Degenerate Bound States in the Continuum in a Grating Waveguide

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We present a remarkable phenomenon of a degenerate bound state in the continuum (BIC) [1] which appears when a well-known symmetry protected BIC meets a leaking waveguide eigenmode. It occurs due to a destructive interference of the corresponding non-leaking odd-parity infinite-grating eigenmode and leaking even-parity infinite-grating eigenmode at their crossing point [2].

We disclose the mechanism of formation of such a degenerate BIC and its extraodinary features by means of the analytical method of the infinite-grating eigenmodes developed in [3]. We reveal the genesis of the degenerate BIC by following the transformation of the eigenmodes of a homogeneous planar dielectric waveguide (which does not support BICs) into the eigenmodes of a grating planar waveguide (which does support symmetry protected BICs) and the merging of two neighboring waveguide modes as is shown in Fig. 1. The obtained analytical results have been verified by the standard numerical Rigorous Coupled Wave Analysis (RCWA).

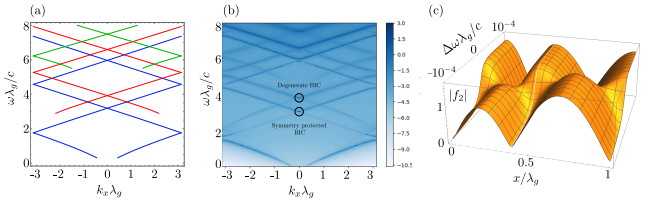

Figure 1: Dispersion curves of the first three eigenmodes of (a) the homogeneous planar waveguide (with the core dielectric permittivity $\varepsilon = 4.9$) and (b) the grating planar waveguide within the first Brillouin zone $k_x\lambda_g \in (-\pi, \pi)$. The dielectric permittivities of the first and second grating sections of the lengths $d_1 = 0.39\lambda_g$ and $d_2 = 0.61\lambda_g$ are $\varepsilon_1 = 6.25$ and $\varepsilon_2 = 3.9$, respectively; λ_g is the grating period. (c) The spatial x-profile of the infinite-grating eigenmode as a function of its frequency detuning $\Delta\omega$ near the degenerate point of its crossing with its degenerate counterpart. Note that the spatial profile changes its parity from even to odd as the detuning changes sign

References

[1] C B Reynolds, Vl V Kocharovsky and V V Kocharovsky, arXiv:2210.00628v1 (2022)

[2] C Reynolds and V Kocharovsky, J. Phys. Conf. Ser. **2494**, 012002 (2023)

[3] V V Kocharovsky, C B Reynolds and Vl V Kocharovsky, Phys. Rev. A **100**, 053854 (2019)