Higher order variational time discretisations for the Oseen equations

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We discuss different time discretisations of variational type applied to the Oseen equations. As spatial discretisation, we will consider both inf-sup stable and equal-order pairs of finite element spaces for approximating velocity and pressure.

Since Oseen problems are generally convection-dominated, a spatial stabilization is needed. We will concentrate on local projection stabilization methods which allow to stabilize the streamline derivative, the divergence constraint and, if needed, the pressure gradient separately.

To discretize in time, continuous Galerkin-Petrov methods (cGP) and discontinuous Galerkin methods (dG) as higher order variational time discretisation schemes are applied. These methods are known to be A-stable (cGP) or even strongly A-stable (dG).

Using a simple postprocessing, both velocity and pressure show at the discrete time points a convergence rate of $2k+1$ for dG(k) and $2k$ for cGP(k), respectively.

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