Two-particle time-domain interferometry in the Fractional Quantum Hall Effect regime

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Abstract

Quasi-particles are elementary excitations of the ground state of condensed matter quantum phases. Demonstrating that they keep quantum coherence while propagating is a fundamental issue for their manipulation for quantum information tasks. This is particularly the case for the quasi-particles called anyons of the Fractional Quantum Hall Effect (FQHE). These fractionally charged quasi-particles obey anyonic statistics intermediate between fermionic and bosonic. Their quantum coherence has been observed by their transmission through the localized states of electronic Fabry-Pérot interferometers. Surprisingly, no or very weak quantum interference of anyons was observed in electronic Mach-Zehnder interferometers for which the quasi-particle transmission occurs via propagating states. Here, we show that FQHE anyons do keep a finite quantum coherence while propagating by using a novel kind of interferometry, namely two-particle time-domain interference (1) using an electronic beam-splitter. By varying the time delay between photo-created electron-hole pairs and measuring cross-correlated noise sensitive to the twoparticle Hanbury Brown Twiss (HBT) phase (1), we observe strong quasiparticle interference (2). At bulk filling factor 2/5, visibilities as high as 53% and 60% are observed for e/5 and e/3 charged propagating anyons, probably limited by copropagating channel mixing (3). At bulk filling factor 2/3 a similar large quantum coherence is observed for the 2/3 edge channel. Our results (2) call for a better understanding of anyon coherence in the FQHE edge channels.

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