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Demonstration of quiet on-demand injection of electrons using Lorentzian voltage pulses

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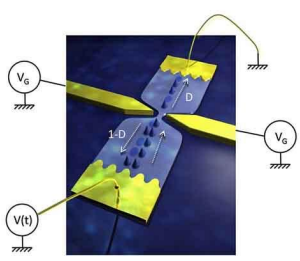
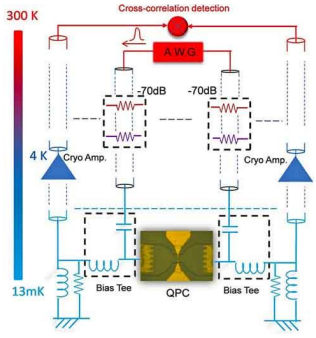
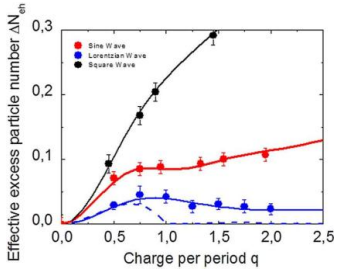
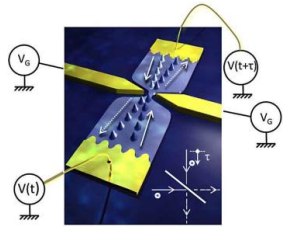
Injecting a controlled number of electrons in a quantum conductor opens the way to new quantum experiment. Here we consider the injection of n electrons using a short time voltage pulse with $\int eV(t)dt = nh$. When the voltage pulse has a Lorentzian shape, L. Levitov et al. [1] have shown that the n-electron injection is free of extra neutral electron-hole pairs and is a minimal excitation state that we will call a "Leviton". We present the first implementation. Using periodic voltage pulses applied on a contact of a 2DEG, a coherent train of n-electron Levitons is send to a QPC which acts as an electron beam splitter. By measuring the shot noise resulting from the partitioning of all excitations we demonstrate that Lorentzian voltage pulses give minimal excitation states, i.e. Levitons. This is complemented by energy domain study of the excitations using shot noise spectroscopy and by a time-domain study using shot noise in a Hong-Ou-Mandel like n-electron collision experiment. The ERC Advanced grant 228273 MeQuaNo is acknowledged.

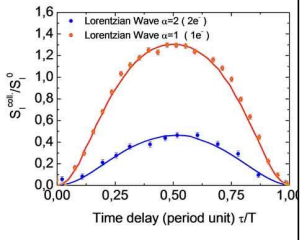
[1] H-W Lee & L. Levitov, cond-mat: 9312013; J. Keeling, I. Klich, and L. Levitov, Phys. Rev. Lett. 97, 116403 (2006).
[2] J. Dubois, T. Jullien, P. Roulleau, F. Portier, P. Roche, Y. Jin, A. Cavanna, W. Wegscheider and D.C. Glattli, submitted.











Upper figures : schematic injection of voltage pulses (left); experimental set-up (center); excess shot noise for various pulses shapes carrying charge q : Levitons show less than 2% extra excitations per electron (right).
Lower figures: Hong Ou Mandel correlation: collision of electron pulses time-shifted by ***t.*** The HOM noise reveals the shape of Leviton wavepackets.