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Electron quantum optics: current and noise of a single electron emitter

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Ballistic electronic transport along the Quantum Hall edge states of two dimensional electron gases presents strong analogies with the propagation of photons which have been best illustrated by the realization of electronic Mach-Zehnder interferometers [1]. The analogy can be pushed to quantum optics where single electron emitters are realized to manipulate one or few charges. Celebrated experiments such as the one electron Hanbury-Brown and Twiss or the two electrons Hong-Ou-Mandel experiments can then be implemented [2]. This brings us closer to the on demand generation of entangled electron pairs. The feasibility of these new quantum optics experiments relies also on the ability to measure the output correlations of the current generated by the source. We will present the first realization of such a single electron source characterized both by the measurement of the average ac current [3] and its fluctuations. The source is made of a periodically driven mesoscopic capacitor [4,5] coupled to the electron reservoir by a tunnel barrier of adjustable transmission. At the first half period of the excitation drive, an occupied energy level of the dot is suddenly promoted above the Fermi energy and a single charge is emitted on the tunnelling escape time. In the second half period, the level is brought back to its initial value and an electron is absorbed, leaving a hole in the Fermi sea. Single electron emission appears as a quantization of the ac current in units of the electric charge times the drive frequency. The occurrence of spurious multiple charge events can be ruled out by the measurement of the noise presented here. Our measurements confirm single electron emission where the noise reduces to the quantum jitter associated with the Heisenberg uncertainty on the emission time.

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