Coulomb Blockade of shot noise

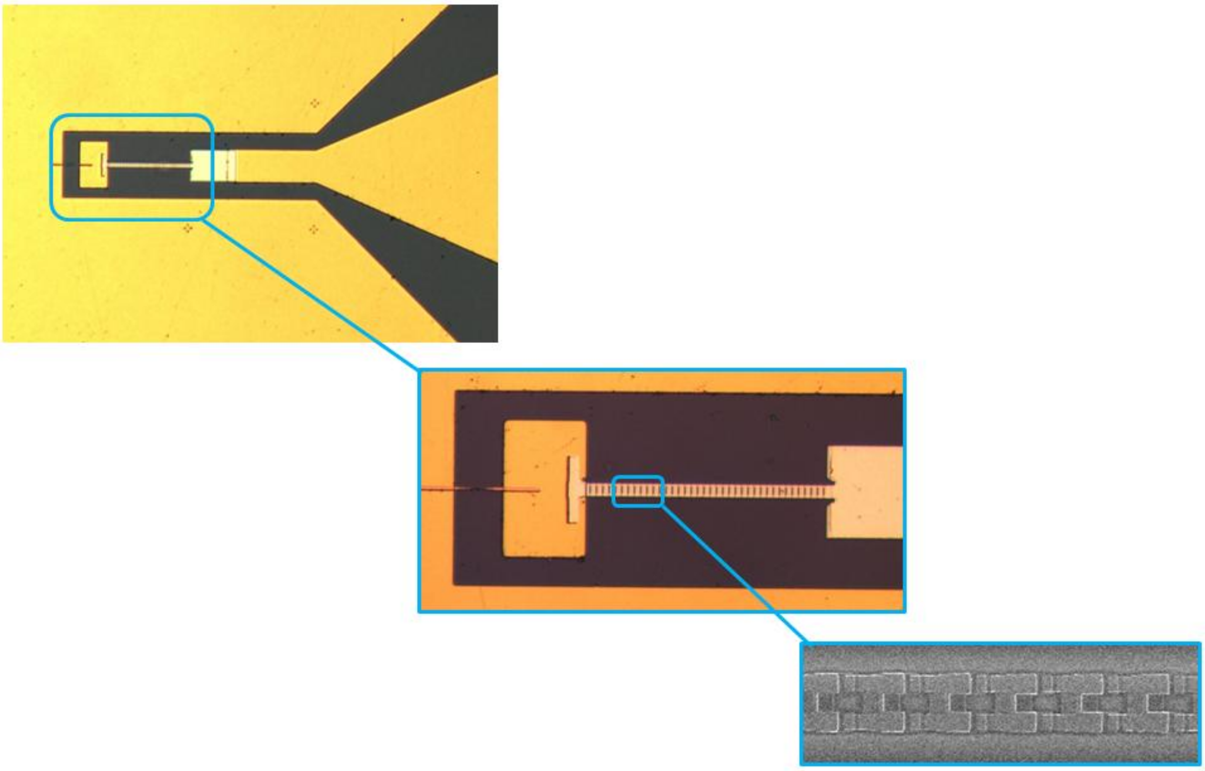
Carles Altimiras[1,2], Olivier Parlavecchio[1], Philippe Joyez[1], Patrice Roche[1], Denis Vion[1], Daniel Estève[1], **Fabien Portier[1]**

[1] SPEC/IRAMIS/DSM/CEA Saclay, URA CNRS 2464, 91191 Gif-sur-Yvette Cedex, France

[2] present address: NEST, Istituto Nanoscienze-CNR and Scuola Normale Superiore, I-56127 Pisa, Italy

Unlike for classical electronic component, the transport properties of a quantum component are not intrinsic and depend on its embedding circuit. This originates from the probabilistic character of quantum transmission of individual electrons through the device, which results in a broad-band current noise called shot noise. When the impedance of the embedding circuit becomes comparable to the resistance quantum h/e^2, shot noise effectively excites its electromagnetic modes, and electronic transfer becomes inelastic. This modifies electrical transport, a phenomenon called Dynamical Coulomb Blockade (DCB). Experimental investigations of this environment feedback have so far been limited to dc conductance measurements, and a complete description of quantum transport, including the current and its fluctuations in the presence of DCB is still lacking. In this work, we have embedded a tunnel junction in a microwave quarter-wave resonator which implements a "single-mode" electromagnetic environment. With such circuit, we can both measure the I(V) characteristic of the junction and the shot noise emitted by the junction at microwave frequencies (~6GHz). Obtaining strong DCB effects requires the resonator to display a characteristic impedance comparable to the resistance quantum (h/e^2~26kOhm), which is hardly achievable by exploiting plain geometric considerations. We have taken advantage of the kinetic inductance of an array of Josephson junctions, to increase up to ~1.5 kOhm the characteristic impedance of an otherwise standard coplanar waveguide. The resulting coupling is strong enough to observe DCB corrections to the shot noise emitted by the tunnel junction, interpreted as spontaneous two-photon emission processes. We can reproduce the observed corrections to the shot noise with the help of an extension to the DCB theory. The methods developed here is applicable to widely used quantum components such as point contacts and quantum dots.

Keywords: Coulomb blockade, high frequency noise, Josephson arrays



Related work:

Experimental Test of the High-Frequency Quantum Shot Noise Theory in a Quantum Point Contact, E. Zakka-Bajjani *et al.,* Phys. Rev. Lett. **99**, 236803 (2007)

Bright Side of the Coulomb Blockade, M. Hofheinz *et al.,* Phys. Rev. Lett. **106**, 217005 (2011)