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Scattering Amplitude from Quantum Computing with Reduction Formula

Utilizing the Lehmann-Symanzik-Zimmermann (LSZ) reduction formula, we present a new general framework for computing scattering amplitudes in quantum field theory with quantum computers in a fully non-perturbative way. In this framework, one only has to construct one-particle states of zero momentum, and no wave packets of incoming particles are needed. The framework is able to incorporate scatterings of bound states, and is ideal for scatterings involving a small number of particles. We expect this framework to have particular advantages when applied to exclusive hadron scatterings. As a proof of concept, by simulations on classical hardware, we demonstrate that the 2-point function and the 4-point function in the Gross-Neveu model obtained from our proposed quantum algorithm has the desired pole structure crucial to the implementation of the LSZ reduction formula.

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