Chairs: Laser Physics and Nonlinear Optics & Complex Photonic Systems

Measuring fields inside a photonic crystal

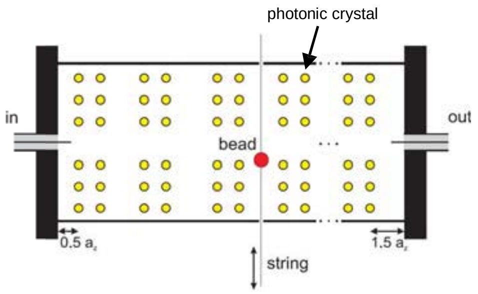
Short project description:

Photonic crystals (PhCs) are structures in which the dielectric constant varies periodically with a period on the order of the wavelength. Such crystals allow an unprecedented control over the velocity of propagating light and emission of light. A most intriguing capability of PhCs is to shape the local density of electromagnetic states (LDOS) inside the crystal, which is the key for suppression or enhancement of spontaneous emission due to Fermi's golden rule.

The LDOS is calculated by summing up, at given frequency and orientation of the emitting dipoles, the strength of the electromagnetic eigenmodes at the location of the emitter. This means that next to the dispersion of the eigenmodes also the electromagnetic eigenmode fields of the PhC are required to determine the LDOS. The overall dispersion has been calculated and measured for various different PhCs. However, all real PhCs suffer inevitably from non-periodic local deviations either due to fabrication errors and even more fundamentally due to thermo-dynamical arguments. Such deviations cannot effectively be included into any kind of numerical calculations.

Only a mapping of the eigenmodes fields throughout the real PhC would allow to determine its LDOS, but measuring the electromagnetic fields inside a PhC is challenging. Especially, as it is required to know the strength of all six field components ($E_j, H_j, j = x, y, z$) to determine the LDOS for all orientations of the emitting dipoles.

At LPNO/COPS we have applied a method known from microwave technology that allows us to measure the fields inside a photonic crystal. The method relies on placing the photonic structure inside a resonator and measure the frequency shift of the (longitudinal) resonances when a sub-wavelength object is placed inside the photonic structure (see figure). The shift depends on the local field strength (of both ***E*** and ***H***) and the coupling of the object to that local field, i.e., it also depends on the shape and material of the object.



A proof-of-principle experiment using a sub-wavelength metal sphere has been successfully performed. However, the sphere only measures the magnitude of the combined E and H fields. It is your task to select an appropriate sub-wavelength object and measure one of the individual field components.

This project is a collaboration between the Laser Physics & Nonlinear Optics and the Complex Photonics chairs.

Supervision	e-mail	tel.	office	project room
Tutor: Peter van der Slot	p.j.m.vanderslot@utwente.nl	3967	ME127	ME132
Teacher: Peter van der Slot	p.j.m.vanderslot@utwente.nl	3967	ME127	