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2D Incompressible viscous flows at moderate and high Reynolds numbers: A direct primitive variables approach

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The unsteady Navier-Stokes equations in primitive variables which model viscous incompressible fluid flow are numerically solved by a simple direct projection method that involves an operator splitting technique of three steps in the time discretization process. The numerical scheme does not involve any iteration, is independent of the spatial dimension, and its costly part relies on the solution of elliptic problems for which very efficient solvers exist regardless of the spatial discretization. The scheme is tested with the well known two-dimensional lid-driven cavity problem at moderate and high Reynolds numbers re in the range $400 \leq Re \leq 15000$. for moderate *Re* the results are compared, for validation matters, with previously published results which are supposed to be correct; for these flows the time *T_ss* when the flow converges to the asymptotic steady state is reported. at high *Re*'s, say *Re*=10000 and 15000, *time-dependent* flows, results at specific final times *T_f* are reported. for both cases, moderate and high *Re*, flows are reported close from its departure from *rest*, and it should be noted that for moderate *Re*'s they look like different than those for high *Re*'s. with the results for high *Re*'s transition to 2*D* turbulence is observed as time and/or *Re* increases, because of the increment of new small structures: sub-vortices or eddies, [1-2].

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