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Autonomous quantum error correction with pair-cat code in superconducting microwave circuits

Stabilized quantum manifolds of a bosonic system can encode error-protected qubits. In particular, a logical qubit encoded in a single-mode manifold spanned by cat states is exponentially protected against phase-flip errors. However, in existing experimental implementations with microwave superconducting circuits, detecting and fully correcting photon-loss errors is challenging without turning off the dissipative stabilization process. On the other hand, a phase-flip error protected logical qubit can be encoded in a stabilized manifold spanned by pair-cat states, which are superpositions of two-mode states called Barut-Girardello/pair-coherent states. Advantageously, photon loss errors in either mode can be detected by monitoring the photon-number difference between them, without stopping manifold stabilization.

In this talk I will introduce the basic theoretical concepts of the pair-cat code and describe our recent results in trying to implement the code in a 3D superconducting microwave architecture.