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Analysis of the Edge Finite Element Approximation of the Maxwell Equations with Low Regularity Solutions

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We derive $H(curl)$-error estimates and improved $L2$-error estimates for the Maxwell equations. These estimates only invoke the expected regularity pickup of the exact solution in the scale of the Sobolev spaces, which is typically lower than $1/2$ and can be arbitrarily close to 0 when the material properties are heterogeneous. The key tools for the analysis are commuting quasi-interpolation operators in $H(curl)$- and $H(div)$-conforming finite element spaces and, most crucially, newly-devised quasi-interpolation operators delivering optimal estimates on the decay rate of the best-approximation error for functions with Sobolev regularity index arbitrarily close to 0. The proposed analysis entirely bypasses the technique known in the literature as the discrete compactness argument.

This is joint work with Jean-Luc Guermond (Texas A&M University).