Time-domain Braiding of Anyons

Mélanie Ruelle [1], Elric Frigerio [1], Emmanuel Baudin [1], Jean-Marc Berroir [1], Bernard Plaçais [1], Benoît Grémaud [2], Thibaut Jonckheere [2], Thierry Martin [2], Jérôme Rech [2], Antonella Cavanna [3], Ulf Gennser [3], Yong Jin [3], Gerbold C. Ménard [1], and Gwendal Fève [1]

[1] *Laboratoire de Physique de l'Ecole normale supérieure, ENS, Université PSL, CNRS, Sorbonne Université, Université Paris-Cité, F-75005 Paris, France*
[2] *Aix Marseille Univ, Université de Toulon, CNRS, CPT, Marseille, France*
[3] *Centre de Nanosciences et de Nanotechnologies (C2N), CNRS, Université Paris-Saclay, 91120 Palaiseau, France*

Recent experiments have evidenced anyons, quasiparticles that keep a memory of particle exchanges via a braiding phase factor [1-5]. This provides them with unique dynamical properties so far unexplored. In this work, we investigate the dynamics of anyon tunneling in the time domain by using triggered anyon pulses incident on a quantum point contact (QPC) in a $\nu = 1/3$ fractional quantum Hall (FQH) fluid.

When an anyon excitation is emitted toward a QPC in a FQH fluid, this memory property translates into tunneling events that may occur long after the anyon excitation has exited the QPC. The dominant mechanism for particle transfer is not the direct tunneling of the incoming excitations, but rather a braiding process between the incoming excitations and particle-hole excitations created at the QPC [5,6,7]. Anyon tunneling is then governed by the mutual braiding phase $\theta \times N$ between the generated anyon pulses and the topological anyons tunneling at the QPC, where N is the number of anyons carried per pulse and $\theta = 2\pi/3$ is the anyon braiding phase at $\nu = 1/3$.

By triggering anyon emission at the input of the QPC, we probe the characteristic timescale for anyon tunneling and demonstrate the influence of anyon braiding mechanisms on this timescale [8]. We observe two different regimes. When braiding is present ($\theta \times N < 2\pi$), the characteristic timescale for anyon tunneling is set by the temporal decay of the anyon correlation function on time $\tau_\delta = \hbar/(\pi k_B T_{el} \delta)$, where T_{el} is the temperature and δ the scaling dimension. In contrast, when braiding is absent ($\theta \times N = 2\pi$), we observe that the characteristic tunneling timescale is set by the temporal width of the generated pulses, as one would naively expect.

This experiment introduces time-resolved measurements for characterizing the scaling dimension and braiding phase of anyons.

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