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Title: Entropy and entanglement in a bipartite quasi-Hermitian system and its Hermitian counterpart

Abstract: We consider a quantum oscillator coupled to a bath of  $N$  other oscillators. The total system evolves with a quasi-Hermitian Hamiltonian. Associated with it is a family of Hermitian systems, parameterized by a unitary map  $W$ . Our main goal is to find the influence of  $W$  on the entropy and the entanglement in the Hermitian systems. We calculate explicitly the reduced density matrix of the single oscillator for all Hermitian systems and show that, regardless of  $W$ , their von Neumann entropy oscillates with a common period which is half of that of the non-Hermitian system. We show that generically, the oscillator and the bath are entangled for almost all times. While the amount of entanglement depends on the choice of  $W$ , it is independent of  $W$  when averaged over a period. These results describe some universality in the physical properties of all Hermitian systems associated to a given non-Hermitian one.