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**Improving Trapped Ion Quantum Simulators via Parametric Amplification** WENCHAO GE, U.S. Army Research Laboratory, Adelphi, Maryland 20783, USA, BRIAN SAWYER, Georgia Tech Research Institute, Atlanta, Georgia 30332, USA, JOE BRITTON, KURT JACOBS, U.S. Army Research Laboratory, Adelphi, Maryland 20783, USA, JOHN BOLLINGER, National Institute of Standards and Technology, Boulder, Colorado 80305, USA, MICHAEL FOSS-FEIG, U.S. Army Research Laboratory, Adelphi, Maryland 20783, USA — Trapped ions offer a pristine platform for quantum simulation of spin models, but decoherence is nevertheless an inevitable source of error that limits their applications. Here we analyze a strategy to enhance the interaction strengths in trapped-ion systems via parametric amplification of the ions motion, thereby suppressing the relative importance of decoherence. As an example, we determine the enhancement this strategy can provide in producing collective states for quantum metrology, a task that is crucially limited by the ratio of the effective spin-spin interaction strength to the decoherence rate. Fundamental limitations of this strategy and the tolerance of various experimental imperfections are also analyzed. Our ideas can be extended to a variety of spin models implemented in trapped ions, and could also be useful for enhancing boson-mediated interactions in a variety of other physical platforms.

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