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Dynamical quantum error correction: recent achievements and prospects[1]

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Precisely controlling the dynamics of real-world open quantum systems is a central challenge across quantum science and technology, with implications ranging from quantum physics and chemistry to fault-tolerant quantum computation. Dynamical quantum error correction strategies based on open-loop time-dependent modulation of the system dynamics provide a general perturbative framework for boosting physical-layer fidelities in the non-Markovian regime. I will describe recent progress in designing dynamical error correction schemes able to incorporate various system and control constraints encountered in realistic scenarios. In particular, I will show how to employ dynamical decoupling methods to achieve high-fidelity quantum storage for long times, while minimizing access latency and sequencing complexity, and how to synthesize dynamically corrected quantum gates for simultaneously canceling non-Markovian decoherence and control errors, while accommodating internal always-on dynamics and limited control. In the process, I will make contact with current qubit devices to the extent possible and point to remaining challenges and directions for further explorations.

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