**HARVARD UNIVERSITY**
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# Mathematical Picture Language Seminar

**Tuesday, February 25**

**4:30 p.m. Boston time**

**Jefferson 256 and Zoom**

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Harvard

## Low overhead fault tolerance for universal quantum computation

**Abstract:** Quantum error correction (QEC) is believed to be essential for scalable quantum computation, but its implementation is challenging due to its considerable space-time overhead. Here we report theoretical and experimental advances in reducing this overhead. Using dynamically reconfigurable arrays of neutral atoms and various types of error-correcting codes, we demonstrate efficient manipulation and entanglement of logical qubits using transversal gates, including improving entangling gates with code distance and simulating classically complex scrambling circuits. In implementing these circuits, we observe their performance can be substantially improved by accounting for error propagation during transversal entangling gates and decoding the logical qubits jointly. By leveraging this deterministic propagation of errors, we show this correlated decoding enables the number of noisy syndrome extraction rounds between gates to be reduced from O(d) to O(1) in transversal Clifford circuits, where d is the code distance. We then generalize this finding to apply to universal computation by developing strategies for handling feed-forward operations and magic state inputs. These techniques result in new theories of fault-tolerance and in practical reductions to the cost of large-scale quantum computation by over an order of magnitude.

**Zoom QR Code & Link:**
https://harvard.zoom.us/j/779283357?pwd=MitXVm1pYUlJVzZqT3lwV2pCT1ZUQT09

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