Anyonization of bosons

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Anyons are low-dimensional quasiparticles that obey fractional statistics, hence interpolating between bosons and fermions. In two dimensions, they exist as elementary excitations of fractional quantum Hall states and they are believed to enable topological quantum computing. One dimensional (1D) anyons have been theoretically proposed, but their experimental realization has proven to be difficult. Here, we discuss the experimental realization and theoretical investigation of anyonic correlations in a 1D strongly-interacting quantum gas, resulting from the phenomenon of spin-charge separation [1]. A mobile impurity provides the necessary spin degree of freedom to engineer anyonic correlations in the charge sector and simultaneously acts as a probe to reveal these correlations. Starting with bosons, the statistical phase is tuned to transmute bosons via anyons to fermions, leading to an asymmetric momentum distribution, which manifests as a hallmark of anyonic correlations. Going beyond equilibrium conditions, we also study the dynamical properties of the anyonized bosons, reminiscent of the dynamical fermionization of anyons. Our work opens up the door to the exploration of nonequilibrium anyonic phenomena in a highly controllable setting.

[1] S. Dhar, B. Wang, M. Horvath, A. Vashisht, Y. Zeng, M. B. Zvonarev, N. Goldman, Y. Guo, M. Landini, and H.-C. Nägerl, Anyonization of bosons, arXiv:2412.21131 (2024).