Schrieffer-Wolff transformation in Quantum Mechanics

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Perturbation theory collects a set of methods for finding approximates solutions to some problem, starting from the solutions of a simpler, exactly solvable, problem. This tool is widely used in Quantum Mechanics, when the Hamiltonian of the system can be written as a sum of the Hamiltonian of an exactly solvable problem, plus a "small" perturbation. The Schrieffer–Wolff (SW) method is a version of perturbation theory dealing with the following case : in the "unperturbed system", described by the Hamiltonian H_0, the low energy states are separated from the high energy states by a large gap ; in the unperturbed system, these two regions are completely decoupled. A small perturbation induces interactions between these two regions. SW method aims at finding, by perturbative techniques, a transformation that decouples the two energy regions and a low-energy effective Hamiltonian describing the dynamics of the lowest energy region.

Another approach to find an effective Hamiltonian for the lowest energy states could be to directly apply perturbation thery on the projection operators of the low energy states and on the spectrum of the Hamiltonian.

We propose to study SW methods (in particular, we suggest to the paper [1]), and to compare it with the results obtained by this second approach.

Références

[1] S. Bravyi, D. P. DiVincenzo, D. Loss, *Schrieffer–Wolff transformation for quantum many-body systems*, Annals of Physics 326 (2011) 2793–2826