Correlation dynamics during a slow interaction quench in a one dimensional Bose gas

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Abstract

We investigate the response of a one-dimensional Bose gas to a slow increase of its interaction strength. We focus on the dynamics of equal-time single-particle correlations treating the Lieb-Liniger model within a bosonization approach and the Bose-Hubbard model using the time-dependent density-matrix renormalization group method (t-DMRG). For short distances, correlations follow a power law with distance with an exponent given by the adiabatic approximation. In contrast, for long distances, correlations decay algebraically with an exponent understood within the sudden quench approximation. This long distance regime is separated from an intermediate distance one by a generalized Lieb-Robinson criterion. In this intermediate regime, bosonization predicts that single-particle correlations decay following a stretched exponential, an unconventional behavior. We develop here an intuitive understanding for the propagation of correlations, in terms of a generalized light cone, applicable to a large variety of systems and quench forms.

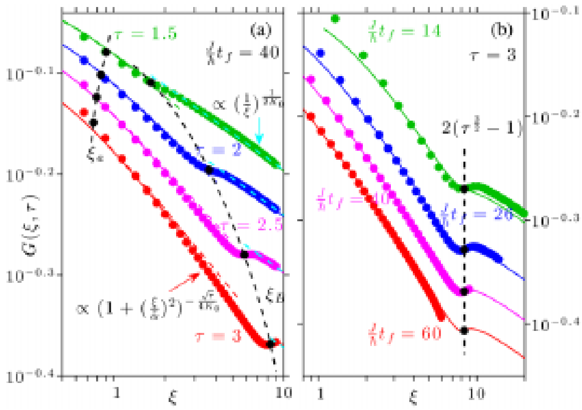

Figure 1 Decay of single-particle correlations with increasing distance for different τ (inverse velocity of the ramp). Comparison between results obtained using bosonization and t-DMRG for the Bose-Hubbard model (circles) for a quench from on-site interaction equal to hopping amplitude J (lattice length: L =100, filling n=1). (a) The two dashed lines define the generalized Lieb-Robinson bound. (b) Comparison between different ramp times t_f for a fixed value of τ=3. The position of the bound does not depend on the velocity of the ramp.