Two-particle time-domain interferometry in the fractional quantum Hall effect regime

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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 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 different 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 two-particle Hanbury Brown Twiss (HBT) phase [1], we observe strong quasi-particle interference [2]. Visibilities as high as 53% and 60% are observed for e/5 and e/3 charged propagating anyons, probably limited by co-propagating channel mixing [3]. We extend these measurements to the 2/3 edge channel which also do demonstrate quantum coherence. Our results [2] call for a better understanding of the absence of interference in Mach-Zehnder interferometers

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[2] I. Taktak, M. Kapfer, J. Nath, P. Roulleau, M. Acciai, J. Splettstoesser, I. Farrer, D. A. Ritchie, D. C. Glattli, arXiv:2201.09553 (2022)

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