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Open Quantum Systems

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Open quantum systems are often described with a maximal dissipative operator A_D, a so-called pseudo-Hamiltonian, and a self-adjoint operator A_0 in some Hilbert space $\mathcal{H}$. If L denotes a minimal self-adjoint dilation of A_D, i.e., L acts in a Hilbert space $\mathcal{H} \oplus L^2(\mathbb{R}, \mathfrak{K})$ such that $P_{\mathcal{H}}(L-\lambda)^{-1}|_{\mathcal{H}} = (A_D-\lambda)^{-1}$, and $L_0 = A_0 \oplus -i\frac{d}{dx}$, then the scattering matrix of the closed system $\{L, L_0\}$ can be recovered from the scattering matrix of the dissipative system $\{A_D, A_0\}$. Since in this model L is not semibounded from below serious doubts arise from a physical point of view.
We propose a slightly different approach where instead of a fixed pseudo-Hamiltonian A_D a family of energy dependent pseudo-Hamiltonians $\{A_{-\tau(\lambda)}\}$ is considered. The outer space $L^2(\mathbb{R}, \mathfrak{K})$ is replaced by some Hilbert space $\mathcal{K}$ and the Hamiltonian L in $\mathcal{H} \oplus \mathcal{K}$ satisfies $P(L-\lambda)^{-1}|_{\mathcal{H}} = (A_{-\tau(\lambda)}-\lambda)^{-1}$ and is often semibounded from below. We show that the scattering matrix of the closed system can be recovered in a similar way as above and that the model with one fixed pseudo-Hamiltonian can be regarded as an approximation. The abstract theory is illustrated with some examples.
The talk is based on joint work with Mark M. Malamud (Donetsk National University, Ukraine) and Hagen Neidhardt (WIAS, Berlin).