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A Realization of Quantum Non-Local Persistent Current: Coupled Metallic Rings through a P-Wave Chiral Superconducting Wire
DAVID SCHMELTZER, City College of New York, AVADH SAXENA, Los Alamos National Lab — The excitations in the p-wave superconductors Sr_2RuO_4, ^3He-A and the $\nu = \frac{5}{2}$ quantum Hall effect are characterized by half vortices, which are zero mode energy Majorana fermions. We consider a p-wave superconducting wire for which the pairing order parameter vanishes at the edges and two zero modes appear at $x = 0$ and $x = L$. Due to the charge conjugation of the Bogoliubov spectrum these zero modes are Majorana Fermions. The ground state is a Z_2 doubly degenerate state and the single particle excitations are non-local. We couple the p-wave wire to two rings, which are pierced by external fluxes, and compute persistent current. The non-locality of the persistent current is manifested in the following way: (a) For a single ring with flux coupled to the p-wave wire at $x = 0$ and grounded at $x = L$, due to the Andreev reflection the current in one ring will decay faster than if we decouple the wire. (b) For two rings with equal fluxes attached to the p-wave wire at $x = 0$ and the second at $x = L$ the current will be equal and independent of the length of the wire. When the flux is π we will have a Berry phase of π. (c) For dufferent fluxes the currents in the two rings will vanish. This situation is very different if instead of a p-wave wire we attach a metallic wire for which the current will be uncorrelated in the two rings.

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