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Quantum simulation of quantum field theory in the light-front formulation[1] GARY GOLDSTEIN, MICHAEL KRESHCHUK, WILLIAM KIRBY, HUGO BEAUCHEMIN, PETER LOVE, Tufts Univ — Quantum simulation of quantum field theories offers a new way to investigate properties of the fundamental constituents of matter. We develop quantum simulation algorithms based on the light-front formulation of relativistic field theories. We analyze a simple theory in 1+1D and show how to compute the analogues of parton distribution functions of composite particles in this theory. Upon quantizing the system in light-cone coordinates, the Hamiltonian becomes block diagonal, each block approximating the Fock space with a certain harmonic resolution K. The lower bound on the number of qubits required is $O(\sqrt{K})$, and we give a complete description of the algorithm in a mapping that requires $O(\sqrt{K}\ \log K)$ qubits and $O(K^6)$ gates. In higher dimensions, the scaling of the number of qubits remains the same, up to logarithmic factors. This is a notable advantage of the light-front formulation.

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