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Quantum algorithms for quantum field theories[1]

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Ever since Feynman's original proposal for quantum computers, one of the primary applications envisioned has been efficient simulation of other quantum systems. In fact, it has been conjectured that quantum computers would be universal simulators, which can simulate all physical systems using computational resources that scale polynomially with the system's number of degrees of freedom. Quantum field theories have posed a challenge in that the set of degrees of freedom is formally infinite. We show how quantum computers, if built, could nevertheless efficiently simulate certain quantum field theories at bounded energy scales. Our algorithm includes a new state preparation technique which we believe may find additional applications in quantum algorithms.

[1]joint work with Keith Lee and John Preskill