Quasi-optimal and pressure robust discretizations of the Stokes equations by new augmented Lagrangian formulations

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We approximate the solution of the stationary Stokes equations with various conforming and nonconforming inf-sup stable pairs of finite element spaces on simplicial meshes. Based on each pair, we design a discretization that is quasi-optimal and pressure robust, in the sense that the velocity H^1-error is proportional to the best H^1-error to the analytical velocity. This shows that such a property can be achieved without using conforming and divergence-free pairs. We bound also the pressure L^2-error, only in terms of the best approximation errors to the analytical velocity and the analytical pressure. Our construction can be summarized as follows. First, a linear operator acts on discrete velocity test functions, before the application of the load functional, and maps the discrete kernel into the analytical one. Second, in order to enforce consistency, we employ a new augmented Lagrangian formulation, inspired by Discontinuous Galerkin methods.