Fidelity Relations in an Array of Neutral Atom Qubits

Rogier Venderbosch,[1,2,*] Ricky Teunissen,[1,2] Yuri van der Werf,[1,2] Rianne Lous,[1,2] Edgar Vredenbregt,[1,2] and Servaas Kokkelmans[1,2]

[1] *KAT-1 Lab, Department of Applied Physics and Science Education, Eindhoven University of Technology, The Netherlands*
[2] *Center for Quantum Materials and Technology, Eindhoven, The Netherlands*

Control noise in driven pulses remains a ubiquitous limitation in NISQ-era quantum processors. Here, we report on our study [1] of the relationship between control noise and qubit state fidelity and compare our experimental results with recent theoretical predictions. The experiments are performed on our Ruby platform, which features a 10×10 optical tweezer array stochastically loaded from an ^{85}Rb MOT. Qubit control is implemented via a global microwave field to which controlled artificial noise is added, and the resulting qubit state fidelity is measured. The observed fidelity distributions are compared with theoretical predictions based on a stochastic Schrödinger equation approach. In both experiment and theory, we observe characteristic dependencies of the fidelity on the noise duration for different noise types, with generally good agreement. These results demonstrate that stochastic Schrödinger equation simulations provide a powerful framework for modeling the impact of control noise on gate performance beyond average fidelity estimates.

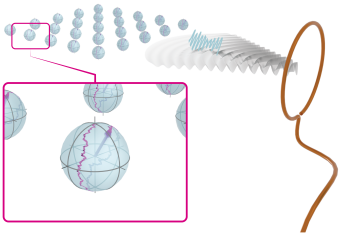

FIG. 1. **Conceptual representation** Using a microwave antenna, a control signal with superimposed noise is sent to an array of neutral atom qubits and leads to qubit infidelity.

[1]. D.A. Janse van Rensburg, R.J.P.T. de Keijzer, R.C. Venderbosch, Y. van der Werf, J.J. del Pozo Mellado, R.S. Lous, E.J.D. Vredenbregt and S.J.J.M.F. Kokkelmans, Phys. Rev. A. 113 (022616) (2026)

* r.c.venderbosch@tue.nl; On behalf of the Neutral Atom Kat-1 collaboration (https://www.tue.nl/rydbergQC)