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Interactions and Disorder in Quantum Hall Interferometers

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Quantum Hall (QH) devices are supposed to be an ideal laboratory for the study of interference effects, because within a conductance plateau, the bulk of a sample is insulating and the current is confined to conducting edge states. Closed interference paths can be defined with the help of two narrow constrictions, which mediate tunneling from one edge to the other. Quantum interference should then manifest itself in flux- and gate-voltage-dependent conductance oscillations. When there is an integer quantized Hall state within the constrictions, a region between them, with higher electron density, may form a compressible island. Electron-tunneling through this island can lead to residual transport, modulated by Coulomb-blockade type effects. Then, the coupling between the fully occupied lower Landau levels and the higher partially occupied level gives rise to flux subperiods smaller than one flux quantum [1]. We generalize this scenario to other geometries and to fractional quantum Hall systems, and compare our predictions to experiments. For interferometers probing non-abelian statistics in the $\nu = 5/2$ QH state, current-carrying quasiparticles flow along edges that encircle N_{qp} bulk quasiparticles, which are localized at impurities. The interference pattern depends on whether N_{qp} is even or odd, and is affected by a coupling that allows tunneling of neutral Majorana fermions between the bulk and edge. While at weak coupling this tunneling degrades the interference signal, at strong coupling the bulk quasiparticle becomes essentially absorbed by the edge and the interference signal is fully restored [2]. These works have been done in collaboration with B.I. Halperin, S.H. Simon, and A. Stern.

[1] B. Rosenow and B.I. Halperin, Phys. Rev. Lett. 98, 106801 (2007).

[2] B. Rosenow, B.I. Halperin, S.H. Simon, and A. Stern, arXiv:0707.4474.