MA 14: Focus: Magnetism as seen by neutrons

Organized by A. Schneidewind, S. Mühlbauer, and R. Georgii (Maier Leibnitz Zentrum, Garching)

Neutron scattering can serve as an essential tool for researchers studying magnetism offering a mostly exclusive access to a broad variety of static and dynamic correlations. It can be used to investigate magnetic structures, to determine magnetic interactions, to refine phase diagrams or to find dynamical timescales. In the suggested focused session examples from cutting edge research performed with the help of neutrons will be presented. We illustrate the diversity of magnetic phenomena -from magnetic spin ice and monopoles to heterostructures and interfaces- successfully understood by the use of neutron scattering and highlight its potential to a broader magnetism community.

Time: Tuesday 9:30–12:15 Location: H32

Invited Talk MA 14.1 Tue 9:30 H32
Breakthrough neutron spectroscopy for quantum magnetism — •Andrey Zheludev — Laboratory for Solid State Physics, ETH Zurich, Switzerland

Quantum magnetism is an area of research where neutron scattering has always played a leading role. Neutrons directly probe the very spin correlation functions that theorists are aiming to calculate. For quantum magnets, this comparison between theory and experiment can be very detailed and quantitative. Neutrons are also a great tool for studying quantum critical phenomena in magnets, just as they were irreplaceable in the study of thermodynamic magnetic phase transitions. Recently, the topic of quantum magnetism seemed to have lost its former luster. Many systems appeared to have been "perfectly well" understood, while for the remaining unexplored models there seemed to be few material prototypes. Fortunately, these concerns are being voided by previously unimaginable breakthroughs in neutron spectroscopy instrumentation, particularly at pulsed neutron facilities. Energy resolutions of 10 μeV are now routinely used to study spin excitations in very small samples and in very difficult sample environments with unprecedented statistics and signal to noise ratios. The enormous gains in data rates now permit us to study excitation spectra in their entirety, rather than focusing on just a few sharp and intense features. Totally new physics is being uncovered in many quantum magnets that were studied and declared "understood" 15 years ago. Theorists are again barely able to keep up with neutron experiments. In my talk I shall illustrate these points with a few recent example.

Invited Talk MA 14.2 Tue 10:00 H32
Topological magnetism as seen by neutrons — •Roderich Moessner — MPI-PKS, Dresden, Germany

Neutron scattering has for a long time been the method of choice for understanding magnetic states of matter. The advent of topological states of matter – such as classical or quantum spin liquids – is posing a new challenge as these lack signatures such as Bragg peaks or spin waves. Here, we present the important role that neutrons can play in probing such new forms of magnetism, in particular their concomitant emergent gauge fields and fractionalised excitations such as spinons, monopoles or Majorana Fermions.

15 min. break

Invited Talk MA 14.3 Tue 10:45 H32
Magnetism at heterostructures and interfaces — Jochen Mannhart and •Hans Boschker — Max Planck Institute for Solid State Research, Heisenbergstrasse 1. 70569 Stuttgart, Germany

Two oxide magnetic heterostructures will be discussed. First is the interface of La0.67Sr0.33MnO3 (LSMO) and SrTiO3 (STO). Using magnetic depth profiling with polarized neutron reflectometry, we show that convential LSMO-STO interfaces have a magnetic dead layer. In contrast, interface engineered LSMO-STO interfaces, where the polar discontinuity has been removed by locally adjusting the LSMO composition, do no have a dead layer. As magnetic devices depend on the magnetization at the interface, the interface engineered heterostructures should improve device performance. The second material is atomically thin SrRuO3. Atomically thin ferromagnetic and conducting electron systems are highly desired for spintronics because they can be controlled with both magnetic and electric fields. We present (SrRuO3)1-(SrTiO3)5 superlattices of exceptional quality. In these superlattices the electron system comprises only a single RuO2 plane. We observe conductivity down to 50 mK and a ferromagnetic state with a Curie temperature of at least 30 K and signals of magnetism in magnetotransport persisting up to approximately 100 K.

Invited Talk MA 14.4 Tue 11:15 H32
Vortex matter: from superconductivity to skyrmions — •Sebastian Mühlbauer — Heinz Maier-Leibnitz Zentrum (MLZ), Garching, Technische Universität München

Both superconducting vortex [1,2] and skyrmion lattices in chiral magnets [3] can be regarded as macroscopic lattices, formed by topological entities. Analogous to condensed matter, a large variety of phases is also observed for vortex and Skyrmion matter, resembling the particle like character and reflecting the underlying physical properties. Moreover, both vortex and Skyrmion matter represent ideal model systems for questions of general importance as topological stability and decay.

As for superconducting vortex matter, Skyrmion melting transitions, Skyrmion liquids and Skyrmion glass phases are expected to exist in various materials. Due to their topology, they provide an excellent showcase for the investigation of topological phase conversion [4].

Neutron scattering provides an ideal tool for the investigation of both vortex and Skyrmion matter. We present an overview how to address the static and dynamic properties of superconducting vortex and Skyrmion matter by means of neutron grating interferometry (nGI), time-resolved small angle neutron scattering (TISANE) and neutron resonance spin echo spectroscopy (NRSE). Our study paves the way how to access vortex and Skyrmion lattice melting as well as their current induced motion and dynamic properties in bulk samples.

[1] S. Mühlbauer et al., Phys. Rev. Lett 102 136408 (2009) [2] S. Mühlbauer et al., Phys. Rev. B 83, 184502 (2011) [3] S. Mühlbauer et al., Science 323 915 (2009) [4] P. Milde et al., Science 340, 6136, (2013)

Invited Talk MA 14.5 Tue 11:45 H32
Neutron spectroscopy – Collective excitations in (un)conventional superconductors — •Jitae Park — TU München at MLZ, Lichtenbergstr. 1, 85748 Garching

Superconductivity is one of the most fascinating phenomena in condensed matter because its macroscopic behavior is apparently originated from the quantum mechanics of electrons: Formation of electron pairs that are bound together via a small attractive interaction between them, also called Cooper pairs. Over several decades, dedicated theoretical works have revealed that collective motions of either atoms or spins are the most important ingredient for the electron pairing in the superconducting state. Owing to the uniqueness of a neutron scattering method with accessibility over wide momentum and energy space, we can preciesly measure such collective excitations in superconducting materials. In this talk, I will introduce how the inelastic neutron scattering study contributes to the superconductivity research field by presenting a few recent example cases mostly done at the research reactor in Munich.