Probing 1D physics by correlations

Jörg Schmiedmayer

Vienna Center for Quantum Science and Technology (VCQ), Atominstitut, TU-Wien

Measurements and analysis of high order correlations [1], and equivalently full distribution functions of quantum observables [2] (full counting statistics) give deep insight into many-body quantum systems and allow us to verify their emerging theoretical descriptions. I will illustrate this in the example of the emergence of the Sine-Gordon quantum field theory from the microscopic description of two tunnel coupled superfluids [1] and in the emergence of Fermionic Pauli blocking in a weakly interacting Bose gas [3]. Special emphasis will be put on how to verify such emergent descriptions and how to characterize them. Thereby I will present three tools: High order correlation functions and their factorization [1], the evaluation of the quantum effective action and the momentum dependence of propagators and vertices (running couplings, renormalization of mass, etc...) of the emerging quantum field theory [4], and learning the emerging Hamiltonian directly from the correlations [5]. Together they establish general methods to analyse quantum systems through experiments and thus represent a crucial ingredient towards the implementation and verification of emergent quantum simulators.

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