Interferometric Measurements of Charge and Statistics in the Fractional Quantum Hall Regime

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A basic tenet of quantum theory is that all elementary particles are either bosons or fermions. Ensembles of bosons or fermions behave differently due to differences in their underlying quantum statistics. Starting in the early 1980's it was theoretically conjectured that excitations that are neither bosons nor fermions may exist under special conditions in two-dimensional interacting electron systems. These unusual excitations were dubbed "anyons" [1]. The fractional quantum Hall effect is the archetype topological phase of matter supporting anyons. Anyons in the fractional quantum Hall regime possess fractional charge and fractional statistics, however directly probing these properties presents experimental challenges. This presentation will focus on the development of electronic Fabry-Pérot interferometers that resulted in the direct observation of anyonic braiding statistics in the fractional quantum Hall state at $\nu=1/3$ [2,3]. Interferometric measurements may be used to understand interactions between localized charge excitations in the bulk and gapless edge modes [4]. These experimental techniques have now been extended to the more fragile multi-edge-mode hierarchy state at $\nu=2/5$ [5]. Extensions of interferometry to the putative non-abelian state at $\nu=5/2$ will be discussed. Most recently our group has applied electron interferometry to understand an unusual flux period halving phenomenon in the integer quantum Hall effect. The experimental versatility of mesoscopic Fabry-Pérot interferometers will be emphasizedd.

References

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