LOCALLY DIVERGENCE FREE DISCONTINUOUS GALERKIN METHODS FOR MHD

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There are many partial differential equations with solutions which are divergence free. Examples include the incompressible Euler and Navier-Stokes equations, the magnetohydrodynamics equations, and the Maxwell equations. Violation of this divergence free condition in the numerical solution for some tough cases will either cause instability or introduce nonphysical features. We consider discontinuous Galerkin methods for this class of equations using locally divergence free basis functions, which reduces the computational cost (since there are fewer functions in such bases than in the full polynomial bases) and maintains or improves stability and accuracy. This framework works very well on two dimensional Maxwell equations.

In this presentation, we focus on the nonlinear two dimensional magnetohydrodynamics equations. Our preliminary numerical results show that the locally divergence free discontinuous Galerkin methods can improve stability comparing with the discontinuous Galerkin method with the standard polynomial basis functions, for some test problems including the Orszag-Tang MHD Turbulence problem.