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Finite element approximation of the eigenvalue problem for the **curl** operator in multiply connected domains.*

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Abstract

In a recent paper [1], two of the authors introduced and analyzed a couple of numerical methods based on Nédélec finite elements to solve the eigenvalue problem for the **curl** operator in simply connected domains. This topological assumption is not just a technicality, since the eigenvalue problem is ill-posed on multiply connected domains, in the sense that its spectrum is the whole complex plane, as is shown in [2]. However, additional constraints can be added to the eigenvalue problem in order to recover a well posed problem with a discrete spectrum [2, 3]. We choose as additional constraints a zero-flux condition of the curl on all the cutting surfaces. We introduce two weak formulations of the corresponding problem, which are convenient variations of those studied in [1]; one of them is mixed and the other a Maxwell-like formulation. We prove that both are well posed and show how to modify the finite element discretization from [1] to take care of these additional constraints. We prove spectral convergence of both discretization as well as a priori error estimates. Finally, we report a numerical test which allows assessing the performance of the proposed methods.

Key words: eigenvalue problems, topological constraints, finite element methods, spectral approximation.

Mathematics subject classifications (2010): Primary 65N15, 65N25, 65N30.

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