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Decoding quantum information from chaos: beyond the standard situation

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A central challenge in large-scale quantum information processing is managing noise in quantum systems. Quantum error correction (QEC) addresses this by encoding quantum states into quantum error correction codes (QECCs) before noise occurs and decoding them afterward. Recently, QEC has attracted significant attention in theoretical physics due to its potential connections to quantum chaos and quantum gravity. As interest in QEC becomes broader, the decoding problem –how to decode a general QECC– is increasingly important. A few were known so far, but we recently proposed two approaches: one extends decoders for the standard class of QECCs based on stabilizers [1], and the other generalizes the Yoshida-Kitaev decoder [2], originally used to explore the black hole information paradox. In this talk, we present an overview of these approaches.

1) "Decoding general error correcting codes and the role of complementarity", YN, T. Matsuura, and M. Koashi, arXiv:2210.06661 (2022).
2) "Explicit decoders using fixed-point amplitude amplification based on QSVT", T. Utsumi, and YN, arXiv:2405.06051 (2024).

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