Are there traps in quantum control landscapes?

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Fundamental problem: Analysis of traps (i.e., local maxima) for quantum control objectives, e.g. for $J(u) = \langle O \rangle_T = \mathrm{Tr}[U_T \rho_0 U_T^\dagger O]$, where $i\dot{U}_t = (H_0 + Vu(t))U_t$.

Two types of controls: Regular and singular (the Jacobian $\delta U_T / \delta u$ is either non-degenerate or degenerate).

Theorem: Regular controls are not traps for both closed[1] and open[2] quantum systems.

Theorem: Singular controls are second-order traps under certain simple, explicitly found and physical conditions[3].

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[1] H. Rabitz, M. Hsieh, C. Rosenthal, *Science* **303**, 1998 (2004).
[2] R. Wu, A. Pechen, H. Rabitz, M. Hsieh, B. Tsou, *JMP* **49**, 022108 (2008).
[3] A.N. Pechen, D.J. Tannor, *Phys. Rev. Lett.* **106**, 120402 (2011).