Towards pressure-robust mixed methods for the incompressible Navier-Stokes equations

Alexander Linke *

Abstract For more than thirty years it was thought that the construction of pressure-robust mixed methods for the incompressible Navier-Stokes equations, whose velocity error is pressure-independent, was practically impossible. However, a novel, quite universal construction approach shows that it is indeed rather easy to construct pressure-robust mixed methods. The approach repairs a certain L^2 orthogonality between gradient fields and discretely divergence-free test functions, and works for families of arbitrary-order mixed finite element methods, arbitrary-order discontinuous Galerkin methods, and finite volume methods. Novel benchmarks for the incompressible Navier–Stokes equations show that the approach promises significant speedups in computational practice compared to pure Galerkin discretizations or grad-div stabilization, whenever the continuous pressure is complicated.

* Weierstrass Institute for Applied Analysis and Stochastics, Mohrenstrasse 39, 10117 Berlin Germany. Email: alexander.linke@wias-berlin.de.