EFFICIENT ALGORITHMS FOR MAGNETOHYDRODYNAMIC (MHD) FLOW PROBLEMS AND THEIR UNCERTAINTY QUANTIFICATION

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Abstract. In this talk, we propose, analyze, and test a set of new MHD discretizations that decouple the system into two Oseen sub-problems at each timestep yet maintain stability with respect to the timestep size and provide optimal accuracy in space. For the MHD flow ensemble simulations, the decoupled identical sub-problems permit a shared coefficient matrix for all the realizations at each timestep. Therefore, a massive amount of computer memory is saved and system matrix assembly and factorization/preconditioner are needed only once per timestep. Moreover, the algorithms can take advantage of block linear solvers. We prove the stability and convergence theorems rigorously. Several numerical tests are given to support the predicted convergence rates. Finally, we test the proposed schemes and observe how the physical behavior changes as the coupling number increases in a regularized lid-driven cavity problem with mean Reynolds number $Re \approx 15000$, and as the deviation of uncertainties in the initial and boundary conditions increases in a channel flow past a step problem.