Computing one-way edge modes in gyromagnetic photonic crystals by Dirichlet-to-Neumann maps

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Anisotropic photonic crystals (PhCs) give rise to devices with tunable physical properties and lead to interesting phenomena, such as one-way edge modes in gyromagnetic PhCs. These modes are confined at the edge of certain two-dimensional magneto-optical (MO) PhCs and possess group velocities pointing in only one direction, determined by the direction of an applied dc magnetic field. Recently, one-way edge modes have been found at the edge between an MO square lattice PhC and a regular PhC [1], at the zigzag edge of a MO honeycomb lattice PhC [2], in an yttrium-iron-garnet (YIG) PhC slab with triangular lattice [3], and at the edge between MO honeycomb lattice PhCs within different topological phases [4]. To analyze one-way edge modes, efficient numerical methods are essential.

In this talk we present an efficient numerical method to compute one-way edge modes in gyromagnetic PhCs. Our method is based on the Dirichlet-to-Neumann (DtN) maps. By using the DtN map of a supercell, a linear eigenvalue problem with relatively small matrices is formulated on two boundaries of the supercell to solve the edge modes with high accuracy. The eigenvalue is related to the wavenumber of edge modes and the angular frequency is a given parameter.

References

[1] Wang, Z., Y. D. Chong, J. D. Joannopoulos, and M. Soljacic, 2008: Reflection-free one-way edge modes in a gyromagnetic photonic crystal. *Phys. Rev. Lett.* **100**, 013905.
[2] Ao, X., Z. Lin, and C. T. Chan, 2009: One-way edge mode in a magneto-optical honeycomb photonic crystal. *Phys. Rev. B* **80**, 033105.
[3] Liu, K., L. Shen, and S. He, 2012: One-way edge mode in a gyromagnetic photonic crystal slab. *Opt. Lett*. **37**, 4110–4112.
[4] Lu, J., X. Chen, W. Deng, M. Chen, and J. Dong, 2018: One-way propagation of bulk states and robust edge states in photonic crystals with broken inversion and time-reversal symmetries. *J. Opt.* **20,** 075103.

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