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# Simulating quantum and classical field theories with a quantum computer

*Wednesday, September 12, 2018 10:35 AM (40 minutes)*

In this talk I will describe quantum algorithms by which universal fault-tolerant quantum computers can simulate quantum and classical field theories. In the case of quantum field theories the number of quantum degrees of freedom is extensive in the volume of the system to be simulated and the speedup over classical algorithms is exponential. As specific applications we consider phi-fourth theory and the Gross-Neveu model. For classical field theories the number of qubits needed for the simulation scales only logarithmically with the volume. The resulting speedup is polynomial for classical field theories in any fixed number of spatial dimensions but exponential in the number of dimensions. As a specific application we consider wave equations in three spatial dimensions (such as Maxwell's equations and the Klein-Gordon equation). In this case the quantum algorithm achieves a cubic speedup while using only logarithmically many qubits, vs. standard classical methods which have memory requirements that grow linearly with volume. I will conclude with some research directions and open questions regarding quantum algorithms for scientific computing.

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