Threshold Preservation of PT-Resonant Structures in Realistic-Dispersive Medium

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The impact of material dispersion in the performance of parity-time (PT) symmetric coupled microresonators is studied. The eigenfrequencies of the coupled PT-system are analysed for different dispersion parameter. We show that realistic dispersion preserves the PT-system with additional stabilising features.

Results and discussions

Photonic structures with balanced gain and loss, known as PT-symmetric structures, have been a subject of intensive investigation theoretically and experimentally, mainly due to the signature properties of the threshold point. Several applications exploiting the unique properties of PT-structures at the threshold point have been proposed such as, logical gate, memory, cloaking, and sensors. In this paper, we study the existence of the threshold point for PT-coupled microresonators and realistic dispersive material parameters that satisfies the Kramers-Kronig relationship.

The complex eigenfrequencies of PT-coupled microresonators are shown in Fig. 1 for three different dispersion parameters in the notation of [1], namely (A) non-dispersive, (B) weakly dispersive $\omega_\sigma\tau = 1$ and (C) $\omega_\sigma\tau = 212$ [2] for a realistic high dispersion. It can be seen that there is a distinct PT threshold in the case of non-dispersive (A) and highly dispersive (C) cases, but not in the case of weak dispersion (B). This is due to the fact that the gain/loss parameter alters the real part of refractive index of the material resulting in a structure that no longer satisfies the PT condition of $n = n^*$ in the case of weak dispersion, but is maintained in the case of high dispersion.

In the talk, we will discuss the implications of dispersion on the performance of PT-coupled microresonators and why the threshold point is preserved in the case of realistic material dispersion. Furthermore, it will be shown that practical dispersion only allows the PT-symmetric condition to be met at a single frequency which consequently also forbids multi-mode PT-symmetry breaking.

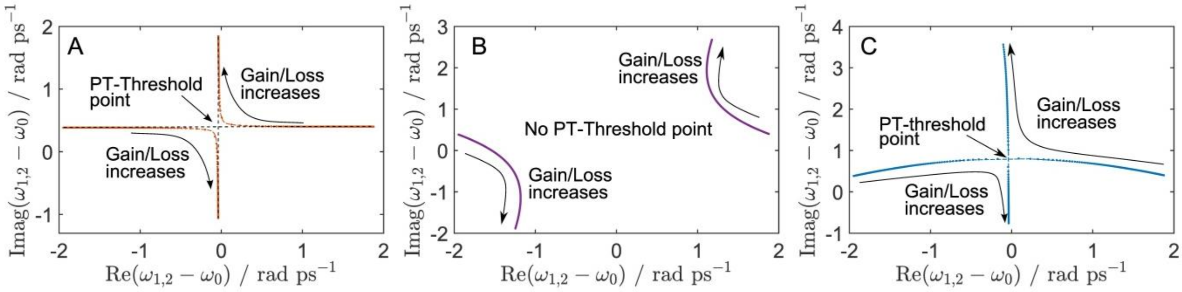

Fig. 1. Complex eigenfrequencies of PT-coupled microresonators for 3 different dispersion parameters, i.e. (A) non-dispersive, (B) small dispersion $\omega_0\tau = 1$ and (C) realistic high dispersion. The structure is operated at a low Q-factor mode (7,2). Radius of each resonator $a = 0.54\mu m$, gap between resonators $g = 0.24\mu m$. For material model refer to [1].

References

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