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Solving the quantum brachistochrone equation through differential geometry[1] CHENGLONG YOU, MARK WILDE, JONATHAN DOWLING, XIAOTING WANG, Department of Physics and Astronomy,Louisiana State University — The ability of generating a particular quantum state, or model a physical quantum device by exploring quantum state transfer, is important in many applications such as quantum chemistry, quantum information processing, quantum metrology and cooling. Due to the environmental noise, a quantum device suffers from decoherence causing information loss. Hence, completing the state-generation task in a time-optimal way can be considered as a straightforward method to reduce decoherence. For a quantum system whose Hamiltonian has a fixed type and a finite energy bandwidth, it has been found that the time-optimal quantum evolution can be characterized by the quantum brachistochrone equation (PRL, 96, 060503 (2006)). In addition, the brachistochrone curve is found to have a geometric interpretation: it is the limit of a one-parameter family of geodesics on a sub-Riemannian model (PRL 114, 170501 (2015)). Such geodesic-brachistochrone connection provides an efficient numerical method to solve the quantum brachistochrone equation. In this work, we will demonstrate this numerical method by studying the time-optimal state-generating problem on a given quantum spin system. We also find that the Pareto weighted-sum optimization turns out to be a simple but efficient method in solving the quantum time-optimal problems.

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