**Mechanically probing coherent tunnelling in a double quantum dot**
Jamie Gardner, Aashish A. Clerk,
arXiv:1109.1445v1 [cond-mat.mes-hall]
*We study theoretically the interaction between the charge dynamics of a few-electron double quantum dot and a capacitively-coupled AFM cantilever, a setup realized in several recent experiments. We demonstrate that the dot-induced frequency shift and damping of the cantilever can be used as a sensitive probe of coherent inter-dot tunnelling, and that these effects can be used to quantitatively extract both the magnitude of the coherent interdot tunneling and (in some cases) the value of the double-dot $T_1$ time. We also show how the adiabatic modulation of the double-dot eigenstates by the cantilever motion leads to new effects compared to the single-dot case.*

---

**Universal Digital Quantum Simulation with Trapped Ions**
B. P. Lanyon, C. Hempel, D. Nigg, M. Müller, R. Gerritsma, F. Zähringer, P. Schindler, J. T. Barreiro, M. Rambach, G. Kirchmair, M. Hennrich, P. Zoller, R. Blatt, and C. F. Roos,
Science, doi:10.1126/science.1208001
*A digital quantum simulator is an envisioned quantum device that can be programmed to efficiently simulate any other local system. We demonstrate and investigate the digital approach to quantum simulation in a system of trapped ions. Using sequences of up to 100 gates and 6 qubits, the full-time dynamics of a range of spin systems are digitally simulated. Interactions beyond those naturally present in our simulator are accurately reproduced, and quantitative bounds are provided for the overall simulation quality. Our results demonstrate the key principles of digital quantum simulation and provide evidence that the level of control required for a full-scale device is within reach.*

**Geometric phase and non-adiabatic effects in an electronic harmonic oscillator**
M. Pechal, S. Berger, A. A. Abdumalikov Jr., A. Wallraff, S. Filipp,
arXiv:1109.1157v1 [quant-ph]
*Steering a quantum harmonic oscillator state along cyclic trajectories leads to a path-dependent geometric phase. Here we describe an experiment observing this geometric phase in an electronic harmonic oscillator. We use a superconducting qubit as a non-linear probe of the phase, otherwise unobservable due to the linearity of the oscillator. Our results demonstrate that the geometric phase is, for a variety of cyclic trajectories, proportional to the area enclosed in the quadrature plane. At the transition to the non-adiabatic regime, we study corrections to the phase and dephasing of the qubit caused by qubit-resonator entanglement. The demonstrated controllability makes our system a versatile tool to study adiabatic and non-adiabatic geometric phases in open quantum systems and in the context of quantum information processing.*

**Transport in disordered two-dimensional topological insulators**
G. M. Gusev, Z. D. Kvon, O. A. Shegai, N. N. Mikhailov, S. A. Dvoretsky, and J. C. Portal,
Phys. Rev. B **84**, 121302(R), doi:10.1103/PhysRevB.84.121302,
*The transport properties of the "inverted" semiconductor HgTe-based quantum well, recently shown to be a two-dimensional topological insulator, are studied experimentally in the diffusive regime. Nonlocal transport measurements are performed in the absence of magnetic field, and a large signal due to the edge states is observed. This shows that the edge states can propagate over a long distance, 1 mm, and therefore, there is no difference between local and nonlocal electrical measurements in a topological insulator. In the presence of an in-plane magnetic field a strong decrease of the local resistance and complete suppression of the nonlocal resistance is observed. We attribute this behavior to an in-plane magnetic-field-induced transition from the topological insulator state to a conventional bulk metal state.*

**Spin texture on the warped Dirac-cone surface states in topological insulators**
Susmita Basak, Hsin Lin, L. A. Wray, S.-Y. Xu, L. Fu, M. Z. Hasan, and A. Bansil
Phys. Rev. B **84**, 121401(R), doi:10.1103/PhysRevB.84.121401,
*We have investigated the nature of surface states in the $Bi_2Te_3$ family of three-dimensional topological insulators using first-principles calculations as well as a model Hamiltonian approach. When the surface Dirac cone is warped due to Dresselhaus spin-orbit coupling in rhombohedral structures, the spin acquires a finite out-of-the-plane component. We provide a simple, minimal model to describe the in-plane spin texture of the warped surface Dirac cone observed in experiments where spins are seen to be not aligned perpendicular to the electron momentum. Our $k{\cdot}p$ model calculation reveals that this in-plane spin texture requires fifth-order Dresselhaus spin-orbit coupling terms.*

**Fractional Chern Insulators from the nth Root of Bandstructure**
John McGreevy, Brian Swingle, Ky-Anh Tran,
arXiv:1109.1569v1 [cond-mat.str-el]
*We provide a parton construction of wavefunctions and effective field theories for fractional Chern insulators. We also analyze a strong coupling expansion in lattice gauge theory that enables us to reliably map the parton gauge theory*

*onto the microsopic Hamiltonian. We show that this strong coupling expansion is useful because of a special hierarchy of energy scales in fractional quantum Hall physics. Our procedure is illustrated using the Hofstadter model and then applied to bosons at 1/2 filling and fermions at 1/3 filling in a checkerboard lattice model recently studied numerically. Because our construction provides a more or less unique mapping from microscopic model to effective parton description, we obtain wavefunctions in the same phase as the observed fractional Chern insulators without tuning any continuous parameters.*

**Experimental control of the transition from Markovian to non-Markovian dynamics of open quantum systems**
Bi-Heng Liu, Li Li, Yun-Feng Huang, Chuan-Feng Li, Guang-Can Guo, Elsi-Mari Laine, Heinz-Peter Breuer, Jyrki Piilo,
Nature Physics, doi:10.1038/nphys2085,
*Realistic quantum mechanical systems are always exposed to an external environment. This often induces Markovian processes in which the system loses information to its surroundings. However, many quantum systems exhibit non-Markovian behaviour with a flow of information from the environment back to the system. The environment usually consists of large number of degrees of freedom which are difficult to control, but some sophisticated schemes for reservoir engineering have been developed. The control of open systems plays a decisive role, for example, in proposals for entanglement generation and dissipative quantum computation, for the design of quantum memories and in quantum metrology. Here we report an all-optical experiment which allows one to drive the open system from the Markovian to the non-Markovian regime, to control the information flow between the system and the environment, and to determine the degree of non-Markovianity by measurements on the open system.*

**The top-transmon: a hybrid superconducting qubit for parity-protected quantum computation**
F. Hassler, A. R. Akhmerov and C. W. J Beenakker,
New J. Phys. **13**, 095004, doi:10.1088/1367-2630/13/9/095004,
*Qubits constructed from uncoupled Majorana fermions are protected from decoherence, but to perform a quantum computation this topological protection needs to be broken. Parity-protected quantum computation breaks the protection in a minimally invasive way, by coupling directly to the fermion parity of the system — irrespective of any quasiparticle excitations. Here, we propose to use a superconducting charge qubit in a transmission line resonator (the so-called transmon ) to perform parity-protected rotations and read-out of a topological (top) qubit. The advantage over an earlier proposal using a flux qubit is that the coupling can be switched on and off with exponential accuracy, promising a reduced sensitivity to charge noise.*

**Non-linear coupling between the two oscillation modes of a dc-SQUID**
Florent Lecocq, Julien Claudon, Olivier Buisson, Pérola Milman,
arXiv:1109.2400v1 [cond-mat.mes-hall]
*We make a detailed theoretical description of the two-dimensional nature of a dc-SQUID, analyzing the coupling between its two orthogonal phase oscillation modes. While it has been shown that the mode defined as "longitudinal" can be initialized, manipulated and measured, so as to encode a quantum bit of information, the mode defined as "transverse" is usually repelled at high frequency and does not interfere in the dynamics. We show that, using typical parameters of existing devices, the transverse mode energy can be made of the order of the longitudinal one. In this regime, we can observe a strong coupling between these modes, described by an Hamiltonian providing a wide range of interesting effects, such as conditional quantum operations and entanglement. This coupling also creates an atomic-like structure for the combined two mode states, with a V-like scheme.*

**Dissipative Quantum Church-Turing Theorem**
M. Kliesch, T. Barthel, C. Gogolin, M. Kastoryano, and J. Eisert
Phys. Rev. Lett. **107**, 120501, doi:10.1103/PhysRevLett.107.120501,
*We show that the time evolution of an open quantum system, described by a possibly time dependent Liouvillian, can be simulated by a unitary quantum circuit of a size scaling polynomially in the simulation time and the size of the system. An immediate consequence is that dissipative quantum computing is no more powerful than the unitary circuit model. Our result can be seen as a dissipative Church-Turing theorem, since it implies that under natural assumptions, such as weak coupling to an environment, the dynamics of an open quantum system can be simulated efficiently on a quantum computer. Formally, we introduce a Trotter decomposition for Liouvillian dynamics and give explicit error bounds. This constitutes a practical tool for numerical simulations, e.g., using matrix-product operators. We also demonstrate that most quantum states cannot be prepared efficiently.*