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# Aharonov-Bohm effect in the chiral Luttinger liquid

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**Author(s)** Geller, MR; Loss, D
**Author(s) at UniBasel** Loss, Daniel ;
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Edge states of the quantum Hall fluid provide an almost unparalled opportunity to study mesoscopic effects in a highly correlated electron system. In this paper we develop a bosonization formalism for the finite-size edge state, as described by chiral Luttinger liquid theory, and use it to study the Aharonov-Bohm affect, The problem we address may be realized experimentally by measuring the tunneling current between two edge states through a third edge state formed around an antidot in the fractional quantum Hall effect regime. The finite size L of the antidot edge state introduces a temperature scale T-0=(h) over bar v/pi k(B)L, where v is the edge-state Fermi velocity. A renormalization group analysis reveals the existence of a two-parameter universal scaling function (G) over tilde(X,Y) that describes the Aharonov-Bohm conductance resonances. We also show that the strong renormalization of the tunneling amplitudes that couple the antidot to the incident edge states, together with the nature of the Aharonov-Bohm interference process in a chiral system, prevent the occurrence of perfect resonances as the magnetic field is varied, even at zero temperature. In an experimentally realizable strong-antidot-coupling regime, where the source-to-drain transmission is weak, and at bulk filling factor g=1/q with q an odd integer, we predict the low-temperature (T much less than T-0) Aharonov-Bohm amplitude to vanish with temperature as T2q-2, in striking contrast to a Fermi liquid (q=1). Near T-0, there is a pronounced maximum in the amplitude, also in contrast to a Fermi liquid. At high temperatures (T much greater than T-0), however, we predict a crossover to a T(2q-1)e(-qT/T0) temperature dependence, which is qualitatively similar to chiral Fermi liquid behavior. Careful measurements in the strong-antidot-coupling regime above T-0 should be able to distinguish between a Fermi liquid and our predicted nearly Fermi liquid scaling. In addition, we predict an interesting high-temperature nonlinear response regime, where the voltage satisfies V-0, which may also be used to distinguish between chiral Fermi liquid and chiral Luttinger liquid behavior. Finally, we predict mesoscopic edge-current oscillations, which are similar to the persistent current oscillations in a mesoscopic ring, except that they are not reduced in amplitude by weak disorder. In the fractional quantum Hall effects regime, these “chiral persistent currents“ have a universal non-Fermi-liquid temperature dependence and may be another ideal system to observe a chiral Luttinger liquid.

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