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Bootstrapping spectral functions of 1+1d QFTs via relativistic cMPS

We present a new method for extracting dynamical information from the ground state of relativistic 1+1-dimensional quantum field theories (QFTs) directly in the continuum and thermodynamic limit, using the framework of relativistic continuous matrix product states (RCMPS).
We reconstruct smeared spectral densities from static (Euclidean) two-point correlation functions, which are directly accessible from the RCMPS ground state approximation. Mathematically, this task corresponds to solving an inverse Laplace transform —an inherently ill-posed problem. Building on a recent approach in arxiv:2408.11766, we recast the reconstruction as a convex linear optimization problem by imposing positivity constraints and constraints from the Källén-Lehmann spectral representation, thereby systematically constraining the space of physically allowed spectral functions. This yields rigorous bounds on the spectral density and real-time correlation functions consistent with the RCMPS Euclidean data.
We bootstrap the mass gap by scanning over spectral ansätze with a given gap and identifying values for which the reconstruction is feasible. This also provides an *a posteriori* estimate of the systematic error on the RCMPS two-point functions as a function of the bond dimension. Additionally, we derive a direct analytic relation between the RCMPS variational parameters and the mass gap of the theory via the spectrum of the transfer operator. Our results demonstrate how continuum tensor network methods can be used to extract non-trivial dynamical information from purely static observables.

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