1 Introduction

1.1 Motivation and goal

- Adaptivity and stability for CFD problems are issues - cite David Young.
- To develop a stable *hp*-adaptive scheme for the steady laminar Navier-Stokes equations in transonic/supersonic regimes.

1.2 Literature review

1. Finite difference, finite volumes
2. Finite elements
   - Taylor-Galerkin, SUPG
   - Upwind DG, HDG (stabilization?)
   - DPG
3. Optimization/NL solvers (?)

2 Range of CFD problems

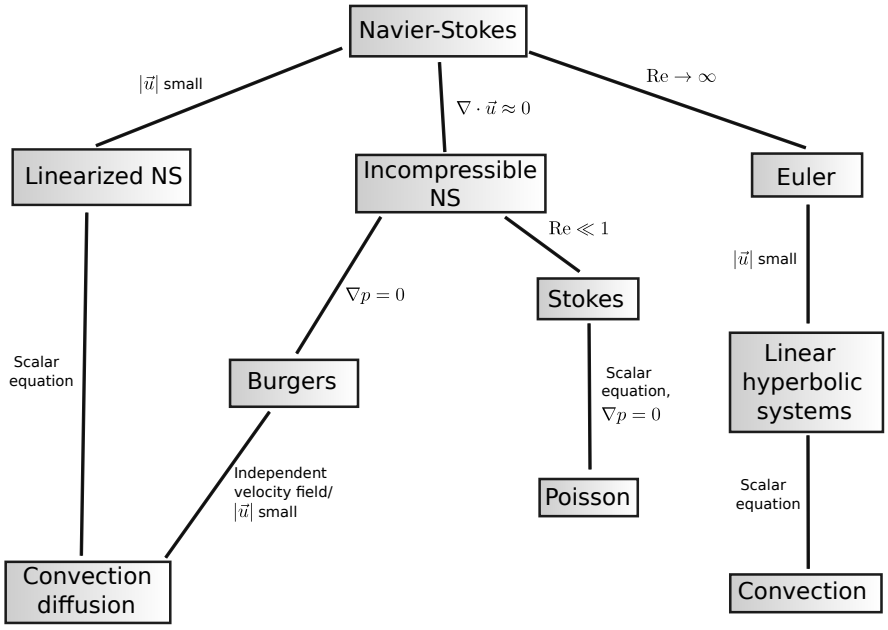

Figure 1: Common CFD problems and their simplifying assumptions.

3 DPG: a minimum residual method for linear problems

4 Robustness for convection-dominated diffusion

5 DPG for nonlinear problems

Introduce nonlinear residual to measure convergence, DPG formulation for nonlinear problems. Discuss solution strategies (pseudo-timestep/damped Newton).

Formulate DPG for Burgers' equation as an example, showing results, then show Navier-Stokes at a broad level.

6 Proposed work

6.1 Area A

Analysis of (incompletely parabolic?) convection-diffusion systems

6.2 Area B

Nonlinear DPG - Hessian adjoint trick, anisotropic refinements, *hp*-adaptivity, distributed static condensation (if it's not implemented by then).

6.3 Area C

Ramp, bump, airfoil, Euler with NS regularization?