Demonstration of multi-qubit algorithms on a neutral-atom quantum computer

T.M. Graham, [1] Yunheung Song, [1,2]* J. Scott, [1] C. Poole, [1] L. Phuttitarn, [1] K. Jooya, [1] P. Eichler, [1] X. Jiang, [1] A. Marra, [1] B. Grinkemeyer, [1] M. Kwon, [1] M. Ebert, [3] J. Cherek, [3] M. T. Lichtman, [3] M. Gillette, [3] J. Gilbert, [4] D. Bowman, [5] T. Ballance, [5] C. Campbell, [4] E.D. Dahl, [4] O. Crawford, [6] N.S. Blunt, [6] B. Rogers, [6] T. Noel, [4] & M. Saffman [1,3]

*presenting author

[1] Department of Physics, University of Wisconsin-Madison, Madison, WI, USA

[2] ysong@kriss.re.kr, Korea Research Institute of Standards and Science (KRISS)

[3] ColdQuanta, Inc., Madison, WI, USA

[4] ColdQuanta, Inc., Boulder, CO, USA

[5] ColdQuanta UK, Oxford Centre for Innovation, Oxford, UK

[6] Riverlane, Cambridge, UK

Neutral atoms have recently emerged as one of promising platforms for quantum technology, thanks to their scalability and controllability from atom rearrangement and Rydberg excitation. Based upon these advances, we build a neutral-atom quantum computer up to 6 qubits with universal gate set implemented by global microwave and tightly focused 459 nm & 1040 nm lasers. Single qubit gates are performed by combination of microwave transitions and local Stark shifts, and site-selective laser beams implement two-qubit gates by two-photon Rydberg transitions. Using these universal gates, we demonstrate multi-qubit algorithms such as GHZ state preparation, quantum phase estimation for hydrogen molecular energy, and quantum approximate optimization algorithm (QAOA) for MaxCut problem.

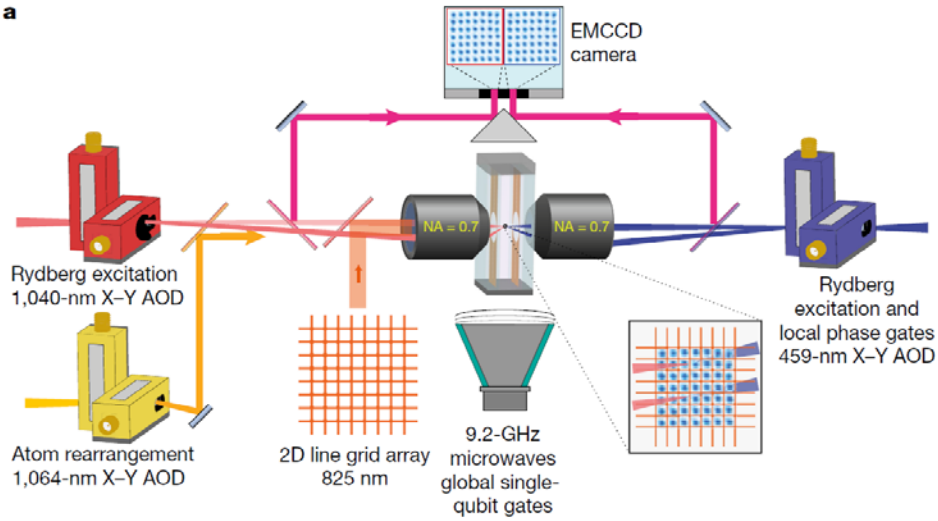

Figure 1. Experimental layout of a neutral-atom quantum computer [1]

References:

1. T. M. Graham et al., Multi-qubit entanglement and algorithms on a neutral-atom quantum computer *Nature* **604**, 457–462 (2022).