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Legume: A guided-mode expansion method for photonic crystal slabs for inverse design and light-matter interaction

Photonic crystal (PhC) slabs, namely 1D or 2D periodic photonic structures embedded in slab waveguides, are at the heart of research in nanophotonics. We present a guided-mode expansion (GME) approach – and the corresponding free python software named Legume – that allows calculating photonic mode dispersion and radiative losses in dielectric photonic crystal slabs. The code can be employed for inverse design, as it is interfaced with the Autograd library for automatic differentiation. We give examples related to (a) symmetry properties and the issue of polarization mixing in coupling to far-field radiation; (b) the occurence of bound states in the continuum (BICs), with very high Q-factors that are accurately calculated by the method; (c) the description of active two-dimensional layers with an excitonic resonance, allowing to describe the regime of strong coupling leading to photonic crystal polaritons.

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