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Quantitative Probes of Entanglement Using Collisional Microscopy CRAIG PRICE, Pennsylvania State University, QI LIU, Pennsylvania State Univ, NATHAN GEMELKE, Pennsylvania State University — Though entanglement is understood to play a critical role in determining the ground state structure and macroscopic properties of many known physical systems, its definitive quantification has until recently, through the creation of entanglement entropy (EE), spectrum and related measures, escaped a simple definition. Moreover, few if any of these measures have been directly extracted in experiments on strongly correlated matter. In this talk, we present a novel method to measure quantifiers of many-body entanglement by pair-wise entangling a small portion of an atomic gas with an optical-lattice-bound array of secondary atoms serving as quantum-non-destructive probes. For a sample with significant pre-existing long range entanglement, such as in a Bose-Hubbard system near its quantum critical point, the quantum back-action following probe detection affects the sample gas in regions spatially extended beyond where measured. This results in a non-local thermal effect; subsequent measurement of the thermal entropy through the local equation of state can reveal the EE. Quantitative analysis of thermodynamic back action and background effects, such as classical propagation of entropy after a measurement quench, will be discussed.

Craig Price
Pennsylvania State University

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