMPP) thin films on the Ni/Cu(110)-(2×1)O system is investigated. The adsorption of the molecules induces characteristic changes in the magnetic properties such as the decrease of the Curie temperature of the Ni thin films upon CoTMPP deposition with different thicknesses.

MA 30.5 Thu 10:30 H48

Thermally-induced magnetic order from glassiness in elemental neodymium — BENJAMIN VERLHAC[1], •LORENA NIGGLI[1], ANDERS BERGMANN[2], UMUT KAMBER[1], ANDREY BAGROV[1,2], DIANA IUŞAN[2], LARS NORDSTRÖM[2], MIKHAIL I. KATSNELSON[1], DANIEL WEGNER[1], OLLE ERIKSSON[2,3], and ALEXANDER A. KHAJETOORIANS[1] — [1]Institute for Molecules and Materials, Radboud University, Nijmegen, The Netherlands — [2]Department of Physics and Astronomy, Uppsala University, Uppsala, Sweden — [3]School of Science and Technology, Örebro University, SE-701 82 Örebro, Sweden

While traditional spin glasses are characterized by randomness and frustration, elemental neodymium shows glassy behavior as a result of competing interactions, particularily without extrinsic disorder [1]. Adding to the list of intriguing effects found in spin glasses, e.g. aging and memory, we observe an unconventional magnetic phase transition from a glassy to a long-range ordered phase in Nd as temperature is increased [2]. To characterize the spatially varying magnetization patterns, we employ temperature-dependent spin-polarized scanning tunnelling microscopy between 5-15K along with atomistic spin dynamics simulations that support our findings. A new analysis method allows us to extract the phase transition temperature directly by evaluating our experimental data. Notably, such an unusual magnetic phase transition serves as a counterexample to the common thermodynamic understanding of temperature and disorder being synonymous.

[1] U. Kamber et al., *Science* **368** (2020).
[2] B. Verlhac et al., arXiv:2109.04815, accepted at Nat. Phys.

MA 30.6 Thu 10:45 H48

Distorted $3Q$ state driven by topological-chiral magnetic interaction — •SOUMYAJYOTI HALDAR[1], SEBASTIAN MEYER[2], ANDRÉ KUBETZKA[3], and STEFAN HEINZE[1] — [1]Institute of Theoretical Physics and Astrophysics, University of Kiel, Leibnizstr. 15, 24098 Kiel, Germany — [2]Nanomat/Q-mat/CESAM, Université de Liège, B-4000 Sart Tilman, Belgium — [3]Department of Physics, University of Hamburg, 20355 Hamburg, Germany

Non-collinear spin structures are of fundamental interest in magnetism since they allow to obtain insight into the underlying microscopic interactions and are promising for spintronic applications [1,2]. Here, we demonstrate that recently proposed topological-chiral magnetic interactions [3] can play a key role for magnetic ground states in ultrathin films at surfaces [4]. Using density functional theory we show that significant chiral-chiral interactions occur in hexagonal Mn monolayers due to large topological orbital moments which interact with the emergent magnetic field. Superposition states of spin spirals such as the $2Q$ state or a distorted $3Q$ state arise due to the competition with biquadratic and four-spin interactions. Simulations of spin-polarized scanning tunneling microscopy images suggest that the distorted 3Q state could be the magnetic ground state of a Mn monolayer on Re(0001).

[1] A. Fert *et al.*, Nat. Rev. Mater. **2**, 17031 (2017). [2] J. Grollier *et al.*, Nat. Electron. **3**, 360 (2020). [3] S. Grytsiuk *et al.*, Nat. Commun. **11**, 511 (2020). [4] S. Haldar *et al.*, Phys. Rev. B **104** L180404 (2021).

MA 30.7 Thu 11:00 H48

The mutual impact of magnetism on proximity-induced superconductivity — •Uriel Aceves[1,2], Filipe Guimaraes[3], and Samir Lounis[1,2] — [1]Peter Grünberg Institut and Institute for Advanced Simulation, Forschungszentrum Jülich & JARA, 52425 Jülich, Germany — [2]Faculty of Physics & CENIDE, University of Duisburg-Essen, 47053 Duisburg, Germany — [3]Jülich Supercomputing Centre, Forschungszentrum Jülich & JARA, 52425 Jülich, Germany

In a conventional superconductor (SC), vibrations on the crystal lattice can cause electrons to attract mutually and bind in the so-called Cooper pairs. At the interface of a normal metal (NM), Cooper pairs can wander from SC to NM resulting in a proximity induced gap. Electrons from NM can also travel into SC by normal transport or Andreev reflection. This exchange of electrons can impact the properties of both materials. Moreover, if the NM is magnetic new and exciting physics appears. In this work, we explore NM/SC interface phenomena by introducing a method to extract the tensor of magnetic exchange interactions within the framework of the Bogoliubov-de Gennes equations where superconductivity is induced via an effective electron-phonon coupling constant λ and accounting for spin-orbit coupling. Based on a realistic description of the electronic structure, we analyze the behaviour of the isotropic exchange and the Dzyaloshinskii-Moriya interaction as a function of λ on a Mn monolayer on top of a superconducting Nb (110) slab. Additionally, we investigate the impact of λ on the proximity-induced gap as a function of the direction of the magnetic moment in Mn.

MA 30.8 Thu 11:15 H48

Observation of spin-correlated exciton-polaritons in a van der Waals magnet — •Florian Dirnberger[1], Rezlind Bushati[1,2], Biswajit Datta[1], Ajesh Kumar[3], Allan H. MacDonald[3], Edoardo Baldini[3], and Vinod M. Menon[1,2] — [1]Department of Physics, City College of New York, New York, NY 10031, USA — [2]Department of Physics, The Graduate Center, City University of New York, New York, NY 10016, USA — [3]Department of Physics, University of Texas at Austin, Austin, TX 78712, USA

The recent discovery of optically active excitons in magnetic van der Waals crystals offers extraordinary opportunities to study collective phenomena in quantum materials via light-matter interactions. A prime candidate in this endeavor is nickel phosphorus trisulfide ($NiPS_3$), a van der Waals antiferromagnet with highly correlated magnetic and electronic degrees of freedom. By coupling optical fields to its excitonic excitations, we demonstrate a previously unobserved class of polaritons with unique signatures of excitons, photons and spins. A detailed spectroscopic analysis of these newly formed quasiparticles in conjunction with our microscopic theory shows that magnetically coupled excitations can have an origin and interactions that are distinct from those of excitons in conventional band semiconductors.