UNIVERSITY of HOUSTON

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Scientific Computing Seminar

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A structure preserving scheme for the compressible MHD system

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1 PM- 2 PM
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Abstract: We introduce a novel structure-preserving method in order to approximate the compressible ideal Magnetohydrodynamics (MHD) equations. This technique addresses the MHD equations using a non-divergence formulation. Contributions of the magnetic field to the momentum and total mechanical energy are treated as source terms. Our approach uses the Marchuk-Strang splitting technique and involves three distinct components: a compressible Euler solver, a source-system solver, and an update procedure for the total mechanical energy. The scheme allows for significant freedom on the choice of Euler's equation solver, while the magnetic field is discretized using a curl-conforming finite element space, yielding exact preservation of the involution constraints. We prove that the method preserves invariant domain properties, including positivity of density, positivity of internal energy, and the minimum principle of the specific entropy. If the scheme used to solve Euler's equation conserves total energy, then the resulting MHD scheme can be proven to preserve total energy. In our approach, the CFL condition does not depend on magnetosonic wave-speeds, but only on the usual maximum wavespeed from Euler's system.