Standard and Generalized FEM for High Frequency Scattering in Locally Periodic Structures

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Abstract

Wave propagation in large, finite locally periodic media at wavelengths of the size of the local periodicity as found in many optical nanostructures such as Photonic Crystals (PhC) (Fig. 1) is a very challenging problem for standard hp-FEM discretizations. In this high-frequency setting the oscillations need to be resolved and cannot be replaced by homogenisation. The local periodicity can be exploited to speed up a standard hp-FEM discretization by exploiting the structure in the resulting discretization matrix, or by using a special problem-adapted non-polynomial multiscale basis [1].

Desired are size robust discretizations which only require a fixed computational effort to simulate arbitrary large, finite periodic structures with a constant $H^1$- or $L^2$-error. Standard discretisation schemes like FD, PWM, $h$, $p$- or $hp$-FEM require more and more basis functions when the number of scatterers increases inside the computational domain. We will show experiments that determine the size dependence of various discretisation techniques and how to obtain size robustness.

![Figure 1: An example Photonic Crystal band](image)

References