A DIVERGENCE-CONFORMING E-HDG METHOD FOR THE LINEARIZED INCOMPRESSIBLE RESISTIVE MHD EQUATIONS

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Abstract. Incompressible Magnetohydrodynamics (MHD) models are relevant in low Lundquist number liquid metals, high Lundquist number, large guide field fusion plasmas, and low Mach number compressible flows. Due to its complexity, it is crucial to understand the dynamics of electrically conducting flow in the presence of electromagnetic fields via simulation. In this work, we proposed an Embedded-hybridized discontinuous Galerkin (E-HDG) method for solving linearized incompressible resistive MHD equations.

In particular, the E-HDG method is computationally cheaper than the corresponding HDG method. The benefit is even significant in the three-dimensional scenario. Furthermore, a specific choice of the approximation spaces guarantees that the proposed method is $H(div)$-conforming, meaning that the velocity and magnetic fields are pointwise divergence-free. We implement our approach in the open source library `MFEM` and validate our method using manufactured solutions. The results indicate that convergence rates in the L^2 norm for the velocity and magnetic fields are optimal, and divergence error can be reduced to machine zero. Furthermore, the proposed E-HDG discretization is pressure robust.

Keywords: discontinuous Galerkin methods, embedded-hybridized, resistive magnetohydrodynamics

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