Hybridizable Discontinuous Galerkin Method for Time-domain Electromagnetics

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Abstract

Discontinuous Galerkin (DG) methods have been the subject of numerous research activities in the last 15 years and have been successfully developed for various physical contexts modeled by elliptic, mixed hyperbolic-parabolic and hyperbolic systems of PDEs. One major drawback of high order DG methods is their intrinsic cost due to the very large number of globally coupled degrees of freedom as compared to classical high order conforming finite element methods. Different attempts have been made in the recent past to improve this situation and one promising strategy has been recently proposed by Cockburn et al. in [1] in the form of so-called hybridizable DG (HDG) formulations. The distinctive feature of these methods is that the only globally coupled degrees of freedom are those of an approximation of the solution defined only on the boundaries of the elements of the discretization mesh. The present work is concerned with the study of such a HDG method for the solution of the three-dimensional time-domain Maxwell equations. On one hand, we are interested in designing a high order HDG method that can handle efficiently locally refined unstructured meshes by considering the possibility of using a fully implicit time scheme or a hybrid implicit-explicit (IMEX) time scheme. On the other hand, we are concerned with applications involving the interaction of light with matter at the nanoscale which possibly requires solving the system of time-domain Maxwell PDEs coupled to a system of ODEs modeling the dispersive properties of the scattering nanostructures.

References

1. B. Cockburn and J. Gopalakrishnan and R. Lazarov. Unified hybridization of discontinuous Galerkin, mixed and continuous Galerkin methods for second order elliptic problems. SIAM Journal on Numerical Analysis, Vol. 47, pp. 1319-1365 (2009).