Entanglement and decoherence in regular systems

Marko Žnidarič

Faculty of Mathematics and Physics,
University of Ljubljana, Ljubljana, Slovenia

Entanglement is on of the most "quantum" quantum features of quantum theory or as A. Peres described it [Bruß02]:"...a trick that quantum magicians use to produce phenomena that can not be imitated by classical magicians.". Its understanding is clearly of high importance particularly in view of recent efforts to build quantum devices that will manipulate individual quantum systems. Lack of control over the entanglement (e.g. decoherence) in such a device is one of the major obstacles that we have to overcome.

We are going to study generation of entanglement in bipartite quantum systems caused by the coupling between the two subsystems. Our approach is based on Hamiltonian dynamics and will typically apply in systems (but is not limited to) with an uncoupled part of the Hamiltonian representing a regular (integrable) dynamics. We derive explicit formulae for the purity decay in the case of an initial state being a localised wave-packet as well as for the so-called cat states. In the later case the decay of purity is an indicator of decoherence, i.e. a loss of quantum interference effects between the two states appearing in a cat state [Zurek91]. Decoherence in regular systems is not just of academic interest as the decoherence for macroscopic superposition will be so fast [Braun01] that the system can be effectively considered as a regular one.

References

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