# ANALYSIS OF A CONFORMING AND MASS-CONSERVATIVE MIXED-FEM FOR THE STOKES PROBLEM

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## ABSTRACT

In this work we propose and analyze a conforming and mass-conservative pseudostress-based numerical scheme for the Stokes problem. More precisely, we extend previous results on pseudostress-velocity formulations for the Stokes problem, with unknowns originally in $\mathrm{H}(\mathrm{div})$ and $\mathrm{L}^2$, respectively, and apply a Helmholtz decomposition to the velocity to derive a new dual-mixed formulation for the fluid flow problem, which considers now the velocity in $\mathrm{H}(\mathrm{div})$. Consequently, we obtain a three-field mixed variational formulation where the pseudostress and the velocity, both in $\mathrm{H}(\mathrm{div})$ and a further unknown in $\mathrm{H}^1$, representing the null function, are the main unknowns of the system. Then the associated Galerkin scheme can be defined by employing Raviart–Thomas elements of degree $k$ for the pseudostress, divergence-free Raviart–Thomas elements of degree $k$ for the velocity, and Lagrange elements of degree $k+1$ for the aforementioned additional unknown. For both, the continuous and discrete problems, we employ the Babuška–Brezzi theory to prove unique solvability. We also provide the convergence analysis and derive the corresponding theoretical rate of convergence. In addition, we propose a reliable and efficient residual-based a posteriori error estimator for the resulting Galerkin scheme. Finally, several numerical results illustrating the performance of the method are provided.

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