TT 41: CE: Spin Systems and Itinerant Magnets 1

Time: Wednesday 18:15–19:30 Location: HSZ 105

TT 41.1 Wed 18:15 HSZ 105

Orbital fluctuations versus classical orbital order in RVO_3 studied via optical spectral weight — •Julia Küppersbusch[1], Agung Nugroho[2], Thomas Palstra[2], and Markus Grüninger[1] — [1]Universität zu Köln — [2]Rijksuniversiteit Groningen

Spin and orbital degrees of freedom play a decisive role in the low-energy physics of strongly correlated transition-metal oxides. Whereas the spin is a true low-energy degree of freedom with propagating low-energy excitations, it is still questionable if the same holds true for the orbital degree of freedom. In a typical situation the orbitals are strongly coupled to the lattice, which makes it sufficient to consider classical orbitals with rigid orbital order. However, different groups have pointed out that orbital fluctuations may be strong in the $3d^2$ Mott-Hubbard insulators RVO_3 (R = rare earth ion or Y).
Optical spectroscopy offers an efficient method to study the nature of the orbital degree of freedom, because the spectral weight of excitations across the Mott-Hubbard gap depends sensitively on nearest-neighbor orbital-orbital correlations. We study the temperature dependence of the optical spectral weight by means of ellipsometry in the frequency range 0.75 - 5.5 eV. By comparing our experimental results for R = Y, Gd, and Ce with a theory which calculates the temperature dependence of the optical spectral weight based on a low-energy spin-orbital superexchange Hamiltonian [1,2], we draw a conclusion about the nature of the orbital degree of freedom in RVO_3.

[1] G. Khaliullin, P. Horsch, and A.M. Oles, Phys. Rev. B 70, 195103 (2004)
[2] A. M. Oles et al. Phys. Rev. B 72, 214431 (2005)

TT 41.2 Wed 18:30 HSZ 105

Orbitons and bi-orbitons in $GdVO_3$ and YVO_3 observed by RIXS — •Luis Mäder[1], Komalavalli Thirunavukkuarasu[1], Eva Benckiser[2,1], Giacomo Ghiringhelli[3], Marco Moretti[3], Graeme R. Blake[4], Nandang Mufti[4], A. Agung Nugroho[4,5], Thomas T. M. Palstra[4], Pasquale Marra[6], Krzysztof Wohlfeld[6], Jeroen van den Brink[6], Maurits Haverkort[2], Thorsten Schmitt[7], and Markus Grüninger[1] — [1]Universität zu Köln — [2]MPI-FKF Stuttgart — [3]Politecnico di Milano — [4]University of Groningen — [5]Institut Teknologi Bandung — [6]IFW Dresden — [7]PSI Villigen

In an orbitally ordered state, exchange interactions between orbitals on neighbouring sites could give rise to a significant dispersion of the orbital excitations. These orbitons are analogous to spin waves. Here, we report on the observation of orbital excitations in YVO_3 and $GdVO_3$ by means of high-resolution RIXS across the V $L_{3,2}$ and O K edges with the new SAXES beamline at the PSI, Villigen. Due to the excellent resolution of 60 meV, we are able to resolve the different intra-t_{2g} excitations. Our data show two different features in the low-energy regime. We interpret them as one- and bi-orbiton excitations in good agreement with our optical data [1]. For $GdVO_3$ the one-orbiton energy shows a shift of up to 40 meV as a function of momentum. This shift could be related to dispersive orbitons or, alternatively, to two different intra-t_{2g} excitations and a transfer of spectral weight between them. To figure this out we compare our data with recent calculations.

[1] E. Benckiser *et al.*, New J. Phys. **10**, 053027 (2008).

TT 41.3 Wed 18:45 HSZ 105

Charge dynamics in $CuGeO_3$: a combined RIXS and EELS study — •Valentina Bisogni[1], Claude Monney[2], Roberto Kraus[1], Kejin Zhou[2], Vladimir Strocov[2], Stefan-Ludwig Drechsler[1], Jeroen van den Brink[1], Thorsten Schmitt[2], and Jochen Geck[1] — [1]IFW, Dresden, Germany — [2]Paul Scherrer Institut, Villigen PSI, Switzerland

Model compounds of the high temperature superconductors (HTCS) are considered of big interest for the understanding of superconductivity but also for their fascinating, tuneable magnetic and electronic properties. Thanks to the low dimensionality, these model systems allow for a thorough theoretical analysis enabling to achieve a good understanding of the interactions at work. $CuGeO_3$ is a well known realization of one-dimensional antiferromagnetic S=1/2 spin chain, made of edge-sharing CuO_4- plaquettes, and undergoing a Spin-Peierls transition at T ≈14 K. Recently, thanks to the improved energy resolution, soft x-ray resonant inelastic scattering (RIXS) has demonstrated to be a suitable tool for the study of the HTCS. We performed RIXS experiments on $CuGeO_3$ at the ADRESS beamline of the Swiss Light Source. *dd*-excitations can be clearly observed at the Cu-L edge, while Cu-O charge transfer processes are enhanced at the O-K edge. Temperature and momentum dependent studies unambiguously identify the Zhang-Rice singlet in $CuGeO_3$, showing the importance of the magnetic configuration at the ground state and the Cu-O-Cu bond geometry. Complementary data measured with high resolution electron energy loss spectroscopy (EELS) are discussed in comparison with RIXS.

TT 41.4 Wed 19:00 HSZ 105

Spin Transfer Torques in MnSi at Ultra-low Current Densities — •F. Jonietz[1], S. Mühlbauer[1,2], C. Pfleiderer[1], A. Neubauer[1], W. Münzer[1], A. Bauer[1], T. Adams[1], T. Schulz[1], M. Wagner[1], R. Georgii[1,2], P. Böni[1], R. A. Duine[3], K. Everschor[4], M. Garst[4], and A. Rosch[4] — [1]Physik-Department E21, Technische Universität München, D-85748 Garching, Germany — [2]Forschungsneutronenquelle Heinz Maier-Leibnitz (FRM II), Technische Universität München, D-85748 Garching, Germany — [3]Institute for Theoretical Physics, Utrecht University, 3584 CE Utrecht, The Netherlands — [4]Institute of Theoretical Physics, University of Cologne, D-50937 Cologne, Germany

Spin manipulation using electric currents is one of the most promising directions in the field of spintronics. We used neutron scattering to observe the influence of an electric current on the magnetic structure in a bulk material. In the skyrmion lattice of MnSi, where the spins form a lattice of magnetic vortices similar to the vortex lattice in type II superconductors [1], we observe the rotation of the diffraction pattern in response to currents [2] which are over five orders of magnitude smaller than those typically applied in experimental studies on current-driven magnetization dynamics in nanostructures. We attribute our observations to an extremely efficient coupling of inhomogeneous spin currents to topologically stable knots in spin structures.

[1] S. Mühlbauer, et al. Science 323, 5916 (2009)
[2] F. Jonietz, et al. Science, in press (2010)

TT 41.5 Wed 19:15 HSZ 105

Higher-order scattering in the Skyrmion lattice in MnSi — •Tim Adams[1], Sebastian Mühlbauer[1,2], Christian Pfleiderer[1], Peter Böni[1], and Achim Rosch[3] — [1]Physik-Department E21, TU München, 85748 Garching, Germany — [2]ETH Zürich, Institut für Festkörperphysik, Zürich, Switzerland — [3]ITP, Universität zu Köln, Köln, Germany

Recent small angle neutron scattering (SANS) experiments suggest the existence of a skyrmion lattice in the A-phase of the archetypal helical magnet MnSi, where the skyrmion lattice is stabilized by thermal Gaussian fluctuations [1]. Such a skyrmion lattice represents a hexagonal spin crystal composed of topologically stable knots of the spin structure. The observation of a topological Hall effect thereby provided stringent evidence of the topological nature of the spin structure [2]. However, in the first neutron scattering studies only first order Bragg peaks were observed. We report a very careful SANS search for higher order scattering in the A-phase to establish the particle-like nature of the skyrmions forming a lattice. So-called Renninger scans thereby allowed us to clearly distinguish double scattering from higher order scattering. We find clear evidence of second order Bragg peaks. Thus the A-phase in MnSi is indeed a lattice of particle-like knots in the spin structure.

[1] S. Mühlbauer, et al., Science 323, 5916 (2009)
[2] A. Neubauer et al., Phys. Rev. Lett. 102, 186602 (2009)
[3] M. Renninger, Z. Physik, 106, 141-176 (1937)