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Non-equilibrium Aspects of Quantum Integrable Systems[1]

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The study of non-equilibrium dynamics of interacting many body systems is currently one of the main challenges of modern condensed matter physics, driven by the spectacular progress in the ability to create experimental systems - trapped cold atomic gases are a prime example - that can be isolated from their environment and be highly controlled. Many old and new questions can be addressed: thermalization of isolated systems, nonequilibrium steady states, the interplay between non equilibrium currents and strong correlations, quantum phase transitions in time, universality among others. In this talk I will describe nonequilibrium quench dynamics in integrable quantum systems. I'll discuss the time evolution of the Lieb-Liniger system, a gas of interacting bosons moving on the continuous infinite line and interacting via a short range potential. Considering a finite number of bosons on the line we find that for any value of repulsive coupling the system asymptotes towards a strongly repulsive gas for any initial state, while for an attractive coupling, the system forms a maximal bound state that dominates at longer times. In the thermodynamic limit -with the number of bosons and the system size sent to infinity at a constant density and the long time limit taken subsequently- I'll show that the density and density-density correlation functions for strong but finite positive coupling are described by GGE for translationally invariant initial states with short range correlations. As examples I'll discuss quenches from a Mott insulator initial state or a Newton's Cradle. Then I will show that if the initial state is strongly non translational invariant, e.g. a domain wall configuration, the system does not equilibrate but evolves into a nonequilibrium steady state (NESS). A related NESS arises when the quench consists of coupling a quantum dot to two leads held at different chemical potential, leading in the long time limit to a steady state current. Time permitting I will also discuss the quench dynamics of the XXZ Heisenberg chain.

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