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Repeated interaction quantum systems

We consider a quantum system $\mathcal{S}$ interacting successively with elements $\mathcal{E}$ of an infinite chain $\mathcal{C} = \mathcal{E} + \mathcal{E} \cdots$. Each interaction is characterized by an interaction time τ and an interaction operator V acting on $\mathcal{S}$ and one of the $\mathcal{E}$. We show that such systems reach an asymptotic state as time tends to infinity. We construct the latter state explicitly (by perturbation theory), linking it to the spectral data of an effective reduced dynamics operator. We explain the physical (thermodynamic) properties of such asymptotic states.

The mathematical framework is that of algebraic quantum (field) theory. We use the Tomita–Takesaki structure to represent the dynamics in a suitable manner by powers of a reduced dynamics operator. The long-time asymptotics is determined by spectral information of that operator, and is analyzed by perturbation theory in the coupling between $\mathcal{S}$ and $\mathcal{C}$.

This is joint work with Laurent Bruneau (Cergy–Pontoise) and Alain Joye (Institut Fourier).