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The Role of Boundary Conditions in Quantum Computations of Scattering Observables

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Quantum computing may offer the opportunity to simulate strongly-interacting field theories, such as quantum chromodynamics, with physical time evolution. This would give access to Minkowski signature correlators, in contrast to the Euclidean calculations routinely performed at present. However, as with present-day calculations, quantum computation strategies still require the restriction to a finite system size, including a finite, usually periodic, spatial volume. In this work, we investigate the consequences of this in the extraction of hadronic and Compton-like scattering amplitudes. Using the framework presented in Phys. Rev. D101 014509 (2020), we quantify the volume effects for various 1 + 1D Minkowski-signature quantities and show that these can be a significant source of systematic uncertainty, even for volumes that are very large by the standards of presentday Euclidean calculations. We then present an improvement strategy, based in the fact that the finite volume has a reduced symmetry. This implies that kinematic points, which yield the same Lorentz invariants, may still be physically distinct in the finite-volume system. As we demonstrate, both numerically and analytically, averaging over such sets can significantly suppress the unwanted volume distortions and improve the extraction of the physical scattering amplitudes.

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