A-POSTERIORI ERROR ESTIMATES AND MESH ADAPTIVITY FOR VARIATIONAL FORMULATIONS OF MAGNETOHYDRODYNAMICS WITH EXACT SOLENOIDAL CONSTRAINT

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A-posteriori error estimates and adaptive mesh algorithms are considered for the discontinuous Galerkin approximation of the ideal magnetohydrodynamic (MHD) equations with solenoidal constraint cast in saddle point form. The saddle point formulation is chosen here so that the MHD equations can be formally written in symmetric form by appending specific multiples of the constraint equation. This formulation also avoids some technical issues associated with local well-posedness of the ideal MHD equations when written in divergence form. The chosen solution technique permits the explicit calculation of Lagrange multipliers for the nonlinear primal problem. Using standard duality arguments, goal-oriented a-posteriori error estimates for user specified functionals are then readily obtained following closely the work of Eriksson et al. [1] and Becker and Rannacher [2]. The resulting error estimates relate the functional error in terms of weighted residuals associated with the primal operator and the solenoidal constraint. Again using standard techniques, the error estimates are further manipulated for use in an adaptive meshing procedure tailored to simplicial arrangements. The talk will include numerous example calculations with error estimates and mesh adaptivity for scalar functional quantities of interest in MHD by our group at NASA engaged in the study of solar physics.

References

[1] K. Erikkson and D. Estep and P. Hansbo and C. Johnson, "Introduction to Numerical Methods for Differential Equations," *Acta Numerica*, 1995.

[2] R. Becker and R. Rannacher, "An Optimal Control Approach to A-Posteriori Error Estimation in Finite Element Methods," *Acta Numerica*, 2001.