Anyon braiding in graphene quantum Hall interferometer

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The search for anyons, quasiparticles with fractional charge and exotic exchange statistics, has inspired decades of condensed matter research. Fractional quantum Hall (FQH) effects, in which electrons are confined to two spatial dimensions and subjected to large magnetic fields, have long been predicted to host emergent fractionally charged excitations that obey neither fermionic nor bosonic exchange statistics. Quantum Hall (QH) interferometers allow direct observation of the anyon braiding phase via discrete interference phase jumps as the quasiparticle number changes. FQH Fabry-Pérot (FP) interferometers allow direct measurements of anyon braiding via the braiding phase (equivalently two exchanges) of quasiparticles around a confined cavity. By partially backscattering the current at two quantum point contact (QPC) constrictions, the conductance through the FP cavity includes interference terms depending on the phase accrued by quantum Hall (QH) edge-traveling quasiparticles. In this talk, we discuss the observation of the universal anyonic braiding phase in both the $\nu = 1/3$ and 4/3 fractional QH states by probing three-state random telegraph noise (RTN) in real time. We find that the observed RTN originates from anyon quasiparticle number fluctuations, and reconstruct three Aharonov-Bohm oscillation signals shifted in phase by $2\pi/3$, corresponding to the three possible interference branches from braiding around n mod 3 anyons. Thus, we fully characterize the anyon exchange statistics at fixed magnetic flux using new methods that can be easily extended to non-abelian states.

References

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