Journal Club

Microscopic Model of Quasiparticle Wave Packets in Superfluids, Superconductors, and Paired Hall States,

S. A. Parameswaran, S. A. Kivelson, R. Shankar, S. L. Sondhi, and B. Z. Spivak,
Phys. Rev. Lett. **109**, 237004 (2012)

We study the structure of Bogoliubov quasiparticles, bogolons, the fermionic excitations of paired superfluids that arise from fermion (BCS) pairing, including neutral superfluids, superconductors, and paired quantum Hall states. The naive construction of a stationary quasiparticle in which the deformation of the pair field is neglected leads to a contradiction: it carries a net electrical current even though it does not move. However, treating the pair field self-consistently resolves this problem: in a neutral superfluid, a dipolar current pattern is associated with the quasiparticle for which the total current vanishes. When Maxwell electrodynamics is included, as appropriate to a superconductor, this pattern is confined over a penetration depth. For paired quantum Hall states of composite fermions, the Maxwell term is replaced by a Chern-Simons term, which leads to a dipolar charge distribution and consequently to a dipolar current pattern.

Dynamical stability of the quantum Lifshitz theory in 2+1 dimensions

B. Hsu and E. Fradkin, Phys. Rev. B **87**, 085102 (2013)

The roles of magnetic and electric perturbations in the quantum Lifshitz model in 2+1 dimensions are examined in this paper. The quantum Lifshitz model is an effective field theory for quantum multicritical systems, which include generalized two-dimensional (2D) quantum dimer models in bipartite lattices and their generalizations. It describes a class of quantum phase transitions between ordered and topological phases in 2+1 dimensions. Magnetic perturbations break the dimer conservation law. Electric excitations, the condensation of which leads to ordered phases, have been studied extensively both in the classical three-dimensional model and in the quantum 2D model...

Collective Suppression of Linewidths in Circuit QED

F. Nissen, J. M. Fink, J. A. Mlynek, A. Wallraff, and J. Keeling, arXiv:1302.0665

We report the experimental observation, and a theoretical explanation, of collective suppression of linewidths for multiple superconducting qubits coupled to a good cavity. This demonstrates how strong qubit-cavity coupling can significantly modify the dephasing and dissipation processes that might be expected for individual qubits, and can potentially improve coherence times...

Quasiclassical theory of disordered multi-channel Majorana quantum wires

P. Neven, D. Bagrets, and A. Altland, arXiv:1302.0747

Multi-channel spin-orbit quantum wires, when subjected to a magnetic field and proximity coupled to s-wave superconductor, may support Majorana states. We study what happens to these systems in the presence of disorder. Inspired by the widely established theoretical methods of mesoscopic superconductivity, we develop a la Eilenberger a quasiclassical approach to topological nanowires valid in the limit of strong spin-orbit coupling. We find that the "Majorana number", distinguishing between the state with Majorana fermion (symmetry class B) and no Majorana *(class D), is given by the product of two Pfaffians of gapped quasiclassical Green's functions fixed by right and left terminals connected to the wire...*

Relaxation and thermalization after a quantum quench: Why localization is important, S. Ziraldo and G. E. Santoro, Phys. Rev. B **87**, 064201 (2013)
We study the unitary dynamics and the thermalization properties of free-fermion-like Hamiltonians after a sudden quantum quench, extending the results of S. Ziraldo et al. [Phys. Rev. Lett. **109***, 247205 (2012)]. With analytical and numerical arguments, we show that the existence of a stationary state and its description with a generalized Gibbs ensemble (GGE) depend crucially on the observable considered (local versus extensive) and on the localization properties of the final Hamiltonian. We present results on two one-dimensional (1D) models, the disordered 1D fermionic chain with long-range hopping and the disordered Ising/XY spin chain...*

Measurement of a qubit and measurement with a qubit, A. Di Lorenzo, arXiv:1302.0882
Generally, the measurement process consists in coupling a system to a detector that can give a continuous output. However, it may be interesting to use as a detector a system with a discrete spectrum, especially in view of applications to quantum information. Here, we study 1) a two-level system measuring another two-level system (qubit); 2) a generic system measuring a qubit; 3) a qubit measuring a generic system. The results include the case when a postselection on the measured system is made. We provide the exact solution, and also a controlled expansion in the coupling parameter, giving formulas valid in the weak measurement regime...

Vacuum Rabi Splitting in a Semiconductor Circuit QED System
H. Toida, T. Nakajima, and S. Komiyama, Phys. Rev. Lett. **110**, 066802 (2013)
Vacuum Rabi splitting is demonstrated in a GaAs double quantum dot system coupled with a coplanar waveguide resonator. The coupling strength g, the decoherence rate of the quantum dot γ, and the decay rate of the resonator κ are derived, assuring distinct vacuum Rabi oscillation in a strong coupling regime [$(g, \gamma, \kappa) = (30, 25, 8.0)$ MHz]. The magnitude of decoherence is consistently interpreted in terms of the coupling of electrons to piezoelectric acoustic phonons...

Many-Body Localization in One Dimension as a Dynamical Renormalization Group Fixed Point, R. Vosk and E. Altman, Phys. Rev. Lett. **110**, 067204 (2013)
We formulate a dynamical real space renormalization group (RG) approach to describe the time evolution of a random spin-1/2 chain, or interacting fermions, initialized in a state with fixed particle positions. Within this approach we identify a many-body localized state of the chain as a dynamical infinite randomness fixed point. Near this fixed point our method becomes asymptotically exact, allowing analytic calculation of time dependent quantities. In particular, we explain the striking universal features in the growth of the entanglement seen in recent...

Electron-electron interactions in nonequilibrium bilayer graphene
W. E. Liu, A. H. MacDonald, and D. Culcer, Phys. Rev. B **87**, 085408 (2013)
Conducting steady states of doped bilayer graphene have a nonzero sublattice pseudospin polarization. Electron-electron interactions renormalize this polarization even at zero temperature, when the phase space for electron-electron scattering vanishes. We show that, because of the strength of interlayer tunneling, electron-electron interactions nevertheless have a negligible influence on the conductivity, which vanishes as the carrier number density goes to zero. The influence of interactions is qualitatively weaker than in the comparable cases of single-layer graphene or topological insulators, because the momentum-space layer pseudospin vorticity is 2 rather than 1...