

Zero-Noise Extrapolation Works in Indirect Control

A breakthrough in scalable quantum error mitigation

28 pages

Paper Length

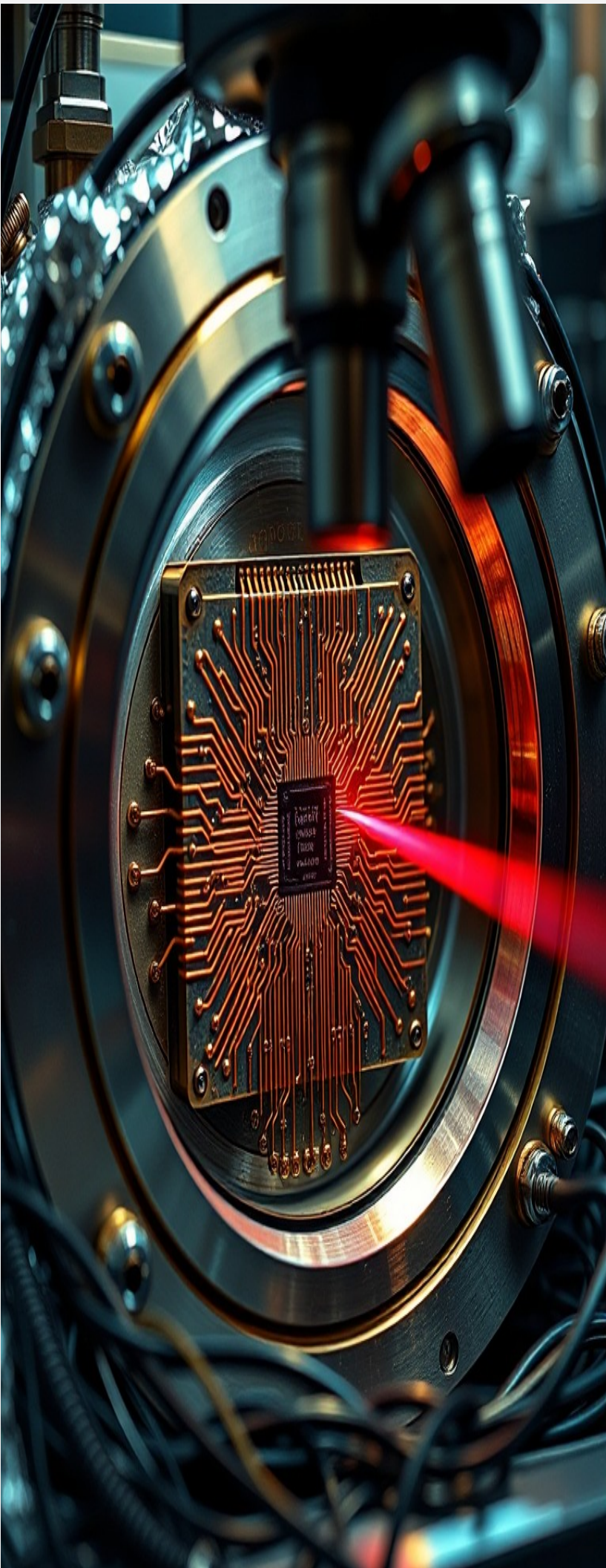
The full technical analysis of ZNE adaptation in indirect-control systems was published in IEEE Access.

This 28-page study rigorously investigates how zero-noise extrapolation (ZNE) can be implemented in an indirect-control quantum architecture—where control is limited to a small subset of qubits and the rest evolve under a many-body Hamiltonian. The authors demonstrate that ZNE remains viable even when circuit-level noise amplification techniques like unitary folding are not directly applicable.

01

Indirect Control Enables Scalable Error Mitigation

The paper reveals that the indirect-control paradigm—by restricting external operations to a small qubit subset—reduces hardware complexity and noise injection from control channels. This makes it a promising path for scalable quantum computing. The study shows that ZNE can be adapted within this framework, even without direct circuit-level noise amplification, by exploiting physical symmetries such as those in a one-dimensional XY spin chain.



02

Symmetry as a Quantum Engineering Lever

Instead of relying on engineered noise amplification, the researchers leverage the intrinsic symmetry of the XY spin chain to implement ZNE. This shift from engineered to natural symmetry-based mitigation suggests a new design principle: quantum systems may not need full control to correct errors, if their physical architecture inherently supports error-mitigation pathways. This could redefine how we build fault-tolerant quantum hardware.

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