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Title: Time-symmetric correlation in exceptional point-based all-optical nonreciprocal light transmission

Abstract: Exceptional points (EP) usually appear as topological singularities in the parameter space of non-Hermitian (open) systems. Unlike conventional singularities, the occurrence of an EP results in the simultaneous coalescence of coupled eigenvalues and the corresponding eigenvectors [1-4]. Lately, the implementation of such EP-like mathematical objects via gain-loss engineering in various photonic systems has revealed a fascinating avenue in achieving a range of quantum-optical phenomena associated with nontrivial mode manipulation and ultra-detection [1-3]. Based on the complex parameter dependence of a non-Hermitian Hamiltonian, the occurrence of a conjugate pair of EPs in two time-symmetric variants of a particular system has recently been revealed in the context of their correlative reverse-chiral optical response [4].

Here, we exploit the concept of conjugate EPs in reporting a time ($\mathcal{T}$)-symmetric correlation in all-optical nonreciprocal light transmission. Without any magneto-optical effect, nonreciprocity is achieved based on a controlled Kerr-type local nonlinearity in a planar gain-loss assisted waveguide. Especially, we reveal a correlation between two $\mathcal{T}$-symmetric variants of the designed nonlinear waveguide, where dynamic gain-loss variations around two conjugate EPs (in their respective parameter spaces) allow asymmetric transfer of two different modes through two waveguide variants, while considering the light propagation in the same direction. Here, both waveguide variants block light in the reverse directions. Moreover, the dependence of the nonlinearity-level is investigated in maximizing the nonreciprocal ratio (NR), where we establish that two $\mathcal{T}$-symmetric variants achieve their maximum NR at the same nonlinearity-level. The physical aspects behind engineering conjugate EPs in such nonlinear optical systems would enrich the platform for building nonreciprocal components like isolators and circulators for all-photonic circuits.

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