A fully error-corrected logical quantum bit encoded in grid states of a superconducting cavity

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Abstract

The operation of universal quantum computers is easily derailed by noise that modifies the state of physical qubits, causing logical errors. Fortunately, such errors can be detected and corrected if quantum information is encoded non-locally. Applying this idea to hardware efficient bosonic codes, Gottesman Kitaev and Preskill proposed to encode a protected qubit into states forming grids in the phase-space of a harmonic oscillator. Here, we prepare and stabilise such a qubit using repeated applications of a novel gate sequence on a superconducting microwave cavity. We demonstrate significant suppression of all logical errors, in quantitative agreement with a theoretical estimate based on the measured imperfections of the experiment. Our results are applicable to other continuous variable systems and, in contrast with previous implementations of quantum error correction, can mitigate the impact of a wide variety of noise processes and open a way towards fault-tolerant quantum computation.

Short Biography

Dr. Steven Touzard received his PhD from Yale university, where he worked with superconducting qubits in the group of Prof. Michel Devoret. His work focused on quantum error correction and exotic quantum state generation, and he pioneered measurement schemes that are currently the state of the art. Dr. Touzard is currently a post-doctoral fellow at NUS in the group of Travis Nicholson.