TEMPLE UNIVERSITY
Department of Mathematics

Applied Mathematics and Scientific Computing Seminar

Room 617 Wachman Hall

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A Local Vorticity Boundary Condition Spectral Collocation Method for 2D Incompressible Fluids

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Abstract.

A simple spectral collocation method for viscous incompressible flow in a bounded 2D domain is presented for the vorticity-stream function formulation of the incompressible Navier-Stokes equations, along with its extension to the Boussinesq system. The no-slip boundary condition for velocity is converted into a local boundary formula for the vorticity, which when used in conjunction with an explicit time stepping scheme allows decoupling the computation of the vorticity and stream function time updates. Numerical results are presented for the singular lid-driven cavity problem, a benchmark differentially heated cavity problem, and a Rayleigh-Bernard convection problem for Rayleigh number up to 10^{10}, demonstrating the efficiency of the method, and in particular that it is well suited for high Reynolds or high Rayleigh number regime simulations.

(joint work with Cheng Wang - UMass Dartmouth and Jian-Guo Liu - Duke)