# Characteristic dynamics near two coalescing eigenvalues incorporating continuum threshold effects

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The survival probability $P(t)$ near two coalescing eigenstates at an exceptional point has been reported in the literature as following $P(t) \sim t^2 e^{-\Gamma t}$, in which $\Gamma$ is the decay width of the coalesced eigenvalue; this result has been confirmed in a microwave cavity experiment [1]. However, the theoretical analysis used to obtain this result usually employs a heuristic finite Hamiltonian that describes only the two modes coalescing in the vicinity of the exceptional point. In this work, we emphasize that this ad hoc approach washes out the details of the continuum and, in particular, ignores the existence of the continuum threshold; as a result it does not correctly describe the time evolution near the exceptional point on all time scales and completely fails in some cases.

To report our results, we divide the exceptional points in Hermitian open quantum systems into two cases: at an EP2A two virtual bound states coalesce before forming a resonance, anti-resonance pair with complex conjugate eigenvalues, while at an EP2B two resonances coalesce before forming two different resonances [2]. We use two simple models to study the EP2A and EP2B as representative cases. For the EP2A we point out that the evolution is non-exponential on all timescales and that the influence of the continuum threshold may be quite significant [3]. When the EP2A appears very near the threshold we obtain the novel evolution $P(t) \sim 1 - C_1\sqrt{t} + D_1 t$ on intermediate timescales, while further away the parabolic decay (Zeno dynamics) on short timescales is very prominent. For the EP2B, which is the case studied in the microwave cavity experiment, we find the survival probability evolves as $P(t) \sim (1 - C_2 t + D_2 t^2)e^{-\Gamma t}$ on intermediate timescales. In either case, an inverse power law decay controls the system dynamics on long time scales.

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