On the numerical solution of a rational eigenvalue problem via linearization and a high-order interior penalty method

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Abstract

We consider the discretization and numerical solution of a rational eigenvalue problem with important applications in the simulation of metallic photonic crystals. The nonlinearity in the eigenvalue problem arises from the rapid frequency dependence of the material parameters. The spectral problem becomes after application of the Floquet transform a family of spectral problems on the torus. The spectrum then consists of isolated eigenvalues of finite geometrical multiplicity. We use a high-order discontinuous Galerkin method with curved elements to discretize the rational eigenvalue problem, and the resulting matrix problem is transformed into a linear eigenvalue problem. Finally, we use an implicitly restarted Arnoldi method to compute approximate eigenpairs of the sparse matrix problem. The limitations of the used linearization will be discussed.

References

[1] K. Sakoda, Optical properties of photonic crystals, Springer-Verlag, Heidelberg, 2001.
[2] P. Kuchment, Floquet theory for partial differential equations, Birkhäuser, Basel, 1993.
[3] C. Engström, *On the spectrum of a holomorphic operator-valued function with applications to absorptive photonic crystals*, To appear in Mathematical Models and Methods in Applied Sciences, 2010.
[4] C. Engström and M. Wang, *Complex dispersion relation calculations with the symetric interior penalty method*, To appear in International Journal for Numerical Methods in Engineering, 2010.