Simulation of Diffraction in periodic Media with a coupled Finite Element and Plane Wave Approach

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Electromagnetic waves propagating towards a grating are diffracted and transmitted into certain spatial directions. While the calculation of these directions, which depend only on the period of the structure, is easy to perform, the corresponding intensities, depending strongly on the shape, are much more complicated to compute.

Modeling such a grating with FEM, we have to solve Maxwell's equations. Due to the periodicity of the system, we are able to use the theorem of Bloch-Floquet, and the computational domain can be reduced to a single unit cell by formulating quasi periodic boundary conditions. In order to compare simulation results with optical experiments, it is useful to express the far field by plane waves and exponential decaying functions. A critical point is to couple these plane waves with the polynomial basis functions of the FEM domain. The innovation of our approach is to perform this coupling by Nitsche's method.

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