High fidelity quantum science with arrays of Strontium Rydberg atoms

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Here we show our ability to manipulate and benchmark with high fidelity a many-body quantum system. Our apparatus relies on the individual trapping of Strontium atoms in optical tweezers [1] (see Figure 1), excited to their Rydberg states [2]. We first uncover the signatures of universal random statistics emerging from both temporal evolution and projective measurement [3]. In particular, we observe the so-called Porter-Thomas distribution, a phenomenon which we find is universal across a wide variety of quantum computers and simulators. The presence of these random statistics allows us to further develop recent protocols for quantum device benchmarking, which we use to demonstrate (i) in situ Hamiltonian learning, and (ii) the measurement of highly-entangled states fidelity (see Figure 2). We finally highlight possibilities for scaling this protocol to hundreds of qubits, and discuss prospects for realizing quantum advantage with near-term quantum simulators.

References

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[3] J. Choi, A. Shaw, I. Madjarov, X. Xin, J. Covey, J. Cotler, D. Mark H.Y. Huang, A. Kale, H. Pichler F. Brandao, S. Choi, and M. Endres arXiv:2103.03535

Figures

Figure 1: Array of Strontium atoms in optical tweezers

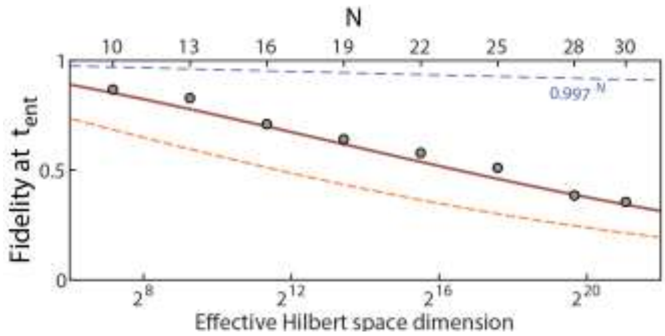

Figure 2: Evolution of the fidelity at entanglement entropy saturation time, as a function of the number of qubits N. The markers and the red line represent the experimental results and the ab-initio calculation including all known imperfections, respectively.