Characterizing open quantum systems through information flow

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We study different characteristics of open quantum systems from the perspective of information flow between the open quantum system and the environment. The information flow between the open system and the environment can be seen as a change in the distinguishability between the open system states. This formalism allows us to characterize many features of open quantum systems without referring to any specific representation of the dynamics.

Especially we study the evolution of a general open quantum system when the system and its environment are initially correlated. We show that the trace distance between two states of the open system can increase above its initial value, and derive tight upper bounds for the growth of the distinguishability of open system states. This represents a generalization of the contraction property of quantum dynamical maps. The obtained inequalities can be interpreted in terms of the exchange of information between the system and the environment, and lead to a witness for system-environment correlations which can be determined through measurements on the open system alone. We introduce a measurement scheme to detect initial correlations, which neither requires a knowledge of the structure of the environment or of the system-environment interaction, nor a full knowledge of the initial system-environment state.

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