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Phase transitions, entanglement and quantum noise interferometry in cold atoms FLORIAN MINTERT, University of Freiburg , INDUBALA SATIJA, George Mason University, ANA MARIA REY, ITAMP, CHARLES CLARK, NIST — Quantum entanglement represents one of the most fascinating features of quantum theory and has emerged as an important resource in quantum information science. Recent studies have suggested that the long range correlations that are established close to a quantum phase transition manifest themselves in a pronounced increase of entanglement. However, to show that is not an easy task given the fact that currently there is not consensus about the best method to define an entanglement measure for multi-particle systems. Using an entanglement measure that includes up to four point correlation functions we study the scaling properties of multi-particle entanglement in a one dimensional Ising chain around and at the critical point. Our study reveals that multiparticle entanglement indeed peaks at the phase transition, whereas pure biparticle entanglement measures often fail to reveal this feature. We discuss the connection between multiparticle entanglement measurements with noise correlations and the possibility of using these experimentally accessible quantities as a probe of entanglement in cold atomic systems.

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