Full counting statistics of Andreev tunneling
V. F. Maisi and D. Kambly and C. Flindt and J. P. Pekola, *arXiv:1307.4176*

The full counting statistics (FCS) of charge transfer in nano-electronic circuits provides information about fundamental tunneling processes. FCS is not limited to normal-state conductors, but may equally well describe charge fluctuations in superconducting structures. Nevertheless, despite considerable theoretical interest in the FCS of superconductors, experiments have so far been restricted to normal-state electrons. Here we measure the FCS of Andreev events in which Cooper pairs are either produced from electrons that are reflected as holes at a superconductor/normal-state interface or annihilated in the reverse process. Surprisingly, the FCS consists of quiet periods with no Andreev processes, interrupted by the tunneling of a single electron that triggers an avalanche of Andreev events giving rise to strongly super-Poissonian distributions. Our experiment is important for quantum metrological applications and for entanglement generation using Cooper pair splitters.

Full counting statistics of persistent current
A. Komnik and G. W. Langhanke, *arXiv:1307.5739*

We develop a method for calculation of charge transfer statistics of persistent current in nanostructures. We consider a simply connected one-dimensional system (a wire) with arbitrary interactions and develop a procedure for the calculation of FCS of persistent currents when the wire is closed into a ring via a weak link. For the non-interacting system we derive a general formula in terms of the two-particle Green's functions. We show that, contrary to the conventional tunneling contacts, the resulting cumulant generating function has a doubled periodicity as a function of the counting variable. We apply our general formula to short tight-binding chains and show that the FCS perfectly reproduces the known evidence for the persistent current. Its second cumulant turns out to be maximal at the switching points and vanishes identically at zero temperature. Furthermore, we consider a system with an embedded Anderson impurity and employing a self-energy approximation find an overall suppression of persistent current as well as of its noise.

Majorana states and devices in magnetic structures
Teemu Ojanen, *arXiv:1307.5506*

The pursuit for Majorana fermions is one of the top priorities in condensed matter physics at the moment. In this work we propose a new method of fabricating Majorana Josephson devices in systems with a weak or no spin-orbit coupling and without external magnetic fields. Our proposal is based on curved semiconductor wires in the proximity of superconducting elements and a small number of nanomagnets. With this method it is possible to fabricate devices that are not feasible by employing straight topological wire segments. The proposed method is naturally scalable and opens up a possibility for a systematic fabrication of arrays of Majorana states where a pair of Majorana states is obtained from a single magnet.

Algebra of Majorana Doubling
Jaehoon Lee and Frank Wilczek, *arXiv:1307.3245*

Motivated by the problem of identifying Majorana mode operators at junctions, we analyze a basic algebraic structure leading to a doubled spectrum. In general the emergent mode creation operator is highly non-linear in the original effective mode operators, and therefore also in the underlying electron creation and destruction operators. We briefly compare and contrast related issues in the Pfaffian quantum Hall state.

Electrical detection of topological phase transitions in disordered Majorana nanowires
Benjamin M. Fregoso and Alejandro M. Lobos and S. Das Sarma, *arXiv:1307.3505*

We study a disordered superconducting nanowire, with broken time-reversal and spin-rotational symmetry, which can be driven into a topological phase with end Majorana bound states by an externally applied magnetic field. It is known that, as a function of disorder strength, the Majorana nanowire has a delocalization quantum phase transition transition from a topologically non-trivial phase, which supports Majorana bound states, to a non-topological insulating phase without them. On both sides of the transition, the system has localized wave functions at zero energy albeit with very different topological properties. We propose a simple electrical transport measurement to detect the localization-delocalization transition occurring in the bulk of the nanowire. The basic idea consists of measuring the difference of conductances at one end of the wire obtained at different values of the coupling to the opposite lead. We show that this experiment reveals the non-local correlations between the left and right ends of the nanowire emergent only at the topological transition. Hence, while the proposed experiment does not directly probe the end Majorana bound states, it might provide direct evidence for the bulk topological quantum phase transition itself.

Non-equilibrium spin-current detection with a single Kondo impurity
Jong Soo Lim and Rosa Lopez and Laurent Limot and Pascal Simon, *arXiv:1307.4970*

We present a theoretical study based on the Anderson model of the transport properties of a Kondo impurity (atom or quantum dot) connected to ferromagnetic leads, which can sustain a non-equilibrium spin current. We analyze the case where the spin current is injected by an external source and when it is generated by the voltage bias. Due to the presence of ferromagnetic contacts, a static exchange field is produced that eventually destroys the Kondo correlations. We find that such a field can be compensated by an appropriated combination of the spin-dependent chemical potentials leading to the restoration of the Kondo resonance. In this respect, a Kondo impurity may be regarded as a very sensitive sensor for non-equilibrium spin phenomena.

Non-monotonic spin relaxation and decoherence in graphene quantum dots with spin-orbit interactions
Marco O. Hachiya and Guido Burkard and J. Carlos Egues, *arXiv:1307.4668*

We investigate the spin relaxation and decoherence in a single-electron graphene quantum dot with Rashba and intrinsic spin-orbit interactions. We derive an effective spin-phonon Hamiltonian via the Schrieffer-Wolff transformation in order to calculate the spin relaxation time T_1 and decoherence time T_2 within the framework of the Bloch-Redfield theory. In this model, the emergence of a non-monotonic dependence of T_1 on the external magnetic field is attributed to the Rashba spin-orbit coupling-induced anticrossing of opposite spin states. A rapid decrease of T_1 occurs when the spin and orbital relaxation rates become comparable in the vicinity of the spin-mixing energy-level anticrossing. By contrast, the intrinsic spin-orbit interaction leads to a monotonic magnetic field dependence of the spin relaxation rate which is caused solely by the direct spin-phonon coupling mechanism. Within our model, we demonstrate that the decoherence time T_2 ~ 2 T_1 is dominated by relaxation processes for the electron-phonon coupling mechanisms in graphene up to leading order in the spin-orbit interaction. Moreover, we show that the energy anticrossing also leads to a vanishing pure spin dephasing rate for these states for a super-Ohmic bath.

Hybrid Microwave Cavity Heat Engine
Christian Bergenfeldt and Peter Samuelsson and Björn Sothmann and Christian Flindt and Markus Büttiker, *arXiv:1307.4833*

We propose and analyze the use of hybrid microwave cavities as quantum heat engines. A possible realization consists of two macroscopically separated quantum dot conductors coupled capacitively to the fundamental mode of a microwave cavity. We demonstrate that an electrical current can be induced in one conductor through cavity-mediated processes by heating up the other conductor. The heat engine can reach Carnot efficiency with optimal conversion of heat to work. When the system delivers the maximum power, the efficiency can be a large fraction of the Carnot efficiency. The heat engine functions even with moderate electronic relaxation and dephasing in the quantum dots. We provide detailed estimates for the electrical current and output power using realistic parameters.

Arbitrarily large steady-state bosonic squeezing via dissipation
Andreas Kronwald and Florian Marquardt and Aashish A. Clerk, *arXiv:1307.5309*

We discuss how large amounts of steady-state quantum squeezing (beyond 3 dB) of a mechanical resonator can be obtained by driving an optomechanical cavity with two control lasers with differing amplitudes. The scheme does not rely on any explicit measurement or feedback, nor does it simply involve a modulation of an optical spring constant. Instead, it uses a dissipative mechanism with the driven cavity acting as an engineered reservoir. It can equivalently be viewed as a coherent feedback process, related to the quantum non-demolition measurement of a single mechanical quadrature. We analyze how to optimize the scheme, how the squeezing scales with system parameters, and how it may be directly detected from the cavity output. Our scheme is extremely general, and could also be implemented with, e.g., superconducting circuits.