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# Energy conservation, return to equilibrium and modular theory — Part 1

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Using methods of spectral analysis and modular theory of operator algebras, we study the energy transfers between a small system $\mathscr{S}$ and a reservoir $\mathscr{R}$ in the process of return to equilibrium. More precisely, we consider a microscopic Hamiltonian model describing a finite level quantum system $\mathscr{S}$ coupled to an infinitely extended thermal reservoir $\mathscr{R}$ at inverse temperature $\beta$, where the coupling strength depend on a constant $\lambda$. We consider the measures $P_{S,\lambda,t}$ and $P_{R,\lambda,t}$ obtained through a two measurement protocol at times 0 and $t$, for fixed $\lambda$.

Assuming that the coupled system is mixing, we can show that in a suitable limit regime for $\lambda$ and $t$, the limiting measures can be identified. This result strengthens the first law of thermodynamics for open quantum systems, which is a statement concerning only the averages of $P_{S,\lambda,t}$ and $P_{R,\lambda,t}$ (*joint work with V. Jaksic, J. Panangaden, C-A. Pillet*).

*This is the first of two talk on this subject (it will be continued in the talk of Annalisa Panati) In this talk, we will introduce the operator algebra formalism for quantum statistical mechanics and some of the key mathematical constructions needed for the result.*

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