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Upper bounds on coherence preservation in dynamical decoupling[1] KAVEH KHODJASTEH, Dartmouth College, TAMÁS ERDÉLYI, Texas A&M University, LORENZA VIOLA, Dartmouth College — We explore the fundamental limits on coherence preservation by dynamical decoupling in terms of control time scales and the spectral bandwidth of the environment. Our main focus is a decohering qubit controlled by arbitrary sequences of π pulses. Using methods from mathematical analysis, we establish a non-perturbative lower bound for the coherence loss in terms of the minimum pulse separation and the cutoff frequency of the environment. We argue that similar bounds are applicable to a variety of open-loop unitary control methods while we find no explicit dependence of such lower bounds on the total control time. We use these findings to generate bandwidth adapted dynamical decoupling sequences that can preserve a qubit up to arbitrary long times within the best fidelities theoretically possible given the available control resources. Our analysis reinforces the impossibility of fault-tolerance accuracy thresholds under purely reversible error control.

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