Condensed Matter Physics Seminar Series

Detection of anyon scaling dimension and braiding properties in the fractional Quantum Hall Effect

Thierry Martin

Professeur Classe exceptionnelle à Aix Marseille Université, Centre de Physique Théorique, Marseille, France

For almost half of a century, anyons in the FQHE have been proposed as excitations which carry fractional charge and statistics, thus bridging between fermions and bosons. I will review briefly the protocols and experiments that have allowed over the years to access their fractional charge, scaling dimension and their braiding/statistical angle. Next, I shall propose an experimental setup to measure “directly” the statistical/braiding angle of anyons. The setup involves an Ω-shaped junction along a fractional quantum Hall liquid edge, formed by defining an open quantum dot. In the weak tunneling regime, the charge current when an anyon is injected upstream from the Ω-junction is computed, showing that its time evolution depends solely on the anyon statistical properties, with temperature and scaling dimension affecting only a constant pre-factor. Next, to connect with experiments, the noise cross-correlation is computed between a Poissonian anyon source impinging on the Ω (originating from another tunnel coupled DC biased edge state) and the current downstream from the Ω junction, providing a realistic, direct method to detect anyon braiding statistics. As the predicted signal suffers thermal suppression for large open quantum dots, a generalization of the above results including charging effects is proposed, with no major modification of the initial protocol. The robustness of these results against the coupling to a dissipative environment is finally discussed.

References:
>>> [1] Time-domain braiding of anyons, Science 389, (2025), M. Ruelle, E. Frigerio, E. Baudin, J.-M. Berroir, B. Plaçais, B. Gremaud, T. Jonckheere, T. Martin, J. Rech, A. Cavanna, U. Gennser, Y. Jin, G. Menard, and G. Feve.
>>> [2] Anyon braiding on the single edge of a fractional quantum Hall state, Phys. Rev. Lett. 135, 146601 (2025), Flavio Ronetti, Noe Demazure, Jerome Rech, Thibaut Jonckheere, Benoit Gremaud, Laurent Raymond, Masayuki Hashisaka, Takeo Kato, and Thierry Martin.
>>> [3] Probing anyon statistics on a single-edge loop in the fractional quantum Hall regime, Phys. Rev. B 112, 125166 (2025) Flavio Ronetti, Noe Demazure, Jerome Rech, Thibaut Jonckheere, Benoıt Gremaud, Laurent Raymond, Masayuki Hashisaka, Takeo Kato, and Thierry Martin.
>>> [4] arXiv:2601.23042 [pdf, ps, other] Charging energy effects on a single-edge anyon braiding detector, Noé Demazure, Flavio Ronetti, Benoît Grémaud, Laurent Raymond, Masayuki Hashisaka, Takeo Kato, Thierry Martin

Thierry Martin did his PhD in 1990 on quantum dissipative systems at UCLA with R. Bruinsma and P. Platzman (AT&T Bell labs.). He worked on quantum noise, and tunneling time problem of quantum mechanics at IBM T.J. Watson Research Cent er in NY, under the guidance of R. Landauer. He did a postdoc in 1992 at Los Alamos National Laboratory working on superconducting instabilities in Luttinger liquids (working with D. Loss), and in 1994 moved to Institut Laue Langevin in Grenoble France (P. Nozières) group, before obtaining a tenured position at Aix Marseille Université in 1996. His career has focused on mesoscopic physics, especially quantum shot noise and Josephson related phenomena in superconducting circuits or in chiral Luttinger liquids of the quantum Hall effect. Between 2011 and 2023 he was the director of Centre de Physique Théorique, a CNRS Laboratory affiliated to Aix Marseille University.

Friday, September 4th at 12pm
4-330 PAB

Hosted by Robijn Bruinsma