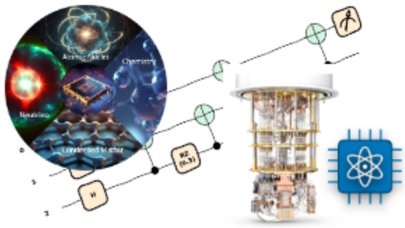

Contribution ID: **33** Type: **Contributed Talk (45min including questions)**

Error mitigation and circuit division for early fault-tolerant quantum phase estimation

Tuesday, November 18, 2025 4:20 PM (45 minutes)

As fully fault-tolerant quantum computers capable of solving useful problems remain a distant goal, we anticipate an era of *early fault tolerance* where limited error correction is available.
We propose a framework for designing early fault-tolerant algorithms by trading between error correction overhead and residual logical noise, and apply it to quantum phase estimation (QPE).
We develop a quantum-Fourier-transform (QFT)-based QPE technique that is robust to global depolarising noise and outperforms the previous state of the art at low and moderate noise rates.
We further introduce the Explicitly Unbiased Maximum Likelihood Estimation (EUMLE), a data processing technique that mitigates *arbitrary* errors in QFT-based QPE schemes. EUMLE provides consistent, asymptotically normal error-mitigated estimates, addressing the open problem of extending error mitigation beyond expectation value estimation.
Applying this scheme to the ground state problem of the two-dimensional Hubbard model and various molecular Hamiltonians, we find we can roughly halve the number of physical qubits with a $\sim 10\times$ wall-clock time overhead, but further reduction causes a steep runtime increase.
This work provides an end-to-end analysis of early fault-tolerance cost reductions and space-time trade-offs, and identifies areas for future improvement.

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