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QUANTUM SIMULATION OF QUANTUM FIELD THEORIES

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We propose an analog-digital quantum simulation of fermion-fermion scattering in quantum field theory with superconducting circuits. This quantum technology naturally provides strong coupling of superconducting qubits with a continuum of electromagnetic modes, that is, a continuum of bosonic modes, in an open transmission line. In this way, we propose qubits to efficiently simulate fermionic modes via digital techniques, while we consider the continuum complexity of an open transmission line to simulate the continuum complexity of bosonic modes in quantum field theories. Therefore, we believe that the complexity-simulating-complexity concept should become a leading paradigm in any effort towards scalable quantum simulations. In particular, using a complex quantum system to simulate another quantum system with similar complexity represents a significant step towards scalable quantum simulations of quantum field theories in perturbative and nonperturbative regimes.