Abstract Submitted
for the DAMOP17 Meeting of
The American Physical Society

**Cryogenic Ion Chains for Large scale Quantum Simulations**

GUIDO PAGANO, HARVEY KAPLAN, WEN-LIN TAN, PAUL HESS, JIEHANG ZHANG, ERIC BIRCKELBAW, MICAH HERNANDEZ, CHRISTOPHER MONROE, Joint Quantum Insititute, University of Maryland-College Park — Ions confined in RF Paul traps are a useful tool for quantum simulation of long-range spin-spin interaction models. As the system size increases, classical simulation methods become incapable of modeling the exponentially growing Hilbert space, necessitating quantum simulation for precise predictions. Current experiments are limited to less than 30 qubits due to collisions with background gas that regularly destroys the ion crystal. We report results achieved in our cryogenic ion-trap quantum simulator, where we can routinely trap up to 100 ions in a linear chain and hold them for hours, thanks to differential cryo-pumping that reduces residual background pressure. Such a long chain provides a platform to investigate simultaneous cooling of many vibrational modes which will enable quantum simulations that outperform their classical counterpart. Our apparatus serves as a versatile test-bed to investigate a variety of Hamiltonians, including spin 1 and spin 1/2 systems with Ising or XY interactions. This work is supported by the ARO Atomic Physics Program, the AFOSR MURI on Quantum Measurement and Verification, the IC Postdoc Fellowship Program and the NSF Physics Frontier Center at JQI.

Guido Pagano
Joint Quantum Insititute, University of Maryland-College Park

Date submitted: 26 Jan 2017 Electronic form version 1.4