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Quantum Simulation of 2D spin lattices in a linear chain of trapped ions SAINATH MOTLAKUNTA, FERESHTEH RAJABI, YI HONG TEOH, MANAS SAJJAN, CHUNG-YOU SHIH, NIKHIL KOTIBHASKAR, ROLAND HABLUTZEL, RAJIBUL ISLAM, Institute for Quantum Computing and Dept of Physics and Astronomy, University of Waterloo, Waterloo, Ontario N2L 3G1, Canada — Trapped ions, a leading candidate for quantum simulation, are most readily trapped in a linear chain, have limited ability to simulate arbitrary higher dimensional models. Here, we describe an analog and analog-digital hybrid quantum simulation protocols that leverage the phonon-mediated long range (Molmer-Sorensen) interactions between ion spins to mimic the interaction graph of 2D lattices. The traditional analog protocol requires individual control of spins and phonon modes. Here, we enhance the experimental feasibility by employingneural networks [1] to efficiently optimizethe required experimental configuration. The hybrid protocol [2], dynamically modifies the targeted interactions between all-to-all coupled spins that are feasible in current experiments. The hybrid protocol scales favorably for lattices with certain symmetries, e.g. O(N)control pulses are required to simulate a square lattice of N sites. We acknowledge financial support from U Waterloo, US ARO, NSERC Discovery grant, and TQT (CFREF). [1] Collaboration with Marina Drygala and Roger Melko [2] Rajabi et al, arXiv 1808.06124 (collaboration with Ashok Ajoy, UC Berkeley and Qudsia Quraishi, ARL).

Sainath Motlakunta
University of Waterloo

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