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Solving a quantum many-body problem by experiment THOMAS SCHWEIGLER, Vienna Center for Quantum Science and Technology, Atominstitut, TU Wien, VALENTIN KASPER, Institut für Theoretische Physik, Universität Heidelberg, SEBASTIAN ERNE, BERNHARD RAUER, TIM LANGEN, Vienna Center for Quantum Science and Technology, Atominstitut, TU Wien, THOMAS GASENZER, Kirchhoff-Institut für Physik, Universität Heidelberg, JÜRGEN BERGES, Institut für Theoretische Physik, Universität Heidelberg, JÖRG SCHMIEDMAYER, Vienna Center for Quantum Science and Technology, Atominstitut, TU Wien — We experimentally study a pair of tunnel-coupled one-dimensional atomic superfluids, which realize the quantum sine-Gordon/massive Thirring models relevant for a wide variety of disciplines from particle to condensed-matter physics. From measured interference patterns we extract phase correlation functions and analyze if, and under which conditions, the higher-order correlation functions factorize into lower ones. This allows us to characterize the essential features of the model solely from our experimental measurements, detecting the relevant quasiparticles, their interactions and the topologically distinct vacua. Our method provides comprehensive insights into a non-trivial quantum field theory and establishes a general method to analyze quantum many-body systems through experiments. The method is also used to investigate the non-equilibrium dynamics following a quench in the tunnel-coupling between the superfluids.

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