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Realization of 1D Anyons with Arbitrary Statistical Phase

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Anyons are particles with exchange statistics that are neither bosonic nor fermionic, but that interpolate between these two limits. We realize a one-dimensional Anyon-Hubbard model (AHM) with ultracold Rubidium 87 atoms in an optical lattice. To engineer the desired Hamiltonian, we use a novel three-tone lattice amplitude modulation technique that allows us to tune the exchange phase of two particles. This Floquet driving technique effectively realizes a Bose-Hubbard model with an occupation-dependent Peierls phase that maps onto the AHM. We observe the Hanbury Brown-Twiss effect for anyons using the correlations emerging from two-particle quantum walks, and the formation of bound states in the absence of on-site interactions. We also demonstrate asymmetric density expansion which arises from the interplay between interactions and fractional statistics. Our scheme can be readily extended to study many-body phases of anyons in one dimension.

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