Semiclassical Approach to Dissipative Quantum Chaos

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Abstract

Dissipative chaotic quantum maps give rise to spectral statistics governed by Ginibre's ensemble of general non–hermitian and non–unitary matrices. We show how important properties of such maps can be obtained via a semiclassical theory. The analysis is based on a semiclassical approximation of the propagator of the reduced density matrix. We show that to leading order asymptotic expansion in $\hbar$ the propagator of the Wigner function is the Frobenius–Perron propagator of phase space density for the corresponding classical map. This statement holds if the Wigner functions propagated are sufficiently smooth. Several consequences arise: Traces of the quantum mechanical propagator agree with traces of the Frobenius–Perron propagator and can therefore be calculated within classical periodic theory. The Wigner transform of the invariant density matrix is a smeared out version of the classical strange attractor. And time dependent expectation values and correlation functions of observables can be evaluated by hybrid quantum–classical formulae in which the quantum character only enters via the initial Wigner function. If a classical phase–space distribution is chosen for the latter or if the map is iterated sufficiently many times the formulae become entirely classical, and powerfull classical trace formulae apply.