Floquet Gibbs state in time periodically driven open quantum systems

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In this work we study long-time asymptotic states of time-periodically driven system coupled to a thermal bath. In order to describe the subclass of such a system, we introduce the Floquet-Gibbs state, i.e., the state whose density matrix is described in a diagonal form in the basis of the Floquet states and its diagonal elements are given by a Boltzmann distribution over its Floquet quesienergies. We obtain the sufficient conditions for the realization of the Floquet-Gibbs state in a system with infinitesimal system-bath coupling [1] as follows:

1. The driving frequency is much larger than the spectral width of the system Hamiltonian
2. The driving Hamiltonians commute with itself at different instants of time
3. The driving Hamiltonian and the system-bath interaction Hamiltonian commute.

These conditions severely restrict a class of suitable physical models attaining the Floquet-Gibbs state. The condition 1 restricts the system with a relatively small Hilbert space and the condition 3 requires a fine tuning of the system-bath coupling. With the aid of a truncated Floquet Hamiltonian in the Floquet-Magnus expansion and without the rotating wave approximation, we lift the condition of the infinitesimal coupling strength and extend the idea of the Floquet-Gibbs state to a broader subclass of open quantum system with a finite dissipation effect. We show in a numerical simulation that the conditions 1 and/or 3 can be lifted by imposing conditions on timescales of the three constituents, the system of interest, heat bath, and driving field.

[1] T. Shirai, T. Mori, and S. Miyashita Phys. Rev. E **91**, 030101 (2015).

[2] T. Shirai, J. Thingna, T. Mori, S. Denisov, P. Hänggi, S. Miyashita, NJP **18**, 053008 (2016)