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Numerical analysis of the stabilized Lagrange-Galerkin method

Abstract

The Lagrange-Galerkin (LG) method is a finite element method (FEM) combined with the method of characteristics, and has the following advantages: (i) It is robust for convection-dominated flow problems. (ii) The resulting matrix is symmetric and the system of linear equations is solved by one of iterative linear solvers for symmetric matrices, e.g., CG and MINRES methods. In this talk, we introduce the stabilized LG method for the Navier-Stokes equations, which additionally has an advantage, a small number of degrees of freedom especially in 3D, since it employs the P1/P1 finite element with Brezzi-Pitkaranta's pressure-stabilization. After reviewing the basic idea of the method of characteristics and the stabilization technique, we present theoretical and numerical results.

Refs. [1] H. Notsu and M. Tabata. Error estimates of a pressure-stabilized characteristics finite element scheme for the Oseen equations. Journal of Scientific Computing, Vol.65 (2015), pp.940-955. [2] H. Notsu and M. Tabata. Error estimates of a stabilized Lagrange-Galerkin scheme for the Navier-Stokes equations. ESAIM: M2AN, Vol.50 (2016), pp.361-380. [3] P.-Y. Hsu, H. Notsu and T. Yoneda. A local analysis of the axisymmetric Navier-Stokes flow near a saddle point and no-slip flat boundary. Journal of Fluid Mechanics, Vol.794 (2016), pp.444-459.