

Alexander Grimm (INAC-CEA Grenoble)

16. Oct. 2015

Josephson photonics: Statistics of photons emitted by inelastic Cooper-pair tunneling

A simple DC voltage bias on a small Josephson junction leads to emission of microwave radiation via inelastic Cooper-pair tunneling. In this process a tunneling Cooper pair emits one or several microwave photons with a total energy of $2eV$ [1]. The observed average photon emission rate is well explained within the so-called $P(E)$ theory [2], but this theory does not make any predictions about the statistics of the emitted photons.

Recent theory [3,4,5] indicates that these statistics can be highly nontrivial. Depending on the bias conditions and the impedance of the circuit in which the junction is embedded, correlations can range from strongly bunched to anti-bunched. I will present experiments investigating photon correlations in circuits with specifically engineered environments including the demonstration of a bright on-demand source of anti-bunched microwave radiation.

This type of source might offer a new way of generating useful photon states for circuit quantum optics experiments without the need of carefully calibrated control pulses. Moreover, the frequency of the emitted radiation is only limited by the gap of the superconductor. We are building our devices using NbN-MgO-NbN tunnel junctions which should in principle allow operation up to the THz regime.

[1] M. Hofheinz et al., "Bright Side of the Coulomb Blockade", PRL 106, 217005 (2011).

[2] G.-L. Ingold and Y.V. Nazarov, in "Single Charge Tunneling, edited by H. Grabert and M.H. Devoret" (Plenum, New York, 1992).

[3] C. Padurariu et al., "Statistics of radiation at Josephson parametric resonance" PRB 86, 054514 (2012).

[4] V. Gramich et al., "From Coulomb-Blockade to Nonlinear Quantum Dynamics in a Superconducting Circuit with a Resonator" PRL 111, 247002 (2013).

[5] J. Leppäkangas et al., "Antibunched Photons from Inelastic Cooper-Pair Tunneling " PRL 115, 027004 (2015).