Analysis of the grad-div stabilization for the time-dependent

Navier-Stokes equations with inf-sup stable finite elements

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In this talk we consider inf-sup stable finite element approximations to the evolutionary Navier-Stokes equations with a grad-div type stabilization. The numerical experiments show that this kind of stabilization improves the quality of the approximations for high Reynolds numbers. The aim is to prove that error bounds can accordingly being obtained that do not deteriorate while decreasing the value of the viscosity parameter. Our analysis covers both the case in which the solution is assumed to be smooth and consequently has to satisfy nonlocal compatibility conditions as well as the practically relevant situation in which the nonlocal compatibility conditions are not satisfied. The constants in the error bounds obtained do not depend on negative powers of the viscosity. Taking into account the loss of regularity suffered by the solution of the Navier-Stokes equations at the initial time in the absence of nonlocal compatibility conditions of the data, error bounds of order $O(h^2)$ in space are proved. The analysis is optimal for quadratic/linear infsup stable pairs of nite elements. Both the continuous-in-time case and the fully discrete scheme with the backward Euler method as time integrator are considered.