

# Emergent Randomness and Benchmarking from Many-Body Quantum Chaos

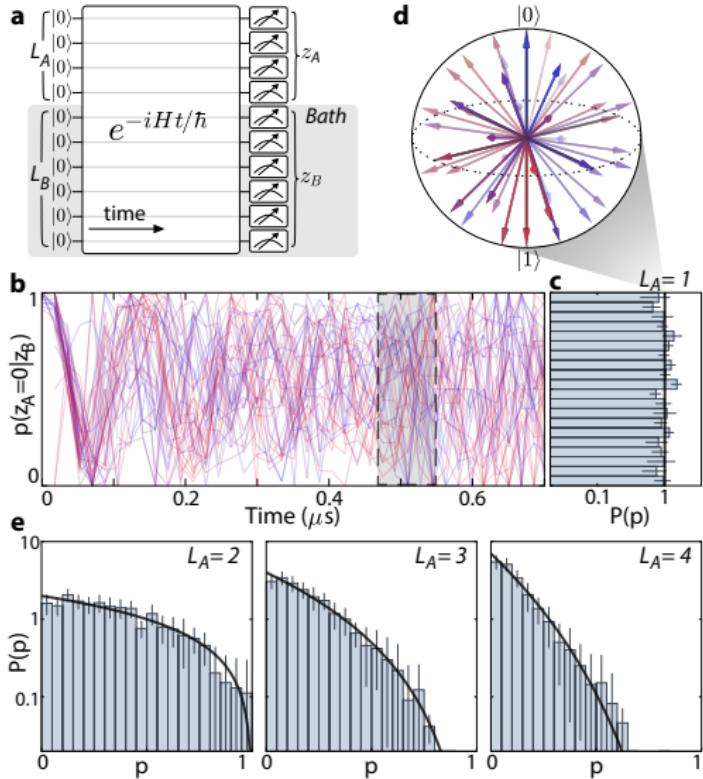
Yichao Yu

Ni Group

Mar. 24, 2021

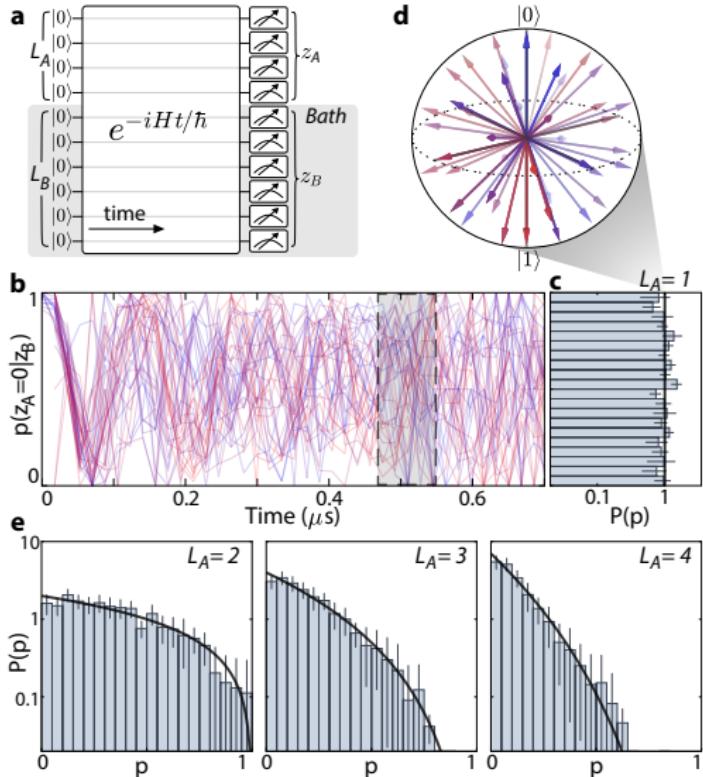
- Experimental observation of thermalization
- Projected state ensemble
- Application

# Experiment



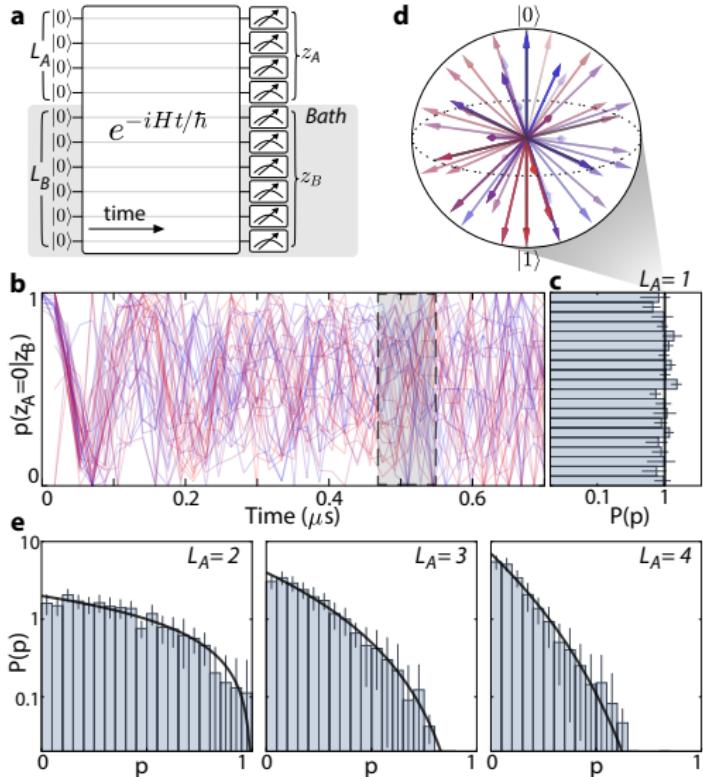
- Rydberg system with chaotic dynamic
- A: system, B: Bath
- Conditional probability  $p(z_A|z_B)$
- Random state vs dephasing
- $L_A > 1$
- Moments  
$$p^{(k)} \equiv \sum_p p^k P(p)$$
- Independent of system division

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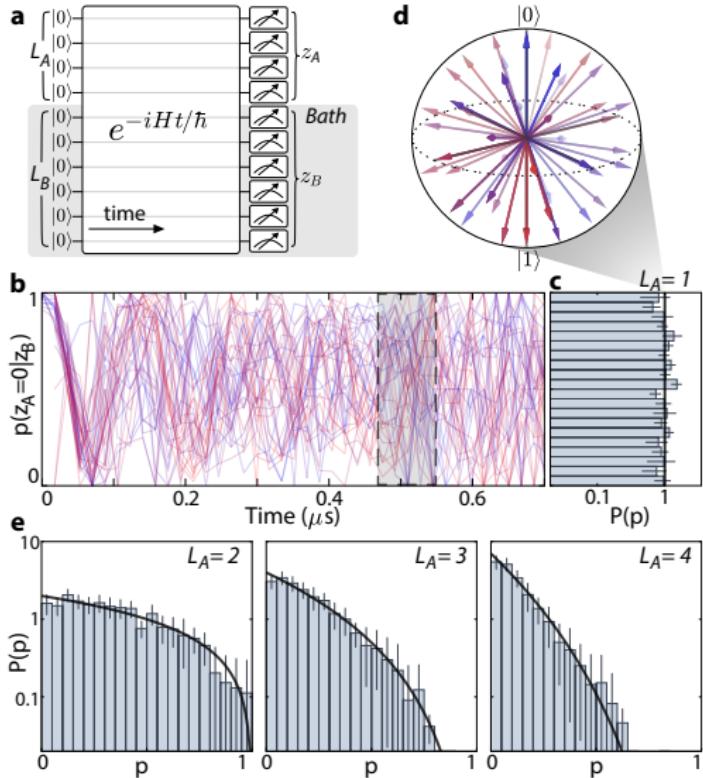
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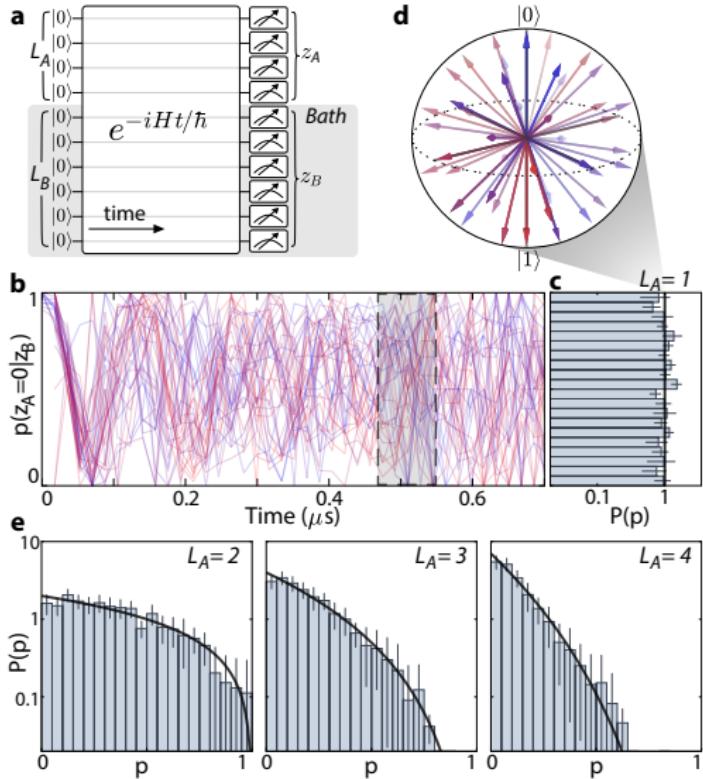
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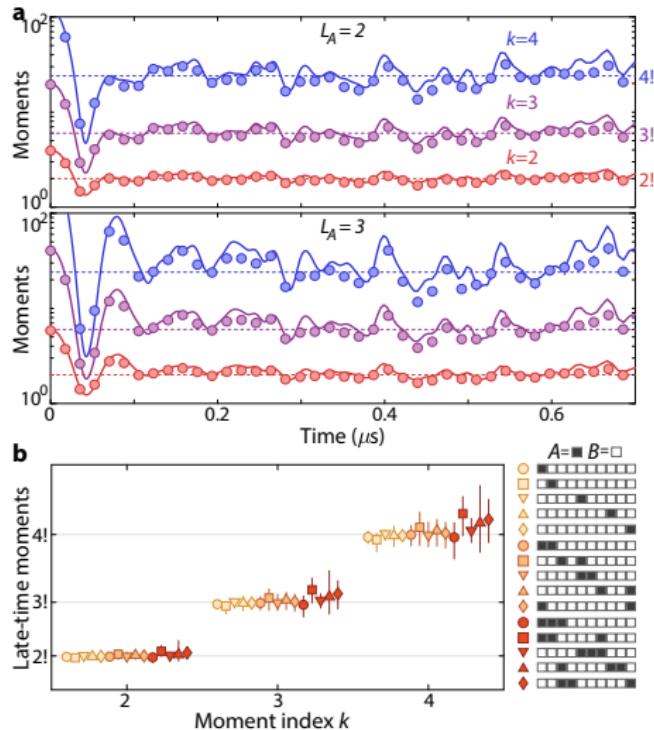
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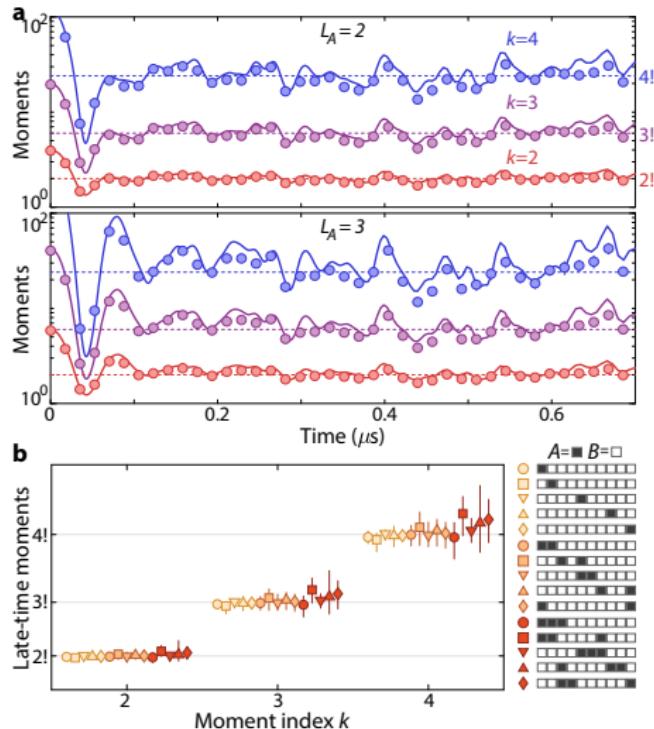
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# Projected State Ensemble

- Density matrix:  
$$\rho = \sum p_i |\psi_i\rangle\langle\psi_i|$$
- Choice of  $\{p_i, \psi_i\}$  is not unique
- Full description if the system is all what can be measured
- Projected state ensemble:  
Determine  $\{p_i, \psi_i\}$  by selecting the bath basis.
- $k$ -design

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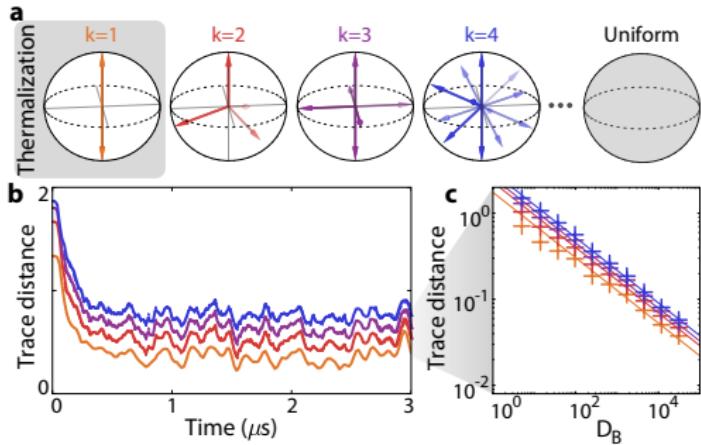
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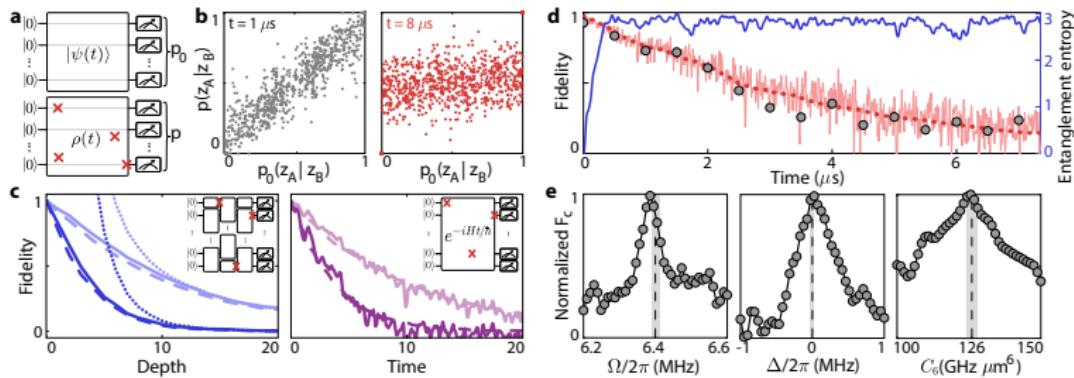
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## Application

- Useful in quantum cryptography and supremacy test
- Fidelity estimation
- $F_c = 2 \frac{\sum_z p(z)p_0(z)}{\sum_z p_0^2(z)} - 1$
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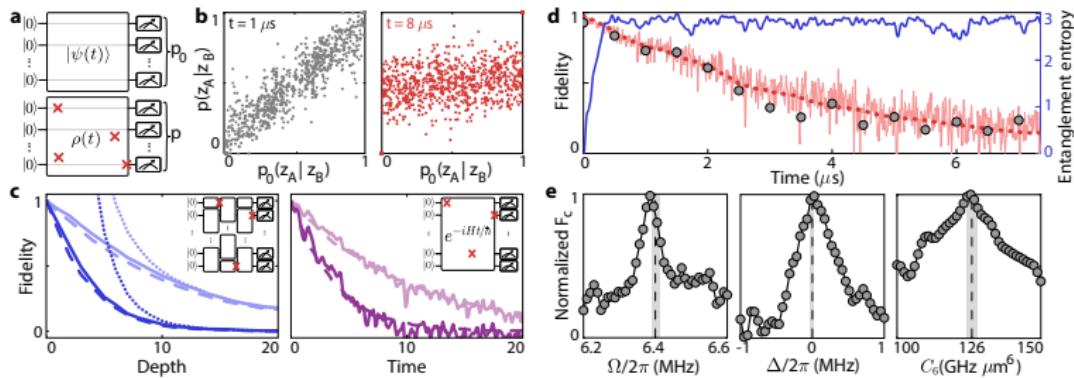
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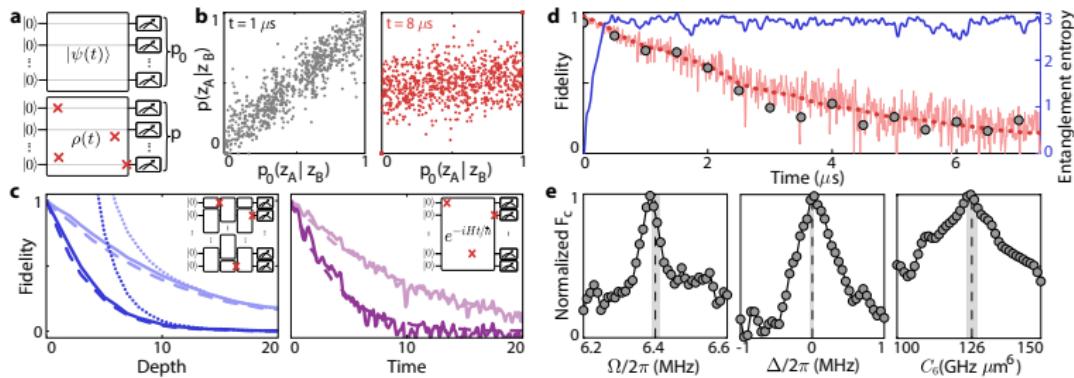
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