Kevin van Hoogdalem **Journal Club** 27/11/2012

Imam Makhfudz, Benjamin Krüger, and Oleg Tchernyshyov
**Inertia and Chiral Edge Modes of a Skyrmion Magnetic Bubble**
*Phys. Rev. Lett. 109, 217201 (2012)*
The dynamics of a vortex in a thin-film ferromagnet resembles the motion of a charged massless particle in a uniform magnetic field. Similar dynamics is expected for other magnetic textures with a nonzero Skyrmion number. However, recent numerical simulations reveal that Skyrmion magnetic bubbles show significant deviations from this model. We show that a Skyrmion bubble possesses inertia and derive its mass from the standard theory of a thin-film ferromagnet. In addition to center-of-mass motion, other low energy modes are waves on the edge of the bubble traveling with different speeds in opposite directions.

R. Ilan, J. Cayssol, J. H. Bardarson, and J. E. Moore
**Nonequilibrium Transport Through a Gate-Controlled Barrier on the Quantum Spin Hall Edge**
Phys. Rev. Lett. 109, 216602 (2012)
The quantum spin Hall insulator is characterized by the presence of gapless helical edge states where the spin of the charge carriers is locked to their direction of motion. In order to probe the properties of the edge modes, we propose a design of a tunable quantum impurity realized by a local gate under an external magnetic field. Using the integrability of the impurity model, the conductance is computed for arbitrary interactions, temperatures and voltages, including the effect of Fermi liquid leads. The result can be used to infer the strength of interactions from transport experiments.

S. Sasaki, Z. Ren, A. A. Taskin, K. Segawa, L. Fu, and Y. Ando
**Odd-Parity Pairing and Topological Superconductivity in a Strongly Spin-Orbit Coupled Semiconductor**
*Phys. Rev. Lett. 109, 217004 (2012)*
The existence of topological superconductors preserving time-reversal symmetry was recently predicted, and they are expected to provide a solid-state realization of itinerant massless Majorana fermions and a route to topological quantum computation. Their first likely example, Cu*x*Bi2Se3, was discovered last year, but the search for new materials has so far been hindered by the lack of a guiding principle. Here, we report point-contact spectroscopy experiments suggesting that the low-carrier-density superconductor Sn1-*x*In*x*Te is accompanied by surface Andreev bound states which, with the help of theoretical analysis, would give evidence for odd-parity pairing and topological superconductivity. The present and previous finding of possible topological superconductivity in Sn1-*x*In*x*Te and Cu*x*Bi2Se3 suggests that odd-parity pairing favored by strong spin-orbit coupling is likely to be a common underlying mechanism for materializing topological superconductivity.

N. R. Cooper and R. Moessner
**Designing Topological Bands in Reciprocal Space**
*Phys. Rev. Lett. 109, 215302 (2012)*
Motivated by new capabilities to realize artificial gauge fields in ultracold atomic systems, and by their potential to access correlated topological phases in lattice systems, we present a new strategy for designing topologically nontrivial band structures. Our approach is simple and direct: it amounts to considering tight-binding models directly *in reciprocal space*. These models naturally cause atoms to experience highly uniform magnetic flux density and lead to topological bands with very narrow dispersion, without fine-tuning of parameters. Further, our construction immediately yields instances of optical Chern lattices, as well as band structures with Chern numbers of magnitude larger than one.

R. Schmidt, A. Schwarz, and R. Wiesendanger
**Magnetization switching utilizing the magnetic exchange interaction**
*Phys. Rev. B 86, 174402 (2012)*
We demonstrate the feasibility of observing and inducing magnetization switching using the distance dependence of the magnetic exchange interaction. The experiments were performed employing an atomic force microscopy setup on the antiferromagnetic iron monolayer on the (001) surface of tungsten with magnetic tips that behaved like independent superparamagnetic clusters with uniaxial anisotropy. Applying the Néel-Brown law, we were able to determine energy barriers from lifetimes measured at different distances with and without external magnetic field. Our findings suggest that the distance dependence of the magnetic exchange interaction can be utilized to monitor and control magnetization dynamics on the atomic level.

Dmitry I. Pikulin, Yuli V. Nazarov
**Two types of topological transitions in finite Majorana wires**
*arXiv:1211.5580v1 [cond-mat.mes-hall]*
Motivated by the recent advances in studying Majorana states in nanowires under conditions of superconducting proximity effect, we address the correspondence between the common topological transition in infinite system and the topological transition of other type that manifests itself in the positions of the poles of the scattering matrices. We establish a universal dependence of the pole positions in the vicinity of the common transition on the parameter controlling the transition, and discuss the manifestations of the pole transitions in the differential conductance.

B. Obry, V. I. Vasyuchka, A. V. Chumak, A. A. Serga, B. Hillebrands
**Spin-wave propagation and transformation in a thermal gradient**
*arXiv:1211.5017v1 [cond-mat.mes-hall]*
The influence of a thermal gradient on the propagation properties of externally excited dipolar spin waves in a magnetic insulator waveguide is investigated. It is shown that spin waves propagating towards a colder region along the magnetization direction continuously reduce their wavelength. The wavelength increase of a wave propagating into a hotter region was utilized to realize its decomposition in the partial waveguide modes which are reflected at different locations. This influence of temperature on spin-wave properties is mainly caused by a change in the saturation magnetization and yields promising opportunities for the manipulation of spin waves in spin-caloritronic applications.

*M. Weitz, J. Klaers, F. Vewinger*
**Optomechanical Generation of a Photon Bose-Einstein Condensate**
*arXiv:1211.4793v1 [cond-mat.quant-gas]*
We propose to thermalize a low-dimensional photon gas and obtain photon Bose-Einstein condensation by optomechanical interactions in a microscopic optical cavity, with a single longitudinal mode and many transverse modes. The geometry of the short cavity is such that it provides a low-frequency cutoff at a photon energy that is far above the thermal energy, so that thermal emission of photons is suppressed and the photon number is conserved. While previous experiments on photon Bose-Einstein condensation have used dye molecules for photon gas thermalization, we here investigate thermalization owing to interactions with thermally fluctuating nanomechanical oscillators forming the cavity mirrors. In the quantum degenerate regime, the nanomechanical cavity converts broadband optical radiation into tuneable coherent radiation.

*A. Barreiro, H. S. J. van der Zant, L. M. K. Vandersypen*
**Quantum Dots at Room Temperature carved out from Few-Layer Graphene**
*arXiv:1211.4551v2 [cond-mat.mes-hall]*
We present graphene quantum dots endowed with addition energies as large as 1.6 eV, fabricated by the controlled rupture of a graphene sheet subjected to a large electron current in air. The size of the quantum dot islands is estimated to be in the 1 nm range. The large addition energies allow for Coulomb blockade at room temperature, with possible application to single-electron devices.