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Towards space-time symmetry preserving lattice discretisation schemes

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The conventional discretisation of space-time entails a breaking of continuum symmetries and spoils the conservation of the associated Noether charges with ramifications for particle spectra and the renormalisation of central quantities, such as the Energy Momentum Tensor on the lattice.
In this work [1] we take first steps towards discretizing classical actions, while retaining its continuum space-time symmetries. Our proof-of-principle for a point particle in (1+1)d adopts the action formalism from general relativity, where both space $x(\gamma)$ and time $t(\gamma)$ are dependent variables of a worldline parameter γ. Discretizing in γ, leaves the values of both x and t continuous and thus the invariance under infinitesimal translations in (1+1)d remains intact. Building upon our previous work on solving initial values on the level of the system action [2], we show that the new relativistic approach allows to compute numerically the classical trajectory of a particle under an arbitrary bounded potential, while conserving the relativistic Noether charge for time translation symmetry *exactly and at its continuum value* in the interior of the simulated domain.

[1] A. Rothkopf, J. Nordström, (in preparation)

[2] A. Rothkopf, J. Nordström, J.Comput.Phys. 477 (2023) 111942 (2205.14028)

Topical area

Theoretical Developments

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