Optimal state pairs for non-Markovian quantum dynamics

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We study a recently proposed measure for the quantification of quantum non-Markovianity in the dynamics of open systems which is based on the exchange of information between the open system and its environment [1]. This measure relates the degree of memory effects to certain optimal initial state pairs featuring a maximal flow of information from the environment back to the open system. We rigorously prove that the states of these optimal pairs must lie on the boundary of the space of physical states and that they must be orthogonal [2]. This implies that quantum memory effects are maximal for states which are initially distinguishable with certainty, having a maximal information content. Moreover, we construct an explicit example which demonstrates that optimal quantum states need not be pure states.

[1] H.-P. Breuer, E.-M. Laine, J. Piilo, [Physical Review Letters 103, 210401 (2009)]
[2] S. Wißmann, A. Karlsson, E.-M. Laine, J. Piilo, H.-P. Breuer, [Physical Review A 86, 062108 (2012)].