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Towards analog quantum simulations of lattice gauge theories with trapped ions ZOHREH DAVOUDI, MOHAMMAD HAFEZI, CHRISTOPHER MONROE, GUIDO PAGANO, ALIREZA SEIF, ANDREW SHAW, University of Maryland, College Park — Gauge field theories play a central role in nuclear physics and are at the heart of the Standard Model of elementary particles and interactions. Despite significant progress in applying classical computational techniques to simulate gauge theories, it has remained a challenging task to compute the real-time dynamic of systems described by these theories, such as the evolution of matter under extreme conditions after heavy ion collisions. An exciting possibility that has been explored in recent years is the use of highly-controlled quantum systems to simulate, in an analog fashion, properties of a target system whose dynamics is difficult to compute. Engineered atom-laser interactions in a linear crystal of trapped ions offer a wide range of possibilities for quantum simulations of complex physical systems. Here, we present practical proposals for analog simulation of lattice gauge theories whose dynamics can be mapped into spin-spin interactions in any dimension. Future possibilities to extend such a mapping to a larger class of gauge field theories include devising higher-order spin interactions and taking advantage of the control over phononic excitations.

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