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11th RQC Colloquium

Error correction of a logical quantum bit

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April 19, 2023(Wed) **9:00 – 10:00**(JST)

This colloquium will be held **ONLINE**.

Registration: https://krs2.riken.jp/m/rqc_registration_form

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 noise-induced evolution before it corrupts the encoded information. We will present an experiment based on a superconducting cavity and a transmon artificial atom – the latter employed here as an auxiliary non-linear element [1] – that implements autonomous error correction, incorporating novel primitive operations [2] and feedback control based on reinforcement learning [3]. Recently, we have stabilized in real-time a logical qubit manifold spanned by the so-called 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 physical qubits composing our system [4].

[1] Campagne-Ibarcq, Eickbusch, Touzard, *et al.*, Nature **584**, 368 (2020).
[2] Eickbusch *et al.*, Nature Physics **18**, 1464 (2022).
[3] Sivak *et al.*, Phys. Rev. X **12**, 011059 (2022).
[4] Sivak *et al.*, Nature **616**, 50 (2023).