MA 29: Quantum information systems

Time: Wednesday 9:30–10:30 Location: H53

MA 29.1 Wed 9:30 H53

Demonstration of coherent Light-Matter-Spin Interaction — •Marco Pfirrmann[1], Alexey V. Ustinov[1,2], and Martin Weides[1,3] — [1]Karlsruhe Institute of Technology, Karlsruhe, Germany — [2]National University of Science and Technology MISIS, Moscow, Russia — [3]University of Glasgow, Glasgow, UK

Cavity-magnon-polaritons, hybrid light-spin quasiparticles, are of considerable interest to implement quantum transducers and memories. Formed by two coupled harmonic subsystems, their level structure is harmonic as well. The addition of a non-linearity would increase their functionalities significantly, e.g. by adding an anharmonic component. We demonstrate such a tripartite quantum hybrid system consisting of cavity photons, qubit transitions and spin excitations. A 3D microwave cavity couples strongly to both a superconducting transmon qubit and a ferrimagnetic YIG sphere. Nearly degenerated qubit and cavity frequencies provide dressed states with a level splitting in excess of 100 MHz. The magnon is tuned into and through resonance by an external magnetic field, with an observed coupling larger than 15 MHz. Spectroscopic and time-resolved data of the collective system are demonstrated.

MA 29.2 Wed 9:45 H53

Spin dynamics of Ho single atom magnets — F. Donati[1,2], S. Rusponi[2], L. Persichetti[3], S. Stepanow[3], •A. Singha[1,2], R. Baltic[2], C. Wäckerlin[2], M. Pivetta[1], C. Nistor[3], J. Dreiser[4], K. Kummer[5], E. V.-Fort[5], D. Juraschek[3], N. Spaldin[3], H. Brune[2], and P. Gambardella[3] — [1]IBS Center for Quantum Nanoscience, South Korea — [2]EPFL, Switzerland — [3]ETH Zurich, Switzerland — [4]PSI, Switzerland — [5]ESRF, France

Single atom magnets represent the smallest unit of matter that can be used to store and manipulate information. The strongly localized 4f electrons in rare earth atoms allow only weak interaction with the environment, leading to long magnetic lifetimes as recently discovered for single Ho atoms adsorbed on MgO/Ag(100) [Science 352, 318 (2016)]. Reading and writing their magnetic states at the atomic scale further demonstrated the potential of these atoms as magnetic bits up to 45 K [PRL 121, 027201 (2018)]. Here we investigate the spin reversal mechanism of the Ho atoms by exploring the effects of temperature and external magnetic field on the magnetic lifetime using x-ray magnetic circular dichroism. At 0.01 T, the lifetime of Ho atoms is 1500 s up to 10 K and decreases with temperature following an exponential Arrhenius law with an effective barrier of 4 ± 0.5 meV. However, spin reversal is suppressed in a strong magnetic field of 6.8 T, and the magnetic lifetime remains constant at about 1200 s up to 30 K. Our results suggest that the Ho atoms can mainly exchange energy and angular momentum with the surface via localized vibrational modes of quantized energy, which limits the effectiveness of spin reversal mechanisms.

MA 29.3 Wed 10:00 H53

Investigation of intrinsic decoherence in different closed quantum spin systems — •Patrick Vorndamme and Jürgen Schnack — Universität Bielefeld, PF 100131, D-33501 Bielefeld

Not only in spintronic devices, but also as constituents of quantum simulators or quantum computers, magnetic molecules have many potential applications. At low temperatures the magnetic levels of molecular nanomagnets enable the use as qubits. For such an application the investigation and understanding of decoherence caused by external and internal effects is very important. For now, we work with a pure spin Hamiltonian which contains both, the qubits of interest and bath spins. Both together form our closed system of which we perform time evolutions numerically. We interpret decoherence as entanglement of the qubits with the bath spins, resulting in a mixed reduced density matrix of the qubits. With our spin Hamiltonian we can treat isotropic exchange couplings and anisotropic effects, such as dipolar interactions and easy magnetization axes caused by spin orbit coupling. Our goal is to find qubit states that are insensitive to decoherence. For this purpose we examine clock transitions as well as the stability of ground states with nonzero toroidal moment and zero magnetic moment in different spin constructs, such as spin-frustrated triangular nanomagnets (like Cu_3) with strong antiferromagnetic coupling and weak spin orbit coupling. In fact, there are several ways to realize toroidal moments with both a strong spin orbit coupling and a weak one. In a quantum computer such moments could be conveniently manipulated with a spin-polarized current.

MA 29.4 Wed 10:15 H53

Edge mode locality of symmetry protected topologically ordered spin chains under perturbations — •Marcel Goihl, Christian Krumnow, Marek Gluza, Jens Eisert, and Nicolas Tarantino — Dahlem Center for Complex Quantum Systems, Freie Universität Berlin, 14195 Berlin, Germany

Spin chains with a symmetry-protected ground state degeneracy are the prototypical systems for exploring topological effects in quantum systems. Recently, various methods of classifying topological order were established and particular representatives, known as fixed-point models, of different classes were constructed. Motivated by on-going experimental developments towards realizing such systems by way of quantum simulation and material engineering, we study how localized edge modes in these systems are deformed by local interactions and disorder. By designing numerical methods for constructing locally conserved operators, we find that interactions of all kinds delocalize the edge modes. The sensitivity of the edge mode operators to disorder is dependent not only on the disorder strength but also the choice and strength of the interaction as well as the edge mode operator being studied. In the many-body interacting regime, we find that one edge mode operator behaves as if subjected to a non-interacting perturbation. This implies that in finite systems edge mode operators effectively delocalize at distinct interaction strengths.