Measure of the Quantum Speedup in Closed and Open systems[1]
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— We construct a general measure for detecting the quantum speedup in both closed and open systems. This speed measure is based on the changing rate of the position of quantum states on a manifold with appropriate monotone Riemannian metrics. Any increase in speed is a clear signature of real dynamical speedup. To clarify the mechanisms of quantum speedup, we first introduce the concept of longitudinal and transverse types of speedup, and then apply the proposed measure to several typical closed and open quantum systems, illustrating that entanglement and the memory effect of the environment together can become resources for longitudinally or transversely accelerating dynamical evolution under certain conditions. Remarkably, a direct measurement of such speedup is feasible without the need for a tomographic reconstruction of the density matrix, which greatly enhances the feasibility of practical experimental tests.

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Date submitted: 23 Nov 2015 Electronic form version 1.4