Mapping the optimal route between two quantum states
S. J. Weber, A. Chantasri, J. Dressel, A. N. Jordan, K. W. Murch, and I. Siddiqi, *arXiv:1403.4992*

A central feature of quantum mechanics is that a measurement is intrinsically probabilistic. As a result, continuously monitoring a quantum system will randomly perturb its natural unitary evolution. The ability to control a quantum system in the presence of these fluctuations is of increasing importance in quantum information processing and finds application in fields ranging from nuclear magnetic resonance to chemical synthesis. A detailed understanding of this stochastic evolution is essential for the development of optimized control methods. Here we reconstruct the individual quantum trajectories of a superconducting circuit that evolves in competition between continuous weak measurement and driven unitary evolution. By tracking individual trajectories that evolve between an arbitrary choice of initial and final states we can deduce the most probable path through quantum state space. These pre- and post-selected quantum trajectories also reveal the optimal detector signal in the form of a smooth time-continuous function that connects the desired boundary conditions. Our investigation reveals the rich interplay between measurement dynamics, typically associated with wave function collapse, and unitary evolution of the quantum state as described by the Schrodinger equation. These results and the underlying theory, based on a principle of least action, reveal the optimal route from initial to final states, and may enable new quantum control methods for state steering and information processing.

Mapping the optimal route between two quantum states
A. Chantasri, J. Dressel, and A. N. Jordan, *Phys. Rev. A **88**, 042110*

We present a stochastic path integral formalism for continuous quantum measurement that enables the analysis of rare events using action methods. By doubling the quantum state space to a canonical phase space, we can write the joint probability density function of measurement outcomes and quantum state trajectories as a phase space path integral. Extremizing this action produces the most-likely paths with boundary conditions defined by preselected and postselected states as solutions to a set of ordinary differential equations. As an application, we analyze continuous qubit measurement in detail and examine the structure of a quantum jump in the Zeno measurement regime.

Optomechanical-like coupling between superconducting resonators
J. R. Johansson, G. Johansson, and Franco Nori, *arXiv:1403.4341*

We propose and analyze a circuit that implements a nonlinear coupling between two superconducting microwave resonators. The resonators are coupled through a superconducting quantum interference device (SQUID) that terminates one of the resonators. This produces a nonlinear interaction on the standard optomechanical form, where the quadrature of one resonator couples to the photon number of the other resonator. The circuit therefore allows for all-electrical realizations of analogs to optomechanical systems, with coupling that can be both strong and tunable. We estimate the coupling strengths that should be attainable with the proposed device, and we find that the device is a promising candidate for realizing the single-photon strong-coupling regime. As a potential application, we discuss implementations of networks of nonlinearly-coupled microwave resonators, which could be used in microwave-photon based quantum simulation.

Quasiperiodicity and revivals in dynamics of quantum phase slips in Josephson junction chains and superconducting nanowires
G. Rastelli, M. Vanevic, and W. Belzig, *arXiv:1403.4565*

Quantum phase slips in superconducting loops threaded by an external magnetic field provide a coupling between macroscopic quantum states with supercurrents circulating in opposite directions. We analyze the dynamics of the phase slips as a function of the superconducting loop length, from fully coherent dynamics for short loops to dissipative dynamics for the long ones. For intermediate lengths of the superconducting loop, the phase slips are coupled to a discrete bath of oscillators with frequencies comparable to the phase-slip amplitude. This gives rise to a quasiperiodic dynamics of the phase slips which manifests itself as a decay of oscillations between the two counterpropagating current states at short times, followed by oscillation revivals at later times. We analyze possible experimental implications of this non-adiabatic regime in Josephson junction chains and superconducting nanowires.

Single-Electron Shuttle Based on Electron Spin
S. I. Kulinich, L. Y. Gorelik, A. N. Kalinenko, I. V. Krive, R. I. Shekhter, Y. W. Park, and M. Jonson, *Phys. Rev. Lett.* ***112****, 117206*

A nanoelectromechanical device based on magnetic exchange forces and electron spin flips induced by a weak external magnetic field is suggested. It is shown that this device can operate as a new type of single-electron "shuttle" in the Coulomb blockade regime of electron transport.

Single-parameter spin-pumping in driven metallic rings with spin-orbit coupling
J. P. Ramos, L. E. F. Foa Torres, P. A. Orellana, and V. M. Apel, *arXiv:1403.4265*

We consider the generation of a pure spin-current at zero bias voltage with a single time-dependent potential. To such end we study a device made of a mesoscopic ring connected to electrodes and clarify the interplay between a magnetic flux, spin-orbit coupling and non-adiabatic driving in the production of a spin and electrical current. By using Floquet theory, we show that the generated spin to charge current ratio can be controlled by tuning the spin-orbit coupling.

Dissipative geometric quantum pumping
Juzar Thingna, Peter Hänggi, Rosario Fazio, and Michele Campisi, *arXiv:1403.3523*

The charge transported when a quantum pump is adiabatically driven by time-dependent external forces in presence of dissipation is given by the line integral of a pumping field F. We give a general expression of F in terms of quantum correlation functions evaluated at fixed external forces. This can be used in a wide range of experimental cases, including electron pumps based on quantum dots and Cooper pair pumps based on superconducting devices. As an illustration we apply it to dissipative Cooper pair pumping. An advantage of our method is that it transforms the original time-dependent problem into an autonomous one. Yet another advantage is that the curl of F gives immediate visual information about the modes of operation of a geometric quantum pump in presence of dissipation. Applied, as an example, to a Cooper sluice we find that dissipation can enhance pumping.

Topology of crystalline insulators and superconductors
Ken Shiozaki and Masatoshi Sato, *arXiv:1403.3331*
We complete a classification of topological phases and their topological defects in crystalline insulators and superconductors. We consider topological phases and defects described by non-interacting Bloch and Bogoliubov de Gennes Hamiltonians that support additional order-two spatial symmetry, besides any of ten classes of symmetries defined by time-reversal symmetry and particle-hole symmetry. The additional order-two spatial symmetry we consider is general and it includes Z_2 global symmetry, mirror reflection, two-fold rotation, inversion, and their magnetic point group symmetries. We find that the topological periodic table shows a novel periodicity in the number of flipped coordinates under the order-two spatial symmetry, in addition to the Bott-periodicity in the space dimensions. Various symmetry protected topological phases and gapless modes will be identified and discussed in a unified framework. We also present topological classification of symmetry protected Fermi points. The bulk classification and the surface Fermi point classification provide a novel realization of the bulk-boundary correspondence in terms of the K-theory.

Anomalous interference in Aharonov-Bohm rings with two Majorana bound states
Akiko Ueda and Takehito Yokoyama, *arXiv:1403.4146*

We investigate the conductance of an Aharonov-Bohm (AB) interferometer coupled to a quantum dot and two Majorana bound states on the edge of the topological superconductor with finite length. When the tunnel couplings between the Majorana bound states and the Aharonov-Bohm interferometerare fixed to the specific phase, the differential conductance becomes zero irrespective of all the parameters if the hoppings to the two Majorana fermions on the opposite side are equal. When the energy level of the quantum dot is equal to the energy of the Majorana bound states, the AB oscillation shows π periodicity due to the particle-hole symmetry. The breaking of the time-reversal symmetry of the topological superconductor results in 2π periodicity of the AB oscillation for the specific phase of the tunnel coupling while the time-reversal symmetry breaking leads to the mixing of the triplet and singlet states in the quantum dot in another specific phase.

Kramers Pairs of Majorana Fermions and Parafermions in Fractional Topological Insulators
Jelena Klinovaja, Amir Yacoby, and Daniel Loss, *arXiv:1403.4125*