Experimental demonstration that qubits can be cloned at will, if encrypted with a single-use decryption key

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arXiv:2602.10695

Reminder (arXiv:2501.02757)

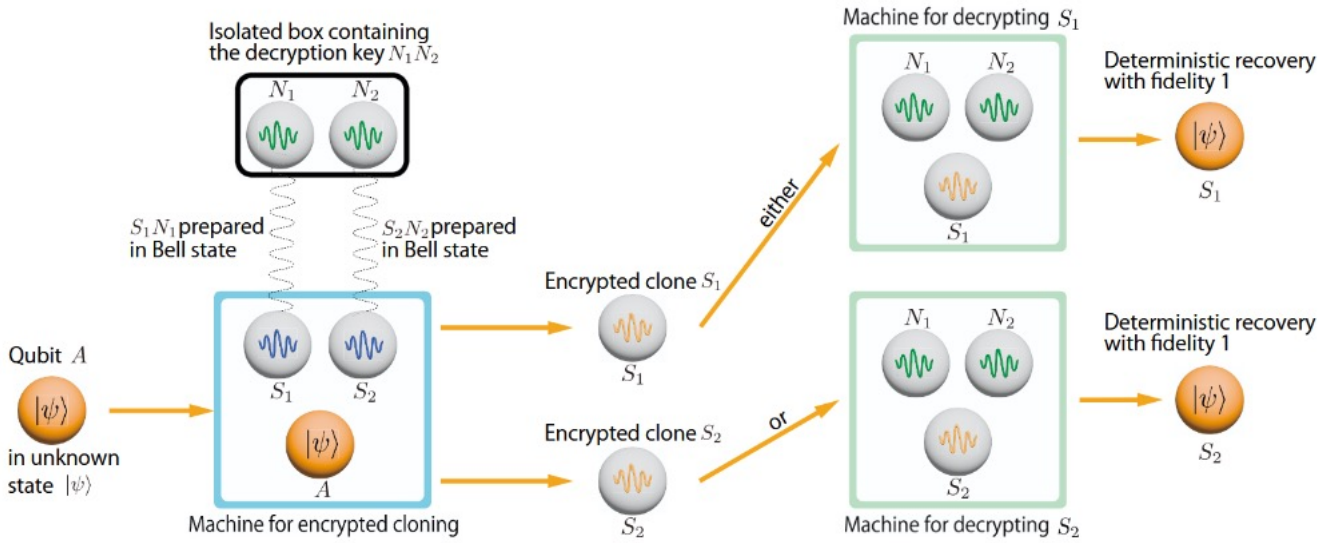
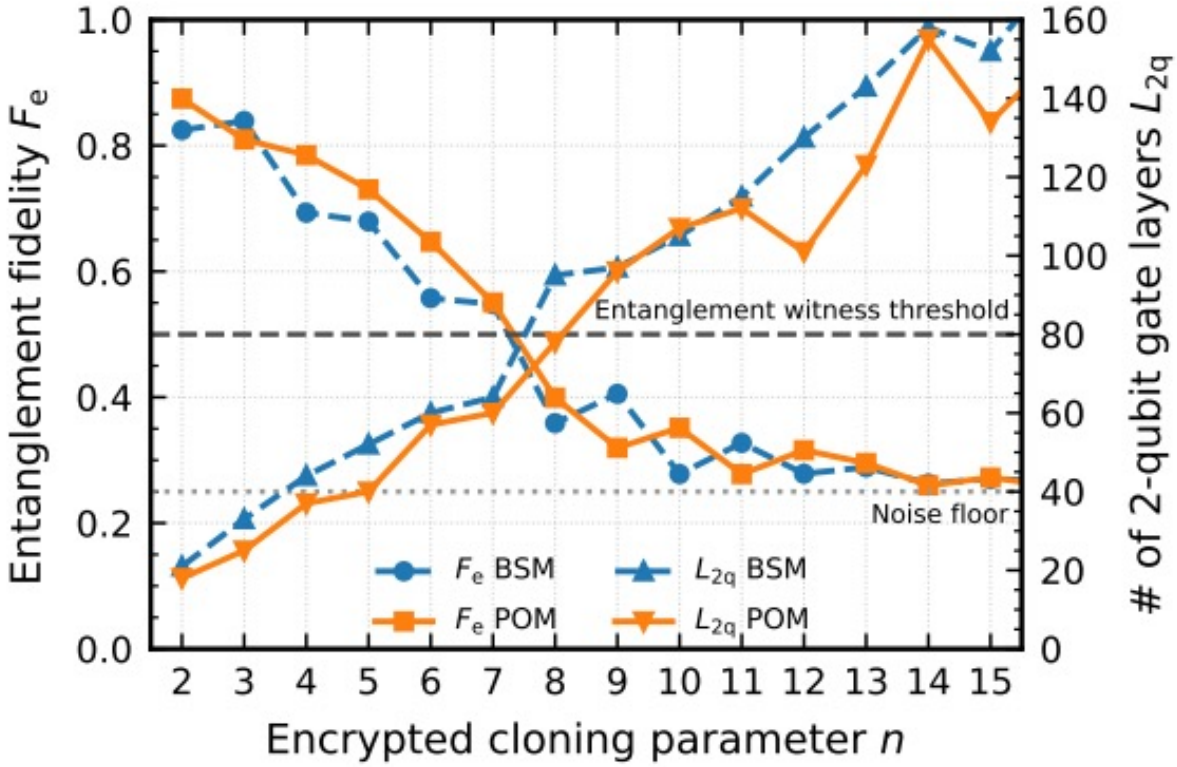


FIG. 1. The protocol for $n = 2$. Qubits whose reduced state is maximally mixed are represented by spheres displaying fluctuations. The initial maximal mixedness of S_1 and S_2, which stems from their being prepared in Bell states with N_1 and N_2 respectively, provides the quantum noise for the encryption. N_1 and N_2 keep a record of this quantum noise and can, therefore, later be used to de-noise or decrypt either S_1 or S_2. Crucially, the decryption machine consumes N_1 and N_2, so that only one decryption can be performed. Therefore, only one unencrypted version of the original state of A can exist at a time, which enables consistency with the no-cloning theorem.

Experiment 1: Fidelity

IBM Heron R2



BSM: Bell State Measurement
POM: Parity Oscillations Method

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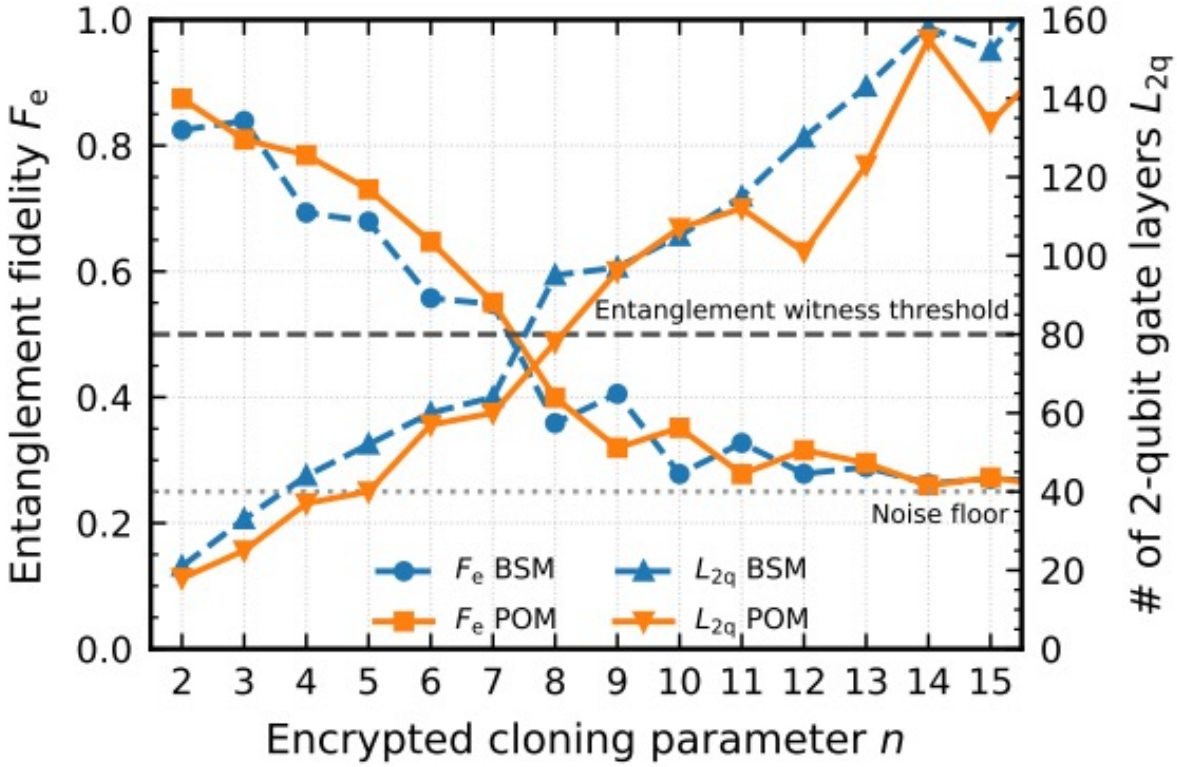
F = 0.5 is the entaglement witness threshold *for a Bell pair*

- If F >= 0.5, there must be some entanglement
- See pg. 15 of arXiv: 0811.2803
  - maximal Schmidt coefficient of a Bell pair is $\frac{1}{\sqrt{2}}$



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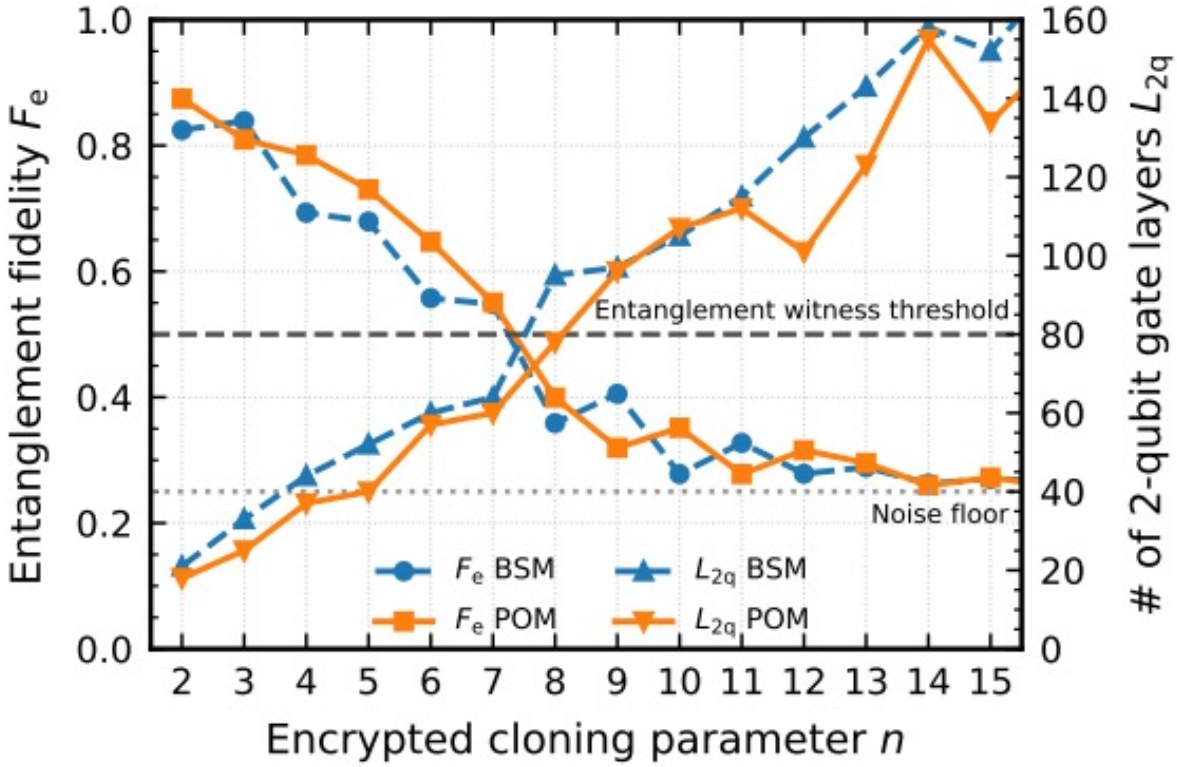
Protocol works even on a NISQ machine, with fidelity dropping with gate depth



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- Experiment 4: Operation in parallel: Feasibility of encrypted cloning inside multipartite circuits
  - GHZ state, encrypt-clone one qubit at a time
  - Recovered state has $F > 0.5$ for up to a 4-qubit GHZ state