PRL 109, 226804: **Magnetoelectric Effects in Superconducting Nanowires with Rashba Spin-Orbit Coupling**
Teemu Ojanen
Recent experiments in semiconductor nanowires with a spin-orbit coupling and proximity-induced superconductivity exhibit signatures of Majorana bound states predicted to exist in the topological phase. In this Letter we predict that these nanowire systems exhibit unconventional magnetoelectric effects showing a sharp crossover behavior at the topological phase transition. We find that magnetic fields with a component parallel to the spin-orbit field can give rise to currents in equilibrium. Surprisingly, also fields perpendicular to the spin-orbit field may induce currents and can be employed in adiabatic charge pumping. The perpendicular field magnetoelectric effect may be regarded as a manifestation of the anomalous Hall effect in one dimension. We discuss how the predicted phenomena could be observed in experiments and in probing the topological phase transition.

Nature 491, 736: **Observing the drop of resistance in the flow of a superfluid Fermi gas**
David Stadler, Sebastian Krinner, Jakob Meineke, Jean-Philippe Brantut, and Tilman Esslinger
The ability of particles to flow with very low resistance is characteristic of superfluid and superconducting states, leading to their discovery in the past century. Although measuring the particle flow in liquid helium or superconducting materials is essential to identify superfluidity or superconductivity, no analogous measurement has been performed for superfluids based on ultracold Fermi gases. Here we report direct measurements of the conduction properties of strongly interacting fermions, observing the well-known drop in resistance that is associated with the onset of superfluidity. By varying the depth of the trapping potential in a narrow channel connecting two atomic reservoirs, we observed variations of the atomic current over several orders of magnitude. We related the intrinsic conduction properties to the thermodynamic functions in a model-independent way, by making use of high-resolution in situ imaging in combination with current measurements. Our results show that, as in solid-state systems, current and resistance measurements in quantum gases provide a sensitive probe with which to explore many-body physics. Our method is closely analogous to the operation of a solid-state field-effect transistor and could be applied as a probe for optical lattices and disordered systems, paving the way for modeling complex superconducting devices.

Nature Physics 8, 902: **Identifying topological order by entanglement entropy**
Hong-Chen Jiang, Zhenghan Wang and Leon Balents
Topological phases are unique states of matter that incorporate long-range quantum entanglement and host exotic excitations with fractional quantum statistics. Here we report a practical method to identify topological phases in arbitrary realistic models by accurately calculating the topological entanglement entropy using the density matrix renormalization group (DMRG). We argue that the DMRG algorithm systematically selects a minimally entangled state from the quasi-degenerate ground states in a topological phase. This tendency explains both the success of our method and the absence of ground-state degeneracy in previous DMRG studies of topological phases. We demonstrate the effectiveness of our procedure by obtaining the topological entanglement entropy for several microscopic models, with an accuracy of the order of 10^(-3), when the circumference of the cylinder is around ten times the correlation length. As an example, we definitively show that the ground state of the quantum S = 1/2 antiferromagnet on the kagome lattice is a topological spin liquid, and strongly constrain the conditions for identification of this phase of matter.

PRL 109, 227201: **Chiral Spin Waves in Fermi Liquids with Spin-Orbit Coupling**
Ali Ashrafi and Dmitrii L. Maslov
We predict the existence of chiral spin waves–collective modes in a two-dimensional Fermi liquid with the Rashba or Dresselhaus spin-orbit coupling. Starting from the phenomenological Landau theory, we show that the long-wavelength dynamics of magnetization is governed by the Klein-Gordon equations. The standing-wave solutions of these equations describe ‘‘particles’’ with effective masses, whose magnitudes and signs depend on the strength of the electron-electron interaction. The spectrum of the spin-chiral modes for arbitrary wavelengths is determined from the Dyson equation for the interaction vertex. We propose to observe spin-chiral modes via microwave absorption by standing waves confined by an in-plane profile of the spin-orbit splitting.

PRL 109, 226406: **Quantum Oscillations in the Topological Superconductor Candidate $Cu_{0.25}Bi_2Se_3$**
Ben J. Lawson, Y. S. Hor, and Lu Li
Quantum oscillations are generally studied to resolve the electronic structure of topological insulators. In Cu0.25Bi2Se3, the prime candidate of topological superconductors, quantum oscillations are still not observed in magnetotransport measurement. However, using torque magnetometry, quantum oscillations (the de Haas–van Alphen effect) were observed in Cu0.25Bi2Se3. The doping of Cu in Bi2Se3 increases the carrier density and the effective mass without increasing the scattering rate or decreasing the mean free path. In addition, the Fermi velocity remains the same in Cu0.25Bi2Se3 as that in Bi2Se3. Our results imply that the insertion of Cu does not change the band structure and that conduction electrons in Cu doped Bi2Se3 sit in the linear Dirac-like band.

Nature Physics 8, 906: **Spin dynamics of molecular nanomagnets unravelled at atomic scale by four-dimensional inelastic neutron scattering**
Michael L. Baker, Tatiana Guidi, Stefano Carretta, Jacques Ollivier, Hannu Mutka, Hans U. Güdel, Grigore A. Timco, Eric J. L. McInnes, Giuseppe Amoretti, Richard E. P. Winpenny and Paolo Santini
Molecular nanomagnets are among the first examples of finite-size spin systems and have been test beds for addressing several phenomena in quantum dynamics. In fact, for short-enough timescales the spin wavefunctions evolve coherently according to an appropriate spin Hamiltonian, which can be engineered to meet specific requirements. Unfortunately, so far it has been impossible to determine these spin dynamics directly. Here we show that recently developed instrumentation yields the four-dimensional inelastic-neutron scattering function in vast portions of reciprocal space and enables the spin dynamics to be determined directly. We use the Cr8 antiferromagnetic ring as a benchmark to demonstrate the potential of this approach, which allows us, for example, to examine how quantum fluctuations propagate along the ring or to test the degree of validity of the Néel-vector-tunnelling framework.

PRL 109, 227001: **Proposed Detection of the Topological Phase in Ring-Shaped Semiconductor-Superconductor Nanowires Using Coulomb Blockade Transport**
Bjorn Zocher, Mats Horsdal, and Bernd Rosenow
In semiconductor-superconductor hybrid structures a topological phase transition is expected as a function of the chemical potential or magnetic field strength. We show that signatures of this transition can be observed in nonlinear Coulomb blockade transport through a ring shaped structure. In particular, on the scale of the superconducting gap and for a fixed electron parity of the ring, the excitation spectrum is independent of flux in the topologically trivial phase but acquires a characteristic h=e periodicity in the nontrivial phase. We relate the h=e periodicity to the recently predicted 4% periodicity of the Josephson current across a junction formed by two topological superconductors.

PRL 109, 223601: **Strong Coupling and Long-Range Collective Interactions in Optomechanical Arrays**
Andre Xuereb, Claudiu Genes, and Aurelien Dantan
We investigate the collective optomechanics of an ensemble of scatterers inside a Fabry-Perot resonator and identify an optimized configuration where the ensemble is transmissive, in contrast to the usual reflective optomechanics approach. In this configuration, the optomechanical coupling of a specific collective mechanical mode can be several orders of magnitude larger than the single-element case, and long-range interactions can be generated between the different elements since light permeates throughout the array. This new regime should realistically allow for achieving strong single-photon optomechanical coupling with massive resonators, realizing hybrid quantum interfaces, and exploiting collective long- range interactions in arrays of atoms or mechanical oscillators.

PRA 86, 053826: **Backaction limits on self-sustained optomechanical oscillations**
M. Poot, K. Y. Fong, M. Bagheri, W. H. P. Pernice, and H. X. Tang
The maximum amplitude of mechanical oscillators coupled to optical cavities is studied both analytically and numerically. The optical backaction on the resonator enables self-sustained oscillations whose limit cycle is set by the dynamic range of the cavity. The maximum attainable amplitude and the phonon generation quantum efficiency of the backaction process are studied for both unresolved and resolved cavities. Quantum efficiencies far exceeding one are found in the resolved sideband regime where the amplitude is low. On the other hand, the maximum amplitude is found in the unresolved system. Finally, role of mechanical nonlinearities is addressed.

arXiv:1211.7215: **A Quantum Single Photon Transistor in Circuit Quantum Electrodynamics**
Lukas Neumeier, Martin Leib, and Michael J. Hartmann
We introduce a circuit quantum electrodynamical setup for a quantum single photon transistor. In our approach single photons propagate in two open transmission lines that are coupled via two interacting transmon qubits. The interaction is such that photons are not exchanged between the two transmission lines but a photon in one line can completely block respectively enable the propagation of photons in the other line. High on-off ratios can be achieved for feasible experimental parameters. Our approach is inherently scalable as all photon pulses can have the same pulse shape and carrier frequency such that output signals of one transistor can be input signals for a consecutive transistor.

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arXiv:1211.6056: **Nonsymmetrized Correlations in Quantum Noninvasive Measurements**
Adam Bednorz, Christoph Bruder, Bertrand Reulet and Wolfgang Belzig

arXiv:1211.7029: **Strong-coupling effects in dissipatively coupled optomechanical systems**
Talitha Weiss, Christoph Bruder and Andreas Nunnenkamp