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Environment-invariant measure of distance between evolutions of an open quantum system MATTHEW GRACE, Department of Scalable Computing Research & Development, Sandia National Laboratories, JASON DOMINY, Program in Applied & Computational Mathematics, Princeton University, ROBERT KOSUT, SC Solutions, Inc., CONSTANTIN BRIF, HERSCHEL RABITZ, Department of Chemistry, Princeton University — The problem of quantifying the difference between evolutions of an open quantum system is important in quantum control, especially in control of quantum information processing. Motivated by this problem, we develop a measure for evaluating the distance between unitary evolution operators of a composite quantum system that consists of the subsystem of interest and environment. The main characteristic of this measure is the invariance with respect to the effect of the evolution operator on the environment, which follows from an equivalence relation that exists between unitary operators acting on the composite system, when the effect on only the sub-system of interest is considered. The invariance to the environment's transformation makes it possible to quantitatively compare the evolution of an open quantum system and its closed counterpart. The distance measure also determines the fidelity bounds of a general quantum channel with respect to a unitary target transformation. As an example, the measure is used in numerical simulations to evaluate fidelities of optimally controlled quantum gate operations, in the presence of an environment.

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