Interplay between Global PT-symmetry and Local PT-symmetry in Coupled Waveguide Chain

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Abstract— Recently parity-time (PT) symmetric system in the field of optics attracts attention due to some intriguing phenomena, i.e., bifurcation and unidirectional light propagation. In presence of loss and gain, PT symmetric system become intrinsically non-Hermitian. Interestingly, in those non-Hermitian system all real eigenvalues still can exist in certain regime in the parameter space of non-Hermiticity [1]. We study interplay between global PT-symmetry and local PT-symmetry in coupled waveguide chain with dimerized waveguide in presence of gain or losses.

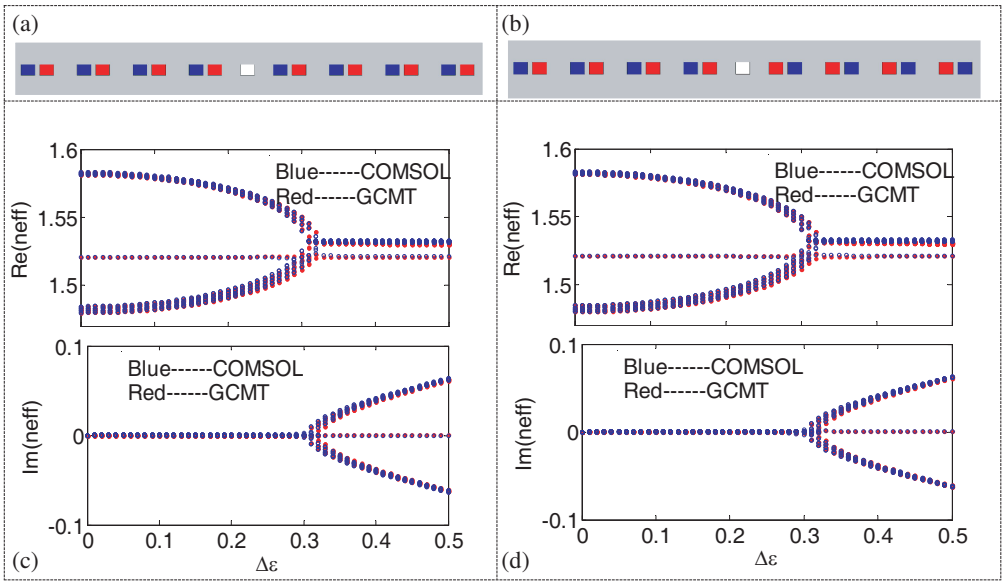

Figure 1: (a) (c) Sketch of coupled waveguide chain with/without global PT symmetry. (b) and (d) show the real and imaginary part of the modal indices as function of non-Hermiticity varying from 0 to 0.5 for structure (a) (c).

With assistance of SSH model and the concept of general coupled mode theory (GCMT) [2] developed from first-principle of Maxwell's equation, we study the coupled waveguide chain which preserves the local PT-symmetry. Globally, the coupled waveguide chain can be either PT symmetric or PT-symmetry broken, as shown in Fig. 1(a) and Fig. 1(c). The existence of edge states depends on Berry phase. If two coupled waveguide chains with different Berry phase are connected to form a new chain as Fig. 1(a), it is likely to form an edge state. Surprisingly, the edge state exists in global PT symmetric system (Fig. 1(a)), and also in global PT-symmetry broken system (Fig. 1(c)). Moreover, the edge state is robust against non-Hermiticity, as confirmed by the existence of edge state regardless of variation of non-Hermiticity shown in Figs. 1(b), (d). It seems that there is no necessary to ensure PT symmetry in entire system for an edge state, but the local PT symmetry in each unit cell is needed.

REFERENCES

1. Bender, C. and S. Boettcher, "Real spectra in non-Hermitian Hamiltonians having PT symmetry," *Physical Review Letters*, 1998.
2. Xu, J. and Y. Chen, "General coupled mode theory in non-Hermitian waveguides," *Optics Express*, Vol. 23, No. 17, 2015.