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Experimental Proposal to Detect Topological Ground State Degeneracy
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arXiv:1401.3750
One of the most profound features of topologically ordered states of matter, such as the fractional quantum Hall (FQH) states, is that they possess topology-dependent ground state degeneracies that are robust to all local perturbations. Here we propose to directly detect these topological degeneracies in an experimentally accessible setup. The detection scheme uses electrical conductance measurements in a double layer FQH system with appropriately patterned top and bottom gates. We discuss two experimental platforms; in the first, the detection of topologically degenerate states coincides with the detection of ZN parafermion zero modes. We map the relevant physics to a single-channel ZN quantum impurity model, providing a novel generalization of the Kondo model. Our proposal can also be adapted to detect the ZN parafermion zero modes recently discovered in FQH line junctions proximitized with superconductivity.

Transmon-based simulator of nonlocal electron-phonon coupling: a platform for observing sharp small-polaron transitions
Vladimir M. Stojanovic, Mihajlo Vanevic, Eugene Demler, Lin Tian
arXiv:1401.4783
We propose an analog superconducting quantum simulator for a one-dimensional model featuring momentum-dependent (nonlocal) electron-phonon couplings of Su-Schrieffer-Heeger and "breathing-mode" types. Because its corresponding vertex function depends on both the electron- and phonon quasimomenta, this model does not belong to the realm of validity of the Gerlach-Löwen theorem that rules out any nonanalyticities in single-particle properties. The superconducting circuit behind the proposed simulator entails an array of transmon qubits and microwave resonators. By applying microwave driving fields to the qubits, a small-polaron Bloch state with an arbitrary quasimomentum can be prepared in this system within times several orders of magnitude shorter than the typical qubit decoherence times. We demonstrate that in this system – by varying the circuit parameters – one can readily reach the critical coupling strength required for observing the sharp transition from a nondegenerate (single-particle) ground state corresponding to zero quasimomentum ($K_{\mathrm{gs}} = 0$) to a twofold-degenerate small-polaron ground state at nonzero quasimomenta K_{gs} and $-K_{\mathrm{gs}}$. Through exact numerical diagonalization of our effective Hamiltonian, we show how this nonanalyticity is reflected in the relevant single-particle properties (ground-state energy, quasiparticle residue, average number of phonons). The proposed setup provides an ideal testbed for studying quantum dynamics of polaron formation in systems with strongly momentum-dependent electron-phonon interactions.

Non-equilibrium noise in the (non-)Abelian fractional quantum Hall effect
Olaf Smits, J. K. Slingerland, Steven H. Simon
arXiv:1401.4581
We analyse the noise of the edge current of a generic fractional quantum Hall state in a tunnelling point contact system. We show that the non-symmetrized noise in the edge current for the system out-of-equilibrium is completely determined by the noise in the tunnelling current and the Nyquist-Johnson (equilibrium) noise of the edge current. Simply put, the noise in the tunnelling current does not simply add up the equilibrium noise of the edge current. A correction term arises associated with the correlation between the tunnelling current and the edge current. We show, using a non-equilibrium Ward identity, that this correction term is determined by the anti-symmetric part of the noise in the tunnelling current. This leads to a non-equilibrium fluctuation-dissipation theorem and related expressions for the excess and shot noise of the noise in the edge current. Our approach makes use of simple properties of the edge, such as charge conservation and chirality, and applies to generic constructions of the edge theory which includes edges of non-Abelian states and edges with multiple charged channels. Two important tools we make use of are the non-equilibrium Kubo formula and the non-equilibrium Ward identity. We discuss these identities in the appendix.

A quantum magnetic RC circuit
Kevin A. van Hoogdalem, Mathias Albert, Pascal Simon, Daniel Loss
arXiv:1401.5712
We propose a setup that is the spin analog of the charge-based quantum RC circuit. We define and compute the spin capacitance and the spin resistance of the circuit for both ferromagnetic (FM) and antiferromagnetic (AF) systems. We find that the antiferromagnetic setup has universal properties, but the ferromagnetic setup does not. We discuss how to use the proposed setup as a quantum source of spin excitations, and put forward a possible experimental realization using ultracold atoms in optical lattices.

Current-induced magnetization dynamics at the edge of a two-dimensional electron system with strong spin-orbit coupling
A. Kononov, S.V. Egorov, G. Biasiol, L. Sorba, E.V. Deviatov

arXiv:1401.5719
We experimentally investigate electron transport through the interface between a permalloy ferromagnet and the edge of a two-dimensional electron system with strong Rashba-type spin-orbit coupling. We observe strongly non-linear transport around zero bias at millikelvin temperatures. The observed nonlinearity is fully suppressed above some critical values of temperature, magnetic field, and current through the interface. We interpret this behavior as the result of spin accumulation at the interface and its current-induced absorption as a magnetization torque.

Robust Transport Signatures of Topological Superconductivity in Topological Insulator Nanowires
Fernando de Juan, Roni Ilan, Jens H. Bardarson
arXiv:1401.5832
Finding a clear signature of topological superconductivity in transport experiments remains an outstanding challenge. In this work, we propose exploiting the unique properties of three-dimensional topological insulator nanowires to generate a normal-superconductor junction in the single-mode regime where an exactly quantized $2e^2/h$ zero-bias conductance can be observed over a wide range of realistic system parameters. This is achieved by inducing superconductivity in half of the wire, which can be tuned at will from trivial to topological with a parallel magnetic field, while a perpendicular field is used to gap out the normal part, except for two spatially separated chiral channels. The combination of chiral mode transport and perfect Andreev reflection makes the measurement robust to moderate disorder, and the quantization of conductance survives to much higher temperatures than in tunnel junction experiments. Our proposal may be understood as a variant of a Majorana interferometer which is easily realizable in experiments.