Contribution ID: **18** Type: **Talk**

Generalized boost transformations in finite volumes and application to Hamiltonian methods

Friday, 2 August 2024 14:35 (20 minutes)

The investigation of hadron interactions within lattice QCD has been facilitated by the well-known quantisation condition, linking scattering phase shifts to finite-volume energies. Additionally, the ability to utilise systems at finite total boosts has been pivotal in smoothly charting the energy-dependent behaviour of these phase shifts. The existing implementations of the quantization condition at finite boosts rely on momentum transformations between rest and moving frames, defined directly in terms of the energy eigenvalues. This energy dependence is unsuitable in the formulation of a Hamiltonian. In this work, we introduce a novel approach to generalise the three-momentum boost prescription, enabling the incorporation of energy-independent finite-volume Hamiltonians within moving frames. We demonstrate the application of our method through numerical comparisons, employing a phenomenological $\pi\pi$ scattering example.

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Session Classification: Hadronic and nuclear spectrum and interactions

Track Classification: Hadronic and Nuclear Spectrum and Interactions