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Natural quantum error-correction in many-body dynamics implies stability of volume-law entangled states against projective measurements SOONWON CHOI, YIMU BAO, University of California, Berkeley, XIAO-LIANG QI, Stanford University, EHUD ALTMAN, University of California, Berkeley — In a generic isolated quantum many-body system, entanglement entropy of any subsystem grows linearly in time until saturated to a value proportional to its volume. Random projective measurements, however, can severely affect such dynamics by disentangling the measured parts from the rest of the system. In this work, we investigate this interplay between entangling dynamics and projective measurements from the perspective of quantum information theory. We show that volume-law entangled states can remain stable even when a substantial fraction of the system is measured in every time unit. Our key observation, based on the quantum decoupling theorem, is that a sufficiently scrambling unitary can hide quantum correlations in a non-local form such that local measurements cannot decrease entanglement. Such dynamics is generic and can be explicitly demonstrated in a toy model involving random local unitary gates acting on a chain of qubit clusters followed by probabilistic measurements. Our work suggests that the stability of the volume-law entangling phase originates from the effective quantum error correcting feature of scrambling dynamics, which protects quantum entanglement from the noisy environment.

Soonwon Choi
University of California, Berkeley

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