1125-VC-1337 **Timo Heister** and **Muhammad Mohebujjaman*** (mmohebu@g.clemson.edu), Clemson, SC 29634, and **Leo Rebholz**. *Efficient Numerical Methods for Magnetohydrodynamics Flow.*

Firstly we propose, analyze, and test a θ-timestepping-method for MHD which decouples the system into two Oseen problems at each timestep, yet maintains unconditional stability with respect to the time step size. The proposed method chooses $\theta \in [0, 1]$, dependent on the viscosity ν and magnetic diffusivity ν_m, so that unconditionally stability is achieved and gives temporal accuracy $O(\Delta t^2 + (1 - \theta)|\nu - \nu_m|\Delta t)$. In practice ν and ν_m are small, and so the method behaves like second order. We show the θ-method provides excellent accuracy in cases where usual BDF2 is unstable. We also proposed another algorithm for computing flow ensembles under uncertainties in initial or boundary data. The ensemble average of J realizations is approximated through a clever algorithm that, at each time step, uses the same matrix for each of the J system solves. Hence, preconditioners need built only once per time step, and the algorithm can take advantage of block linear solvers. Additionally, an Elsässer variable formulation is used, which allows for a stable decoupling of each MHD system at each time step. We prove stability and convergence of the algorithm, and test it with two numerical experiments. (Received September 16, 2016)