Clemens Müller, Jürgen Lisenfeld, Alexander Shnirman, Stefano Poletto

Interacting two-level defects as sources of fluctuating high-frequency noise in superconducting circuits

arXiv:1503.01637

Since the very first experiments, superconducting circuits have suffered from strong coupling to environmental noise, destroying quantum coherence and degrading performance. In state-of-the-art experiments it is found that the relaxation time of superconducting qubits fluctuates as a function of time. We present measurements of such fluctuations in a 3D-Transmon circuit and develop a qualitative model based on interactions within a bath of background two-level systems (TLS) which emerge from defects in the device material. Assuming both high- and low-frequency TLS are present, their mutual interaction will lead to fluctuations in the noise spectral density acting on the qubit circuit. This model is further supported by direct measurements of energy fluctuations in a single high-frequency TLS.

Pablo M. Perez-Piskunow, Luis E. F. Foa Torres, Gonzalo Usaj

Hierarchy of Floquet gaps and edge states for driven honeycomb lattices

arXiv:1503.01797

Electromagnetic driving in a honeycomb lattice can induce gaps and topological edge states with a structure of increasing complexity as the frequency of the driving lowers. While the high frequency case is the most simple to analyze we focus on the multiple photon processes allowed in the low frequency regime to unveil the hierarchy of Floquet edge-states. In the case of low intensities an analytical approach allows us to derive effective Hamiltonians and address the topological character of each gap in a constructive manner. At high intensities we obtain the net number of edge states, given by the winding number, with a numerical calculation of the Chern numbers of each Floquet band. Using these methods, we find a hierarchy that resembles that of a Russian nesting doll. This hierarchy classifies the gaps and the associated edge states in different orders according to the electron-photon coupling strength. For large driving intensities, we rely on the numerical calculation of the winding number, illustrated in a map of topological phase transitions. The hierarchy unveiled with the low energy effective Hamiltonians, alongside with the map of topological phase transitions discloses the complexity of the Floquet band structure in the low frequency regime. The proposed method for obtaining the effective Hamiltonian can be easily adapted to other Dirac Hamiltonians of two dimensional materials and even the surface of a 3D topological insulator.

Yuxi Tian, Pedro Navarro, and Michel Orrit

1D topological chains with Majorana fermions in 2D non-topological optical lattices,

arXiv:1503.01810

The recent experimental realization of 1D equal Rashba-Dresselhaus spin-orbit coupling (ERD-SOC) for cold atoms provide a disorder-free platform for the implementation and observation of Majorana fermions (MFs), similar to the well studied solid state nanowire/superconductor heterostructures. However, the corresponding 1D chains of cold atoms possess strong quantum fluctuation, which may destroy the superfluids and MFs. In this Letter, we show that such 1D topological chains with MFs may be on demand generated in a 2D non-topological optical lattice with 1D ERD-SOC by modifying local potentials on target locations using experimentally already implemented atomic gas microscopes or patterned (e.g., double or triple well) optical lattices. All ingredients in our scheme have been experimentally realized and the combination of them may pave the way for the experimental observation of MFs in a clean system.

Lei Jiang, Chunlei Qu, Chuanwei Zhang

Topological Spin Texture in a Quantum Anomalous Hall Insulator,

arXiv:1503.01810

The recent experimental realization of 1D equal Rashba-Dresselhaus spin-orbit coupling (ERD-SOC) for cold atoms provide a disorder-free platform for the implementation and observation of Majorana fermions

(MFs), similar to the well studied solid state nanowire/superconductor heterostructures. However, the corresponding 1D chains of cold atoms possess strong quantum fluctuation, which may destroy the superfluids and MFs. In this Letter, we show that such 1D topological chains with MFs may be on demand generated in a 2D non-topological optical lattice with 1D ERD-SOC by modifying local potentials on target locations using experimentally already implemented atomic gas microscopes or patterned (e.g., double or triple well) optical lattices. All ingredients in our scheme have been experimentally realized and the combination of them may pave the way for the experimental observation of MFs in a clean system.

D. Tan, S. J. Weber, I. Siddiqi, K. Mølmer, and K. W. Murch
Prediction and Retrodiction for a Continuously Monitored Superconducting Qubit
Phys. Rev. Lett. **114**, 090403 (2015)

The quantum state of a superconducting transmon qubit inside a three-dimensional cavity is monitored by transmission of a microwave field through the cavity. The information inferred from the measurement record is incorporated in a density matrix ρt, which is conditioned on probe results until t, and in an auxiliary matrix Et, which is conditioned on probe results obtained after t. Here, we obtain these matrices from experimental data and we illustrate their application to predict and retrodict the outcome of weak and strong qubit measurements.

Z. B. Tan, D. Cox, T. Nieminen, P. Lähteenmäki, D. Golubev, G. B. Lesovik, and P. J. Hakonen
Cooper Pair Splitting by Means of Graphene Quantum Dots
Phys. Rev. Lett. **114**, 096602 (2015)

A split Cooper pair is a natural source for entangled electrons which is a basic ingredient for quantum information in the solid state. We report an experiment on a superconductor-graphene double quantum dot (QD) system, in which we observe Cooper pair splitting (CPS) up to a CPS efficiency of ~10%. With bias on both QDs, we are able to detect a positive conductance correlation across the two distinctly decoupled QDs. Furthermore, with bias only on one QD, CPS and elastic cotunneling can be distinguished by tuning the energy levels of the QDs to be asymmetric or symmetric with respect to the Fermi level in the superconductor.

V. S. Asadchy, Y. Ra'di, J. Vehmas, and S. A. Tretyakov
Functional Metamirrors Using Bianisotropic Elements
Phys. Rev. Lett. **114**, 095503 (2015)

Conventional mirrors obey the simple reflection law that a plane wave is reflected as a plane wave, at the same angle. To engineer spatial distributions of fields reflected from a mirror, one can either shape the reflector or position some phase-correcting elements on top of a mirror surface. Here we show, both theoretically and experimentally, that full-power reflection with general control over the reflected wave phase is possible with a single-layer array of deeply subwavelength inclusions. These proposed artificial surfaces, metamirrors, provide various functions of shaped or nonuniform reflectors without utilizing any mirror. This can be achieved only if the forward and backward scattering of the inclusions in the array can be engineered independently, and we prove that it is possible using electrically and magnetically polarizable inclusions. The proposed subwavelength inclusions possess desired reflecting properties at the operational frequency band, while at other frequencies the array is practically transparent. The metamirror concept leads to a variety of applications over the entire electromagnetic spectrum, such as optically transparent focusing antennas for satellites, multifrequency reflector antennas for radio astronomy, low-profile conformal antennas for telecommunications, and nanoreflectarray antennas for integrated optics.