A HDG FRAMEWORK FOR CONVECTED WAVE EQUATIONS. APPLICATIONS IN HELIOSESIMOLOGY.

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ABSTRACT

As a first step toward the development of efficient and reliable numerical methods for wave-propagation problems arising in helioseismology, we construct three different Hybridizable Discontinuous Galerkin (HDG) methods to solve the convected Helmholtz equation. HDG methods are mixed DG methods whose solution is computed thanks to a surfacic auxiliary unknown. The original unknowns can be eliminated using a static condensation process, leading to a so-called global problem set on the skeleton of the mesh only. The original unknowns can then be reconstructed inside each element by solving small local problems in parallel. As a result of this, HDG methods keep the advantages of the DG methods (eg. hp-adaptivity, high order,...) without incurring their high numerical cost. For the three HDG methods that we have constructed, we present theoretical results including well-posedness of the local and global problems, convergence analysis for regular solutions and a discussion about the choice of penalization parameters. Numerical experiments illustrate the efficiency of the methods.

References

[1] B. Cockburn, J. Gopalakrishnan, R. Lazarov. *Unified Hybridization of Discontinuous Galerkin, Mixed, and Continuous Galerkin Methods for Second Order Elliptic Problems*, SIAM Journal on Numerical Analysis, 2009.

[2] S. Du, FJ. Sayas. *An Invitation to the Theory of the Hybridizable Discontinuous Galerkin Method: Projections, Estimates, Tools*, Springer, 2019.

[3] F. Faucher. *'hawen': time-harmonic wave modeling and inversion using hybridizable discontinuous Galerkin discretization*, Journal of Open Source Software, 2019.

[4] H. Barucq, N. Rouxelin, S. Tordeux. *HDG and HDG+ methods for harmonic wave problems with convection*, Rapport de Recherche Inria 9410, 2021.

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