High-frequency analysis of periodically driven quantum system with slowly varying amplitude

V. Novičenko[1], E. Anisimovas[1] and G. Juzeliūnas[1]
[1]*Institute of Theoretical Physics and Astronomy, Faculty of Physics, Vilnius University*

E-mail: `viktor.novicenko@tfai.vu.lt`

We consider a quantum system periodically driven with a strength which varies slowly on the scale of the driving period (see FIG. 1 as an example of the perturbation). The analysis is based on a general formulation of the Floquet theory relying on the extended Hilbert space. It is shown that the dynamics of the system can be described in terms of a slowly varying effective Floquet Hamiltonian that captures the long-term evolution, as well as rapidly oscillating micromotion operators [1]. We obtain a systematic high-frequency expansion of all these operators. Generalizing the previous studies [2, 3], the expanded effective Hamiltonian now varies slowly in time and contains extra terms appearing due to changes in the periodic driving. The same applies to the micromotion operators which exhibit a slow temporal dependence in addition to the rapid oscillations. As an illustration, we consider a quantum-mechanical spin in an oscillating magnetic field with a slowly changing direction [1]. The effective evolution of the spin is then associated with non-Abelian geometric phases reflecting the geometry of the extended Floquet space. The developed formalism is general and also applies to other periodically driven systems, such as shaken optical lattices with a time-dependent shaking strength, a situation relevant to the cold atom experiments.

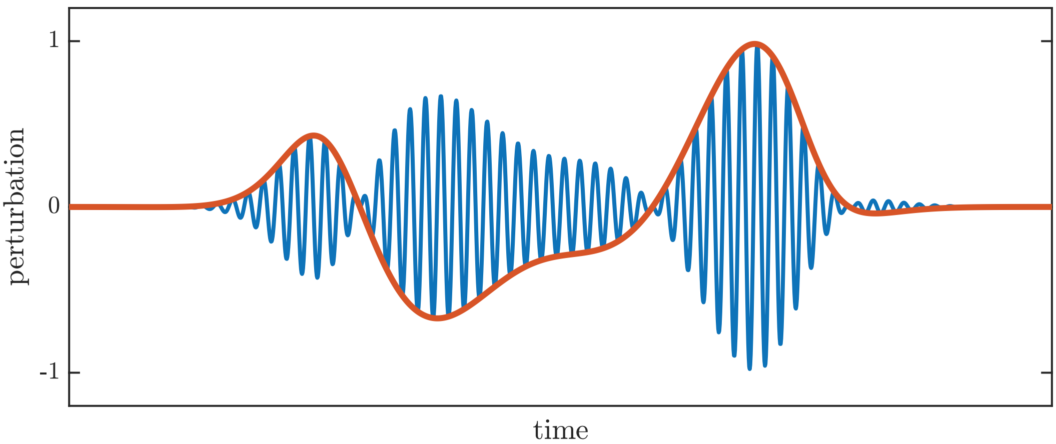

FIG. 1: An example of the perturbation containing rapid oscillations (blue line) and a slowly varying envelope (orange line).

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