Minimal excitations in the fractional quantum Hall regime

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Single electron sources have opened up the way to the realization of electronic interferometers involving the controlled preparation, manipulation and measurement of single electron excitations in ballistic conductors, therefore emulating quantum optics experiments to the realm of mesoscopic physics.

One such source consists in applying properly quantized Lorentzian voltage pulses to the contacts of a quantum conductor, thus emitting electrons in the form of minimal excitations states, called "levitons" [1]. Their peculiar properties offer exciting new applications in quantum physics. However, their fate in the presence of interactions is still an open problem.

We propose to study the minimal excitation states of fractional quantum Hall edges, extending the notion of levitons to interacting systems. Interaction and quantum fluctuations strongly affect low dimensional systems leading to dramatic effects like spin-charge separation and fractionalization. This is particularly true when the ground-state is a strongly correlated state, as are the edge channels of a fractional quantum Hall (FQH) system.

Using both perturbative and exact calculations, we show that minimal excitations arise in response to a Lorentzian potential with quantized flux [2]. They carry an integer charge, thus involving several Laughlin quasiparticles (anyons), and leave a Poissonian signature in a Hanbury-Brown and Twiss partition noise measurement at low transparency.

They are further characterized in the time domain using Hong-Ou-Mandel interferometry, revealing some peculiar features in the case of multiply charged Levitons in the form of additional side dips in the computed noise. These dips are concomitant with a regular pattern of peaks and valleys in the charge density, reminiscent of analogous self-organization recently observed for optical solitons in nonlinear environments, ultimately suggesting some kind of crystallization mechanism [3].

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