Spectral Theory of Open Quantum Systems

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The dissipative dynamics of a small quantum system (a N-level atom) interacting with its environment (a radiation field) is usually described by a Markovian semi-group, or equivalently by a quantum master equation. However, this reduced description of the system is only justified in the small coupling regime and on a large time scale: In the so-called van Hove limit. Recently, some progresses have been made in the study of open quantum systems beyond the Markovian approximation. In particular, the problem of return to equilibrium of a system coupled to an environment which is at thermal equilibrium is now fairly well understood (see [JP1], [BFS], [DJ],[M]). The thermal relaxation process is controlled by the complex resonances of a self-adjoint operator: The Liouvillean. In a recent work with V. Jaksic [JP2], we have extended this spectral approach to the study of the long time asymptotics of quantum systems out of equilibrium. Our method allows us to construct natural, non-equilibrium steady states of such systems, and to study their basic properties. Again, the relaxation process is related to the complex resonances of some (non-selfadjoint) operator. I will review some of these results and provide specific examples.

References:

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