Levitons and Quantum tomography of an electron

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The on-demand generation of pure quantum excitations is important for the operation of quantum systems, but it is particularly difficult for a system of fermions. This is because any perturbation affects all states below the Fermi energy, resulting in a complex superposition of particle and hole excitations. However, it was predicted nearly 20 years ago that a Lorentzian time-dependent potential with quantized flux generates a minimal excitation with only one particle and no hole. Here we report that such quasiparticles (hereafter termed levitons) can be generated on demand in a conductor by applying voltage pulses to a contact. Partitioning the excitations with an electronic beam splitter generates a current noise that we use to measure their number. Minimal-excitation states are observed for Lorentzian pulses, whereas for other pulse shapes there are significant contributions from holes. Further identification of levitons is provided in the energy domain with shot-noise spectroscopy, and in the time domain with electronic Hong–Ou–Mandel noise correlations. The latter, obtained by colliding synchronized levitons on a beam splitter, exemplifies the potential use of levitons for quantum information : using linear electron quantum optics in ballistic conductors, it is possible to imagine flying-qubit operation in which the Fermi statistics are exploited to entangle synchronized electrons emitted by distinct sources.
We will show that using Levitons, we could realize for the first time the tomography of an itinerant electron.

Minimal-excitation states for electron quantum optics using levitons, J. Dubois, T. Jullien, F. Portier, P. Roche, A. Cavanna, Y. Jin, W. Wegscheider, P. Roulleau, & D. C. Glattli, **Nature** 502, 659-663 (2013)
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