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**Cryogenic Trapped-Ion System for Large Scale Quantum Simulation**[1] WEN LIN TAN, GUIDO PAGANO, HARVEY KAPLAN, PAUL HESS , PATRICK BECKER, ANTONIOS KYPRIANIDIS, JIEHANG ZHANG, CHRISTOPHER MONROE, Joint Quantum Institute, University of Maryland-College Park, PHIL RICHERME, Department of Physics, Indiana University, Bloomington, YUKAI WU, Department of Physics, University of Michigan, Ann Arbor — Trapped ion systems are a leading platform for quantum simulation of spin models. Current experiments are limited to less than 55 ions due to collisions with background gas that destroy the ion crystal. Here, we present a novel cryogenic ion trapping system designed for large scale quantum simulation of spin models. The apparatus is a segmented blade trap enclosed in a 4 K cryostat, which enables us to routinely trap above 100 $^{171}Yb^{+}$ ions in a linear configuration with an ion chain lifetime more than four hours due to a low background pressure from differential cryo-pumping. We characterize the cryogenic vacuum by using the ion crystals as pressure gauge by measuring both inelastic and elastic collision rates with the molecular background gas. We also show the capability of reducing the ion space inhomogeneity for chains with up to 44 ions by means of anharmonic axial potential. With these improvements, we are moving forward to perform large scale quantum simulation of spin models that will challenge classical simulators.

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