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# Robust methods for the determination of fractional charge

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## Abstract

The Fractional Quantum Hall Effect (FQHE) is a fascinating manifestation of collective quantum phenomena. Elementary excitations are quasiparticles with fractional charge (1) and statistics (anyons) (2). Both can be revealed through various methods based on non-equilibrium current correlations through a Quantum Point Contact (QPC) created in a Hall bar, where quasiparticles tunnel between opposite edge states. The determination of their fractional charge  $q$  has been conclusive only for Laughlin states, thus at simple fractional filling factors  $\nu$  for which  $q = \nu e$ , and has been based on zero-frequency Poissonian shot noise (1). Nonetheless, this method is sensitive to disorder and noise. We have developed a unifying perturbative approach for non-equilibrium transport (3, 4, 5) which offers more robust equilibrium fluctuation relations from which the Josephson-type frequency can be extracted. We will present first the frequency noise (5), which have been implemented by Gwendal Fève's group (coll.) to determine  $q = e/3$  at  $\nu = 2/3$  (6). Secondly, we will address those based on the photo-assisted noise under an ac voltage, and implement  $q = e/5$  for  $\nu = 2/5$  (7). We will finally revisit the implementation and the charge of minimal excitations (8) under Lorentz. L. Saminadayar *et al.*, *Phys. Rev. Lett.*, 79 : 2526, 1997. R. de Picciotto *et al.*, *Nature* 389 : 162 (1997). I. Safi *et al.*, *Phys. Rev. Lett.*, 86 : 4628 (2001). B. Rosenow *et al.*, *Phys. Rev. Lett.*, 116 : 156802 (2016). H. Bartolomei *et al.*, *Science*, 368 (6487) : 173 (2020). Safi and E. Sukhorukov, *Eur. Phys. Lett.* 91 : 67008 (2010). I. Safi, *Phys. Rev. B* 99 : 045101 (2019); *Phys. Rev. B* 106 : 205130 (2022). I. Safi, *arXiv* : 1401.5950 (2014). O. Parlavecchio, C. Altimiras, J.-R. Souquet, P. Simon, I. Safi, P. Joyez, D. Vion, P. Roche, D. Estève, and F. Portier, *Phys. Rev. Lett.* 114 : 126801 (2015). C. Bena and I. Safi, *Phys. Rev. B*, 76 : 125317 (2007). B. Roussel, P. Degiovanni and I. Safi, *Phys. Rev. B* 93 : 045102 (2016). I. Safi, *Phys. Rev. B* 102 : 041113 (R) (2020).

- R. Bisognin, H. Bartolomei, M. Kumar, I. Safi, J.-M. Berroir, E. Bocquillon, B. Plaçais, A. Cavanna, U. Gennser, Y. Jin, and G. Fève. *Nat. Comm.*, 10 (1) : 2231 (2019).
- M. Kapfer, P. Roulleau, I. Farrer, D. A. Ritchie, and D. C. Glattli, *Science* 363 : 846 (2019). J. Keeling *et al.*, *Phys. Rev. Lett.* 97, 116403 (2006). J. Dubois *et al.*, *Nature* 502, 659–663 (2013).

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