Quantum Electrodynamics with microwaves and Josephson Junctions?

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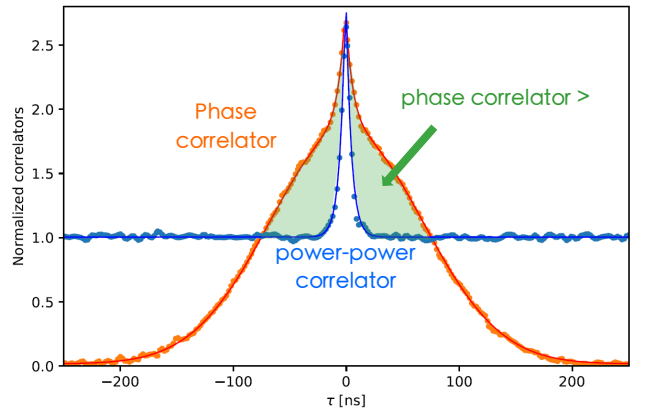
Originally the project was to study quantum optomechanics with microwaves and graphene membrane oscillators.A microfabricated sample was partially prepared and a dilution cryostat has been equipped with mirowave measuring chain. Unfortunatly, the project has been put on hold for lack of manpower and financial support. The equipment, purchased with the help of PALM was used in similar field: quantum electrodynamics lwith microwaves and Josephson Junctions.

We have studied interaction between a voltage-biased Josephson junction and engineered electromagnetic background. The impedance of the environment is not negligible compared to resistance quantum value, so the system is in Dynamic Coulomb Blockade regime. Such systems can serve as a bright source of non-classical radiation, in particular of entangled photons pairs, whichh can be used as a "fuel for quantum computing".

In one experiment the junction is connected to two microwave resonators tuned to different frequencies. It is biased at voltage corresponding to sum of these frequencies. We demonstrate non-classical nature of the radiation emitted from the resonator in two different ways. First we measure cross-correlation of power received at two different frequencies and demonstrate that Cauchy-Schwartz inequality is violated. Secondly, demonstrate that the photons were created with common phase, i.e. they are phas-ecorrelated.

In the second experiment we study a junction coupled to a single high-impedance resonator. Due to strong coupling we can observe emission of up to 8 photons per Cooper pair. However the main purpose of this experiment in progress is to demonstrate sub-Poissonian statistics of photons, which may eventually lead to a practical single-photon source.



Westig, M., et al., *Emission of Nonclassical Radiation by Inelastic Cooper Pair Tunneling.* Physical Review Letters 119, 13 (2017)

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