High-accuracy computation of photonic crystal bands and scattering of waves from polygons

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Abstract

Predicting how linear waves interact with geometric structures is key to optimizing the optical and electronic devices of tomorrow. One example is the design of photonic crystals: periodic dielectric structures that can guide at the wavelength scale. I will present a new method for efficient and accurate modeling of these crystals using boundary integral equations of the second kind. It will turn out that the usual approach of periodizing the integral equations fails, leading us to develop a new scheme which adds sources of waves on the boundary of the lattice cell. I will also explain recent work on efficient methods for scattering of scalar waves from polygons. The corners cause singularities, which leads to problems with standard solvers; however, with our approach we achieve accuracies approaching machine precision. Finally I will show the MATLAB toolbox we have released to make such computations easy (or easier!) Joint work with Leslie Greengard (NYU) and Timo Betcke (Reading).