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The Discontinuous Galerkin method for highly inhomogeneous media

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The simulation of geophysical measurements involves a physical description of the earth's interior by spatially varying constitutive parameters. In particular, these parameters may be discontinuous and have jumps by orders of magnitude. We address the problem of solving Maxwell's equations for that case by a discontinuous approach also for the fields. The Discontinuous Galerkin (DG) method allows us to enforce the interface conditions explicitly by adding appropriate penalty or Lagrange multiplier terms to the variational formulation. We restrict ourselves to the case of time-harmonic fields and derive a symmetric discretization for the first order Maxwell system. In spite of potential savings in storage for a second order formulation we prefer to discretize the first order form as it results in accuracy for both the electric and magnetic fields; both needed for geophysical applications. The main challenge in the DG method is the solution of the linear system. We propose and experiment with a number of preconditioning techniques. In particular, we use a preconditioner based on the potentials formulation to Maxwell's equations. We show that using our approach we are able to obtain significant accuracy even for very challenging problems.