

# Distinguished Bhaumik Lecture and Physics & Astronomy Colloquium

## Error correction of a logical quantum bit beyond the break-even point

Michel Devoret

(Yale)

Thursday, May 8<sup>th</sup> 2025, 4PM

PAB 1-434

Refreshments will be served at 3:30PM on the PAB 3rd floor patio.

Undergraduates welcome!

The accuracy of logical operations on quantum bits (qubits) must be improved for quantum computers to surpass classical ones in useful tasks. To that effect, quantum information needs to be made robust to noise that affects the underlying physical system. Rather than suppressing noise, quantum error correction aims at preventing it from causing logical errors. This approach derives from the reasonable assumption that noise is local: it does not act in a coordinated way on different parts of the physical system. Therefore, if a logical qubit is adequately encoded non-locally in the larger Hilbert space of a composite system, it is possible, during a limited time, to detect and correct the noise-induced evolution before it corrupts the encoded information. We will present an experiment implementing a logical qubit in a superconducting cavity coupled to a transmon synthetic atom – the latter employed here as an auxiliary non-linear element. Error correction involves a novel primitive operation and feedback control based on reinforcement learning. We have stabilized in real-time a logical qubit manifold spanned by the Gottesman-Kitaev-Preskill grid states, reaching a correction efficiency such that the lifetime of the encoded information was prolonged by more than a factor of two beyond the lifetime of the best physical qubits composing our system.

