PRL 113, 020407: **General and Robust Cancellation of Decoherence via No-Knowledge Quantum Feedback**
Stuart S. Szigeti, Andre R. R. Carvalho, James G. Morley, and Michael R. Hush
A "no-knowledge" measurement of an open quantum system yields no information about any system observable; it only returns noise input from the environment. Surprisingly, performing such a no- knowledge measurement can be advantageous. We prove that a system undergoing no-knowledge monitoring has reversible noise, which can be canceled by directly feeding back the measurement signal. We show how no-knowledge feedback control can be used to cancel decoherence in an arbitrary quantum system coupled to a Markovian reservoir that is being monitored. Since no-knowledge feedback does not depend on the system state or Hamiltonian, such decoherence cancellation is guaranteed to be general and robust, and can operate in conjunction with any other quantum control protocol. As an application, we show that no-knowledge feedback could be used to improve the performance of dissipative quantum computers subjected to local loss.

Science 345, 532: **Unconditional quantum teleportation between distant solid-state quantum bits**
W. Pfaff, B. J. Hensen, H. Bernien, S. B. van Dam, M. J. Tiggelman,…, R. N. Schouten, R. Hanson
Realizing robust quantum information transfer between long-lived qubit registers is a key challenge for quantum information science and technology. Here we demonstrate unconditional teleportation of arbitrary quantum states between diamond spin qubits separated by 3 meters. We prepare the teleporter through photon-mediated heralded entanglement between two distant electron spins and subsequently encode the source qubit in a single nuclear spin. By realizing a fully deterministic Bell-state measurement combined with real-time feed-forward, quantum teleportation is achieved upon each attempt with an average state fidelity exceeding the classical limit. These results establish diamond spin qubits as a prime candidate for the realization of quantum networks for quantum communication and network-based quantum computing.

Nature 511, 570: **Mapping the optimal route between two quantum states**
S. J. Weber, A. Chantasri, J. Dressel, A. N. Jordan, K. W. Murch and I. Siddiqi
A central feature of quantum mechanics is that a measurement result is intrinsically probabilistic. Consequently, 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 under the competing influences of continuous weak measurement and Rabi drive. By tracking individual trajectories that evolve between any chosen 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 inform new quantum control methods for state steering and information processing.

arXiv:1407.6985: **Characterization and stability of a fermionic $\nu = 1/3$ fractional Chern insulator**
Adolfo G. Grushin, Johannes Motruk, Michael P. Zaletel, and Frank Pollmann
Using the infinite density matrix renormalization group method on an infinite cylinder geometry, we characterize the 1/3 fractional Chern insulator state in the Haldane honeycomb lattice model at $\nu = 1/3$ filling of the lowest band and check its stability. We investigate the chiral and topological properties of this state through (i) its Hall conductivity, (ii) the topological entanglement entropy, (iii) the U(1) charge spectral flow of the many body entanglement spectrum, and (iv) the charge of the anyons. We probe the character of the metal to fractional Chern insulator transition and find indications it is first order. Since our approach does not rely on any band or subspace projection, we are able to prove the stability of the fractional state in the presence of interactions exceeding the band gap, as has been suggested in the literature. As a biproduct we discuss the signatures of Chern insulators within this technique.

arXiv:1407.7034: **Continuous Preparation of a Fractional Chern Insulator**
M. Barkeshli, N.Y. Yao, and C.R. Laumann
We present evidence of a direct, continuous quantum phase transition between a Bose superfluid and the 1/2 Laughlin state in a microscopic lattice model of optically dressed spin defects. In the process, we develop a detailed field theoretic description of this transition in terms of the low energy vortex dynamics, which takes into account the role of lattice symmetry breaking and half-filling. The continuity of this transition enables the quasi-adiabatic preparation and study of the topological state by optical techniques.

arXiv:1407.7607: **Microwave-driven coherent operation of a semiconductor quantum dot charge qubit**
Dohun Kim, …, Robin Blume-Kohout, M. G. Lagally, Mark Friesen, S. N. Coppersmith, and M. A. Eriksson
A most intuitive realization of a qubit is a single electron charge sitting at two well-defined positions, such as the left and right sides of a double quantum dot. This qubit is not just simple but also has the potential for high-speed operation, because of the strong coupling of electric fields to the electron. However, charge noise also couples strongly to this qubit, resulting in rapid dephasing at nearly all operating points, with the exception of one special "sweet spot." Fast dc volt- age pulses have been used to manipulate semi- conductor charge qubits, but these previous experiments did not achieve high-fidelity control, because dc gating requires excursions away from the sweet spot. Here, by using resonant ac microwave driving, we achieve coherent manipulation of a semiconductor charge qubit, demonstrating an Rabi frequency of up to 2 GHz, a value approaching the intrinsic qubit frequency of 4.5 GHz. Z-axis rotations of the qubit are well-protected at the sweet spot, and by using ac gating, we demonstrate the same protection for rotations about arbitrary axes in the X-Y plane of the qubit Bloch sphere. We characterize operations on the qubit using two independent tomographic approaches: standard process tomography and a newly developed method known as gate set tomography. Both approaches show that this qubit can be operated with process fidelities greater than 86% with respect universal set of unitary single-qubit operations.

Nature Physics 10, 588: **Observation of chiral currents with ultracold atoms in bosonic ladders**
Marcos Atala, Monika Aidelsburger, Michael Lohse, Julio T. Barreiro, Belén Paredes and Immanuel Bloch
Engineering optical lattices with laser-induced tunnelling amplitudes has enabled the realization of artificial magnetic fields with remarkable tunability. Here, we report on the observation of chiral Meissner currents in bosonic ladders exposed to a strong artificial magnetic field. By suddenly decoupling the individual ladders and projecting into isolated double wells, we are able to measure the currents on each side of the ladder. For large coupling strengths along the rungs of the ladder, we find a saturated maximum chiral current, which is analogous to the surface currents in the Meissner effect. Below a critical inter-leg coupling strength, the chiral current decreases in good agreement with our expectations for a vortex lattice phase. Our realization of a low-dimensional Meissner-like effect and spin–orbit coupling in one dimension opens the path to exploring interacting particles in low dimensions exposed to a uniform magnetic field.

PRL 113, 050402: **Measuring a Topological Transition in an Artificial Spin-1/2 System**
M. D. Schroer, M. H. Kolodrubetz, …, J. Gao, M. R. Vissers, D. P. Pappas, Anatoli Polkovnikov, and K. W. Lehnert
We present measurements of a topological property, the Chern number (C1), of a closed manifold in the space of two-level system Hamiltonians, where the two-level system is formed from a super- conducting qubit. We manipulate the parameters of the Hamiltonian of the superconducting qubit along paths in the manifold and extract C1 from the nonadiabatic response of the qubit. By adjusting the manifold such that a degeneracy in the Hamiltonian passes from inside to outside the manifold, we observe a topological transition C1 1/4 1 → 0. Our measurement of C1 is quantized to within 2% on either side of the transition.

PRL 113, 053604: **PT-Symmetric Phonon Laser**
Hui Jing, S. K. Özdemir, Xin-You Lü, Jing Zhang, Lan Yang, and Franco Nori
By exploiting recent developments associated with coupled microcavities, we introduce the concept of the PT - symmetric phonon laser with balanced gain and loss. This is accomplished by introducing gain to one of the micro-cavities such that it balances the passive loss of the other. In the vicinity of the gain-loss balance, a strong nonlinear relation emerges between the intra-cavity-photon intensity and the input power. This then leads to a giant enhancement of both optical pressure and mechanical gain, resulting in a highly efficient phonon-lasing action. These results provide a promising approach for manipulating opto- mechanical systems through PT - symmetric concepts. Potential applications range from mechanical cooling to designing phonon-laser amplifiers.

PRL 113, 057003: **Scattering Matrix Formulation of the Topological Index of Interacting Fermions in One-Dimensional Superconductors**
Dganit Meidan, Alessandro Romito, and Piet W. Brouwer
We construct a scattering matrix formulation for the topological classification of one-dimensional superconductors with effective time-reversal symmetry in the presence of interactions. For an isolated system, Fidkowski and Kitaev have shown that such systems have a topological classification. We here show that these systems have a unitary scattering matrix at zero temperature when weakly coupled to a normal-metal lead, with a topological index given by the trace of the Andreev-reflection matrix. With interactions, it generically takes on the finite set of values 0, 1, 2, 3, and 4. We show that the two topologically equivalent phases with it support emergent many-body end states, which we identify to be a topologically protected Kondo-like resonance. The path in phase space that connects these equivalent phases crosses a non-Fermi-liquid fixed point where a multiple-channel Kondo effect develops. Our results connect the topological index to transport properties, thereby highlighting the experimental signatures of interacting topological phases in one dimension.