An overlapping Schwarz method for spectral element simulation of three-dimensional incompressible flows

P. F. Fischer *
N. I. Miller
H. M. Tufo

November 21, 1997

Abstract

As the characteristic propagation speed is infinite for unsteady incompressible flows, solving for the pressure operator is the most computationally challenging phase of flow simulation. Efficient solution is dependent upon the availability of fast solvers for sparse linear systems. In this paper we develop an Schwarz preconditioner using overlapping subdomains for the pressure. These local subdomain problems are derived from tensor products of one-dimensional finite element discretizations and admit use of fast diagonalization methods based upon matrix-matrix products. In addition, we use a coarse grid projection operator applied directly to the pressure on the interior Gauss points whose solution is computed via a fast parallel direct solver. The combination of overlapping Schwarz preconditioning and coarse grid solver provides as much as a four-fold reduction in simulation time over previously employed methods based upon deflation for parallel solution of multi-million grid point flow problems.

*Present address: Division of Applied Mathematics, Brown University, Providence, RI 02912, USA. E-mail: *pff@cfm.brown.edu*