Dressing the chopped-random-basis optimization: A bandwidth-limited access to the trap-free landscape

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Author(s):
N. Rach, M. M. Müller, T. Calarco, and S. Montangero

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In quantum optimal control theory the success of an optimization algorithm is highly influenced by how the figure of merit to be optimized behaves as a function of the control field, i.e., by the control landscape. Constraints on the control field introduce local minima in the landscape—false traps—which might prevent an efficient solution of the optimal control problem. Rabitz et al. [Science 303, 1998 (2004) [4]] showed that local minima occur only rarely for unconstrained optimization. Here, we extend this result to the case of bandwidth-limited control pulses showing that in this case one can eliminate the false traps arising from the constraint. Based on this theoretical understanding, we modify the chopped-random-basis (CRAB) optimal control algorithm and show that this development exploits the advantages of both (unconstrained) gradient algorithms and of truncated basis methods, allowing one to always follow the gradient of the unconstrained landscape by bandwidth-limited control functions. We study the effects of additional constraints and show that for reasonable constraints the convergence properties are still maintained. Finally, we numerically show that this approach saturates the theoretical bound on the minimal bandwidth of the control needed to optimally drive the system.

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