Signatures of classical chaos in driven transmons

Alexandru Petrescu
Joachim Cohen, Ross Shillito, Alexandre Blais

Centre Automatique et Systemes, Ecole des Mines, France

alexandru.petrescu@inria.fr

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Abstract: Transmons are ubiquitously used in superconducting quantum information processing architectures. Strong drives are required to realize fast high-fidelity gates and measurements, including parametrically activated processes. We show that even off-resonant drives, in regimes routinely used in experiments, can cause strong modifications to the structure of the transmon spectrum rendering a large part of it chaotic. Chaotic states, often neglected through the hypothesis that the anharmonicity is weak, strongly impact the lifetime of the computational states. In particular, chaos-assisted quantum phase slips greatly enhance band dispersions. In the presence of a readout resonator, the onset of chaos correlates with high transmon-resonator entanglement, and an average resonator response centered on the bare resonator frequency. We define a photon number threshold to characterize the appearance of chaos-induced quantum demolition effects during strong-drive operations, such as dispersive qubit readout. More generally, chaos-induced phenomena such as the ones studied here are expected to be present in all circuits based on low-impedance Josephson junctions.

References

[1] Joachim Cohen, Alexandru Petrescu, Ross Shillito, and Alexandre Blais, arXiv:2207.09361references with sequential numbers within [square brackets].