Physikalisches Kolloquium

Universität Konstanz

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Di 15.12.20
15:15 Uhr
Zoom-Meeting

An error-protected qubit encoded in a parametrically-driven nonlinear resonator

Quantum two-level systems are routinely used to encode qubits, but tend to be inherently fragile leading to errors in the encoded information. Quantum error correction (QEC) addresses this challenge by encoding effective qubits into more complex quantum systems [1,2].

A qubit that is intrinsically protected against certain quantum errors can be encoded into superpositions of two opposite-phase oscillations in a resonator, so-called Schrödinger-cat states [3-5]. This "cat qubit" has the potential to significantly reduce the complexity of QEC. However, the practical operation of a cat qubit faces several challenges: The oscillations are highly excited states of the resonator and need to be stabilized in order to maintain the protection. At the same time, the system has to be compatible with fast gate operations and an efficient readout of the encoded information.

In this talk, I will present our recent experimental results on the stabilization and operation of an error-protected cat qubit through the interplay between Kerr nonlinearity and single-mode squeezing in a superconducting microwave resonator [6]. I will start by reviewing some key concepts of QEC and situate our work within the field. I will also give an outlook on different applied and fundamental research directions enabled by this experiment [7-9].

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[5] Puri, S., Boutin, S. & Blais, A. *npj Quantum Information* **3**, 18 (2017)
[6] Grimm, A., Frattini N.E. *et al. Nature* **584**, 205–209 (2020)
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