Journal Club

Unbounded growth of entanglement in models of many-body localization
J. H. Bardarson, F. Pollmann, and J. E. Moore, arXiv:1202.5532
An important and incompletely answered question is whether a closed quantum system of many interacting particles can be localized by disorder. The time evolution of an initially unentangled state is studied for a random-field XXZ Hamiltonian. Interactions induce a dramatic change in the propagation of entanglement and a smaller change in the propagation of particles. For even weak interactions, when the system is thought to be in a many-body localized phase, entanglement shows neither localized nor diffusive behavior but grows without limit in an infinite system: interactions act as a singular perturbation on the localized state with no interactions. The significance for proposed atomic experiments is that local measurements will show a large but non-thermal entropy in the many-body localized state...

Superconducting qubit in waveguide cavity with coherence time approaching 0.1ms
C. Rigetti, S. Poletto, J. M. Gambetta, B. L. T. Plourde, J. M. Chow, A. D. Corcoles, J. A. Smolin, S. T. Merkel, J. R. Rozen, G. A. Keefe, M. B. Rothwell, M. B. Ketchen, and M. Steffen, arXiv:1202.5533
We report a superconducting artificial atom with an observed quantum coherence time of $T_2^* = 95\mu s$ and energy relaxation time $T_1 = 70\mu s$. The system consists of a single Josephson junction transmon qubit embedded in an otherwise empty copper waveguide cavity whose lowest eigenmode is dispersively coupled to the qubit transition. We attribute the factor of four increase in the coherence quality factor relative to previous reports to device modifications aimed at reducing qubit dephasing from residual cavity photons. This simple device holds great promise as a robust and easily produced artificial quantum system whose intrinsic coherence properties are sufficient to allow tests of quantum error correction.

A straightforward quantum-mechanical derivation of the Crooks fluctuation theorem and the Jarzynski equality, D. Cohen and Y. Imry, arXiv:1202.4529
We obtain the Crooks and the Jarzynski non-equilibrium fluctuation relations using a direct quantum-mechanical approach for a finite system that is either isolated or coupled not too strongly to a heat bath. These results were hitherto derived mostly in the classical limit. The two main ingredients in the picture are the time-reversal symmetry and the application of the first law to the case where an agent performs work on the system. No further assumptions regarding stochastic or Markovian behavior are necessary, neither a master equation or a classical phase-space picture are required...

Pseudogap phenomenon in an ultracold Fermi gas with a p-wave pairing interaction
D. Inotani, R. Watanabe, M. Sigrist, and Y. Ohashi, arXiv:1202.5353
We investigate single-particle properties of a one-component Fermi gas with a tunable p-wave interaction. Including pairing fluctuations associated with this anisotropic interaction within a T-matrix theory, we calculate the single-particle density of states, as well as the spectral weight, above the superfluid transition temperature T_c. Starting from the weak-coupling regime, we show

that the so-called pseudogap first develops in these quantities with increasing the interaction strength. However, when the interaction becomes strong to some extent, the pseudogap becomes obscure to eventually disappear in the strong-coupling regime. This non-monotonic interaction dependence is quite different from the case of an s-wave interaction...

Non-equilibrium dynamics of coupled qubit-cavity arrays
F. Nissen, S. Schmidt, M. Biondi, G. Blatter, H. E. Türeci, and J. Keeling, arXiv:1202.1961
We study the coherence and fluorescence properties of the coherently pumped and dissipative Jaynes-Cummings-Hubbard model describing polaritons in a coupled-cavity array. At weak hopping we find strong signatures of photon blockade similar to single-cavity systems. At strong hopping the state of the photons in the array depends on its size...

Single-Charge Transistor Based on the Charge-Phase Duality of a Superconducting Nanowire Circuit, T. T. Hongisto and A. B. Zorin, Phys. Rev. Lett. **108**, 097001(2012)
We propose a transistorlike circuit including two serially connected segments of a narrow superconducting nanowire joint by a wider segment with a capacitively coupled gate in between. This circuit is made of amorphous NbSi film and embedded in a network of on-chip Cr microresistors ensuring a sufficiently high external electromagnetic impedance. Assuming a virtual regime of quantum phase slips (QPS) in two narrow segments of the wire, leading to quantum interference of voltages on these segments, this circuit is dual to the dc SQUID. Our samples demonstrated appreciable Coulomb blockade voltage (analog of critical current of the SQUIDs) and periodic modulation of this blockade by an electrostatic gate (analog of flux modulation in the SQUIDs)...

Fourier optics on graphene, A. Vakil and N. Engheta, Phys. Rev. B **85**, 075434 (2012)
Using numerical simulations, here, we demonstrate that a single sheet of graphene with properly designed inhomogeneous, nonuniform conductivity distributions can act as a convex lens for focusing and collimating the transverse-magnetic (TM) surface plasmon polariton (SPP) surface waves propagating along the graphene. Consequently, we show that the graphene can act as a platform for obtaining spatial Fourier transform of infrared (IR) SPP signals...

Effect of electron-electron interaction on surface transport in the Bi_2Te_3 family of three-dimensional topological insulators, H. K. Pal, V. I. Yudson, and D. L. Maslov, Phys. Rev. B **85**, 085439 (2012)
We study the effect of electron-electron interaction on the surface resistivity of three-dimensional (3D) topological insulators of the Bi_2Te_3 family. In the absence of umklapp scattering, the existence of the Fermi-liquid (T^2) term in resistivity of a two-dimensional (2D) metal depends on the Fermi surface geometry, in particular, on whether it is convex or concave. On doping, the Fermi surface of 2D metallic surface states in 3D topological insulators of the Bi_2Te_3 family changes its shape from convex to concave due to hexagonal warping, while still being too small to allow for umklapp scattering...

Tuning the Magnetic Dimensionality by Charge Ordering in the Molecular TMTTF Salts, K. Yoshimi, H. Seo, S. Ishibashi, and S. E. Brown, Phys. Rev. Lett. **108**, 096402 (2012)
We theoretically investigate the interplay between charge ordering and magnetic states in quasi-one-dimensional molecular conductors $TMTTF_2X$, motivated by the observation of a complex variation of competing and/or coexisting phases. We show that the ferroelectric-type charge order increases two-dimensional antiferromagnetic spin correlation, whereas in the one-dimensional regime two different spin-Peierls states are stabilized...