

# Bound States in the Continuum in resonant electric and/or magnetic dipole metasurfaces

**D. R. Abujetas**<sup>1,2</sup>

J. J. Sáenz<sup>2</sup>, J. A. Sánchez-Gil<sup>1</sup>

<sup>1</sup>*Instituto de Estructura de la Materia (IEM-CSIC), Madrid, Spain*

<sup>2</sup>*Donostia International Physics Center, Donostia, Spain*

[diego.romero@iem.cfmac.csic.es](mailto:diego.romero@iem.cfmac.csic.es)

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]. A similar phenomenology is theoretically predicted for a Si cylinder/disk metasurface supporting overlapping MD/ED resonances [2]. 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 [4].

---

## References

---

- [1] C. W. Hsu, B. Zhen, A. D. Stone, D. D. Joannopoulos, and M. Soljagic, *Nature Review Materials*, 1 (2016) 16048
- [2] D. R. Abujetas, J. A. Sánchez-Gil, and J. J. Sáenz, *Optics Express*, 26 (2018) 24
- [3] D. R. Abujetas, N. van Hoof, S. Huurne, J. Gómez-Rivas, and J. A. Sánchez-Gil, *Optica*, 6 (2019) 996
- [4] D. R. Abujetas, A. Barreda, F. Moreno, J. J. Sáenz, A. Litman, J.-M. Geffrin, and J. A. Sánchez-Gil, *Scientific Reports*, 9 (2019) 1