Implicit-explicit time discretization for Oseen's equation at high Reynolds number with application to fractional step methods

Deepika Garg[1] Erik Burman[2] Johnny Guzman[3]

In this talk we consider the application of implicit-explicit (IMEX) time discretizations for the incompressible Oseen equations. The pressure velocity coupling and the viscous terms are treated implicitly, while the convection term is treated explicitly. Both the second order backward differentiation and the Crank-Nicolson methods are considered for time discretization, resulting in a scheme similar to Gear's method on the one hand and to Adams Bashforth of second order on the other. For the discretization in space we consider finite element methods with stabilization on the gradient jumps. The stabilizing terms ensures inf-sup stability for equal order interpolation and robustness at high Reynolds number. Under suitable Courant conditions we prove stability of Gear's scheme in this regime. The stabilization allows us to prove error estimates of order $O(h^{k+\frac{1}{2}}+\tau^2)$. Here h is the mesh parameter, k the polynomial order and τ the time step. Finally we show that for inviscid flow (or underresolved viscous flow) the IMEX scheme can be written as a fractional step method in which only a mass matrix is inverted for each velocity component and a Poisson type equation is solved for the pressure.

[1]University College London
d.garg@ucl.ac.uk

[2]University College London
e.burman@ucl.ac.uk

[3]Brown University
johnny_guzman@brown.edu