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Application of multigrid techniques to magnetic and electromagnetic systems

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We discuss the use of multigrid techniques for several novel systems related to electromagnetics. One of these is the magnetostatic problem, in which systems can involve highly anisotropic and nonlinear materials. We describe the linear problems arising in several variations of this problem, including fully static, hysteretic, and eddy-current. We show results of tests of several AMG methods for solving these systems in 2D and 3D. We then discuss the challenges in solving the nonlinear system and some techniques for overcoming these challenges.

We also discuss several other systems, including implicit electromagnetics, which gives rise to a positive-definite curl-curl system, and frequency-domain electromagnetics, which gives rise to an indefinite curl-curl system. The latter problem is especially challenging, and while the physics of the system can relieve the challenges somewhat, the combination of operator indefiniteness and curl null space continues to present difficulties.