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The quench action approach in finite integrable spin chains

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We consider the problem of constructing the stationary state following a quantum quench, using the exact overlaps for finite size integrable models. We focus on the isotropic Heisenberg spin chain with initial state N\'eel or Majumdar-Ghosh (dimer), although the proposed approach is valid for an arbitrary integrable model. We consider only eigenstates which do not contain zero-momentum strings because the latter are affected by fictitious singularities that are very difficult to take into account. We show that the fraction of eigenstates that do not contain zero-momentum strings is vanishing in the thermodynamic limit. Consequently, restricting to this part of the Hilbert space leads to vanishing expectation values of local observables. However, it is possible to reconstruct the asymptotic values by properly reweighting the expectations in the considered subspace, at the price of introducing finite-size corrections. We also develop a Monte Carlo sampling of the Hilbert space which allows us to study larger systems. We accurately reconstruct the expectation values of the conserved charged and the root distributions in the stationary state, which turn out to match the exact thermodynamic results. The proposed method can be implemented even in cases in which an analytic thermodynamic solution is not obtainable.

Primary author: Dr ALBA, Vincenzo (SISSA)

Co-author: Prof. CALABRESE, Pasquale (SISSA)

Presenter: Dr ALBA, Vincenzo (SISSA)

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