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Direct measurements of entanglement entropy in one-dimensional bosonic systems RUICHAO MA, ERIC TAI, ALEXANDER LUKIN, PHILIPP PREISS, MATTHEW RISPOLI, RAJIBUL ISLAM, MARKUS GREINER, Harvard University — The presence of large-scale entanglement is a defining characteristic of exotic quantum phases of matter. However, its experimental verification is an outstanding challenge in condensed matter physics. Within small quantum information processing units, entanglement may be detected via resource-intensive state tomography or class-specific entanglement witnesses. Here, we demonstrate a novel approach to the measurement of entanglement entropy of any bosonic system, using a quantum gas microscope with tailored potential landscapes. We extend the concept of Hong-Ou-Mandel interference from two particles to many-body states. Interfering two copies of identically prepared states measures the quantum mechanical purity of the system and its subsystems, placing bounds on the entanglement entropy. We apply this technique to observe the entanglement dynamics in a few-particle quench of a bosonic system. Our protocol may be applied to any many-body state and provides a new platform for the characterization of strongly correlated states in optical lattices.

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