Bound States in the Continuum in all-dielectric resonant metasurfaces

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Bound states in the continuum (BICs) have attracted much interest lately in photonics for their (theoretically) infinite Q factor. These states are leaky modes that in a certain limit of some parameter space cannot couple to any radiation channel [1]. In order to trap light in such nearly-zero-linewidth electromagnetic modes, a common approach is to exploit metasurfaces: outgoing specular channels can be suppressed by tuning the parameters of the system in various manners, leading to symmetry-protected BICs.

Here we will show that simple metasurface configurations may support robust, symmetry-protected BICs. On the basis of a generalized coupled electric/magnetic dipole theory for infinite arrays [2], a variety of scenarios are investigated where single/double meta-atoms can be simply described by a combination of various electric (ED) and/or magnetic dipoles (MD). First, a dipole-dimer array is shown to yield a BIC at normal incidence as the dipole detuning parameter vanishes; this has been experimentally verified through Au-rod dimer metasurface in the THz domain [3], unveiling the symmetry-protection mechanism through near-field excitation and detection [4]. Second, an array of single perpendicular MDs exhibits a so-called Brewster BIC at normal incidence, which evolves into a quasi-BIC at oblique incidence with a rich phenomenology as the (non-degenerate) MD is tilted. We will show that a high-refractive-index disk metasurface in the GHz domain in turn provides clear experimental evidence of such Brewster quasi-BICs [5].

All these configurations can be exploited at the nanoscale on the basis of all-dielectric resonant metasurfaces, allowing for robust BICs in the visible domain with Si nanodisk metasurfaces [6], in turn leading to e.g. lasing action demonstrated in TiO_2 disk metasurfaces [7], and magneto-optical BIC tuning and switching, theoretically proposed in Ref. [8].

References

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