Investigation of the dissipation driven speeding up of entanglement generation in the vicinity of exceptional points

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Open physical systems described by non-Hermitian Hamiltonians have attracted increasing attention from researchers in recent years due to the possibility of the occurrence of so-called exceptional points (EP), which cannot be observed in closed systems described by Hermitian Hamiltonians. EPs are points in parameter space where at least two eigenvectors of the Hamiltonian become parallel, and the corresponding eigenvalues are the same. Many previously unknown physical phenomena occur near EPs, which may have important potential applications, such as detecting very weak signals [1–3].

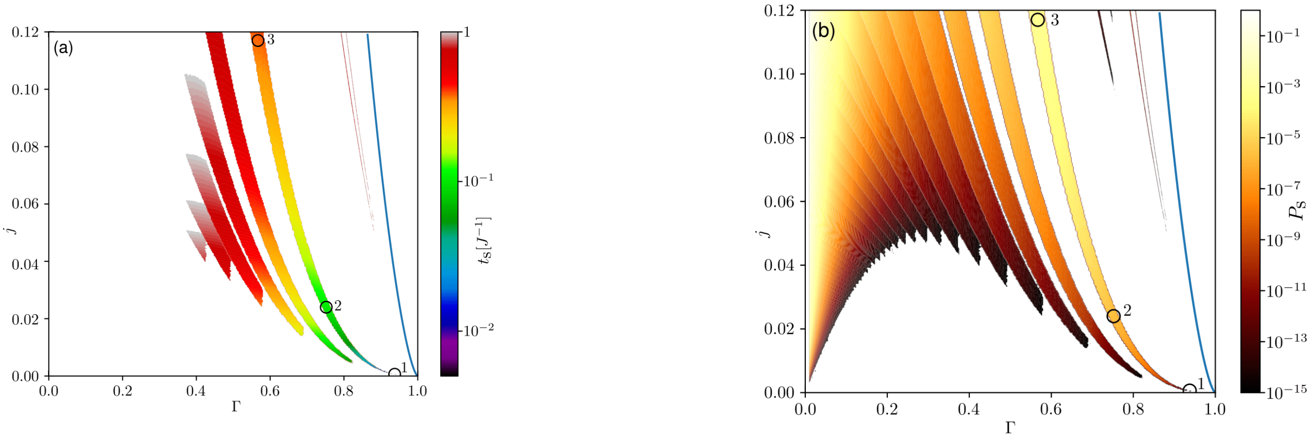

Figure 1: Time of successful entanglement generation t_S (panel (a)) and probability of success P_S (panel (b)) as functions of dimensionless coupling strength j and damping Γ.

Another important phenomenon occurring near EPs was theoretically predicted — the acceleration of entangled state generation [4]. The authors have suggested that their scheme can be realized using the three lowest levels of transmon: $|g\rangle$, $|e\rangle$, and $|f\rangle$. However, they have neglected quantum jumps that can occur in this system. Due to the quantum jumps, the probability of success P_S in this scheme is negligibly small (of the order of 10^{-15}), which would not allow observing this experimentally. In this presentation, we shall show the effect of quantum jumps from the level $|e\rangle$ to the ground level $|g\rangle$ on the entanglement generation. To address this, we introduce dimensionless variables $\Gamma = \frac{\gamma_e}{4\Omega}$ and $j = \frac{J}{\Omega}$ to investigate the performance of the scheme for all allowed parameter values. We demonstrate the existence of the trade-off between the success probability and the speed-up rate as shown in the panels (a) and (b) of Fig. 1. Therefore, the mean time of success would surpass or be of the order of the characteristic time of J^{-1}. Thus, our results demonstrate the impossibility of the beneficial implementation of the proposed scheme by only changing system parameters.

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