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Hong-Ou-Mandel Interference with Atomic Many-Body States
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— Hong-Ou-Mandel (HOM) interference experiments are a powerful probe for the indistinguishability and underlying quantum statistics of particles. In the classic HOM experiment, a pair of identical photons incident on different input ports of a beamsplitter exits via the same output port. Using the precise control and readout afforded by our quantum gas microscope, we present an implementation of this classic experiment using massive bosons in a doublewell optical potential. Identical states are prepared on each site of the doublewell and by lowering the tunnel coupling between the sites for specific times, we drive a beam splitter operation between the sites. For single-atom Fock input states, we have realized a high fidelity beamsplitter operation and observed an HOM interference contrast of >90%. By generalizing to more complex initial states on the input ports, we have been able to establish HOM experiment protocols as a robust approach towards studying the indistinguishability of many-body states as well as probe interaction-induced effects. These techniques open a path towards the measurement of purity in a quantum system and entanglement entropy in many-body states.

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