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# Quantum Computing and Simulations with Long Ion Chains

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To apply today's quantum hardware to challenging problems, we need to efficiently use native interactions while minimizing the effects of noise. While operations on trapped ion qubits can be first-order resilient to noisy electric fields, deep computations with long ion chains suffer from high axial temperatures. To counter this, we employ sympathetic cooling in $^{171}Yb^{+}$-$^{172}Yb^{+}$ chains. To speed up digital computations and simulations, we developed a new class of quantum gates based on state-dependent squeezing. To speed up analog simulations, we leverage individual addressing of spins. We prepare near-ground states of the long-range 1D XY model, which break the U(1) symmetry of the underlying Hamiltonian, resulting in long-range off-diagonal order.

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