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Single quasiparticle and electron emitter in the fractional quantum Hall regime

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Abstract:

We propose a device consisting of an antidot periodically driven in time by a magnetic field as a fractional quantum Hall counterpart of the celebrated mesoscopic capacitor-based single-electron source. We fully characterize the setup as an ideal emitter of individual quasiparticles and electrons into fractional quantum Hall edge channels of the Laughlin sequence. Our treatment relies on a master equation approach and identifies the optimal regime of operation for both types of sources. The quasiparticle/quasihole emission regime involves in practice only two charge states of the antidot, allowing for an analytic treatment.We show the precise quantization of the emitted charge, we determine its optimal working regime, and we compute the phase-noise/shot-noise crossover as a function of the escape time from the emitter. The emission of electrons, which calls for a larger amplitude of the drive, requires a full numerical treatment of the master equations as more quasiparticle charge states are involved. Nevertheless, in this case the emission of one electron charge followed by one hole per period can also be achieved, and the overall shape of the noise spectrum is similar to that of the quasiparticle source, but the presence of additional quasiparticle processes enhances the noise amplitude.