TRACE-DISTANCE ANALYSIS OF INITIAL CORRELATIONS IN THE DYNAMICS OF OPEN QUANTUM SYSTEMS: THEORY AND EXPERIMENT

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The dynamics of an open quantum system interacting with an environment is usually described by means of completely positive trace preserving maps on the state space of the open system. The very existence of such maps generally requires that the initial correlations between the open system and the environment can be neglected. However, this assumption is not always physically justified, especially outside the weak coupling regime. Thus, it becomes of interest to introduce different strategies in order to characterize the open-system dynamics in the presence of initial system-environment correlations.

An approach for the study of initial correlations that is based on the use of the trace distance has been introduced in [1]. The trace distance between two states of an open quantum system quantifies their distinguishability, and, for a fixed environmental state, can increase above its initial value only in the presence of initial correlations. In the first part of my contribution, the general theoretical scheme as well as its first experimental realization [2] are presented. The latter has been performed by the quantum optics group at the University of Milan through an all-optical apparatus, in which spontaneous parametric down conversion is exploited as a source of polarization entangled states, and a spatial light modulator introduces in a general fashion correlations between the polarization and the momentum degrees of freedom, which act as environment.

After that, the paradigmatic and exactly solvable model provided by the Jaynes-Cummings Hamiltonian is briefly discussed [3]. In particular, the correlations contained in the thermal equilibrium state for the total system are considered, showing their connection to the entanglement properties of the eigenstates of the Hamiltonian. The trace-distance evolution of the open system states evolving from the thermal state and its corresponding uncorrelated product state shows that the open system dynamically uncovers typical features of the initial correlations.

[1]E.-M. Laine, J. Piilo and H.-P. Breuer, *Europhys. Lett.* **92,** 60010 (2010).

[2]A. Smirne, D. Brivio, S. Cialdi, B. Vacchini and M.G.A. Paris, (*Phys.Rev. A.* to appear); eprint: arXiv:1105:0174.

[3]A. Smirne, H.-P. Breuer, J. Piilo and B. Vacchini, *Phys.Rev. A* **82**, 062114 (2010).