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Quantum Many-Body Dynamics in a Tonks-Girardeau Gas

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The Tonks-Girardeau (TG) model describes a system of infinitely repulsive ("impenetrable core") bosons in 1D. Quantum dynamics of the TG gas can be numerically exactly solved by using the famous Fermi-Bose mapping. A recently derived formula [1] enables calculation of the one-body density matrix and related observables such as the momentum distribution during nonequilibrium dynamics.

We employ this method to study Bragg-reflections of a many-body wavepacket [1] and dark soliton states in a TG gas [2,3]. We find strong suppression of a Bragg-reflection peak for a large and dense TG wavepacket; our observation illustrates dependence of the momentum distribution on the interactions/wave function symmetry [1]. The excitation of dark soliton states, that is, specially tailored excited many body eigenstates, was recently proposed with a use of light-control mechanism [2]. Their correlation properties exhibit a peculiar type of off-diagonal long-range order despite of the fact that dark TG solitons are not Bose-condesed states [3].

References:

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