

Breakdown of adiabaticity in the quasi-static limit

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A semiclassical picture is most appropriate for the analysis of quasi-static protocols for systems that feature a mixed phase-space with both chaos and quasi-regular regions. Specifically we focus on many-body system of atoms that are described by the Bose-Hubbard Hamiltonian. A circuit that consists of bosonic sites is formally equivalent to a set of coupled anharmonic oscillators. We consider a sweep process, specifically, changing slowly the rotation frequency of the device (time dependent Sagnac phase) [1], or changing slowly the couplings (nonlinear STIRAP) [2] or changing slowly the site potential (reversing the bias) [3]. We argue that the parametric variation of phase-space topology implies that the quasi-static limit is not adiabatic. Residual irreversibility for slow sweep is inevitable. Detailed analysis is essential in order to determine the outcome of quasi-static transfer protocols, and their efficiency.

[1] Yehoshua Winsten, Doron Cohen, *Sci Rep* 11, 3136 (2021).

[2] A. Dey, D. Cohen, A. Vardi, *Phys. Rev. Lett.* 121, 250405 (2018).

[3] R. Burkle, A. Vardi, D. Cohen, J.R. Anglin, *Phys. Rev. Lett.* 123, 114101 (2019).