Revealing electron-electron interactions in low-dimensional electron systems with time-resolved measurements

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With the advent of coherent single electron sources the field of electron quantum optics has emerged and it is now possible to realize quantum interference experiments at the single electron level [1]. The simplest way to generate a pure Fermionic excitation can be realized by applying a short voltage pulse of Lorentzian shape that can excite a single electron charge - a Leviton - into a two dimensional electron system. Very little is known, however, on the physics of such single electron charge excitations, in particular their propagation speed. Here, we present time of flight experiments of ultra short charge pulses injected into a quasi-one dimensional quantum conductor. We find that the velocity of such an electron wave packet is found to be much faster than the Fermi velocity due to the presence of strong electron-electron interaction. We show that the velocity can be tuned over more than an order of magnitude depending on the number of modes or electrostatic confinement potential. These results demonstrate a powerful new tool for the investigation of electron-electron interactions in low-dimensional conductors.

[1]J. Dubois et al., Nature 502, 659 (2013); E. Bocquillon et al., Science 339, 1054 (2013)