

Dynamical Semigroups and Evolution of Quantum Entropies

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Entropy plays a fundamental role in several branches of physics, e.g., in the theory of open quantum systems and in quantum information science. In the quantum setting, the standard notion of entropy is provided by the so-called von Neumann entropy, but other remarkable quantities have been proposed and studied as well; in particular, the Rnyi and the Tsallis entropies. The evolution of an open quantum system, described by a dynamical semigroup, may decrease a quantum entropy (for some initial condition). We will discuss various characterizations of those dynamical semigroups that do not decrease a quantum entropy for every initial condition of a physical system. We will not require, in general, that such a semigroup of operators be completely positive, because the physical justification of this condition is controversial. Therefore, we will consider semigroups of trace-preserving, positive (but not necessarily completely positive) linear maps in Banach spaces of trace class operators. On the basis of this discussion, a general class of quantum entropies will be then proposed.