Advanced Newton Methods for Viscoplastic Stokes Flows

Scientific Achievement
Nonlinear iterative methods with fast convergence and robustness with respect to severe nonlinearities and singularities in Hessians

Significance and Impact
Advancement of Newton methods for challenging nonlinearities for problems such as viscoplastic Stokes flow; Enabling simulations of Earth’s lithosphere modeled by non-Newtonian incompressible Stokes PDEs with frictional plasticity

Research Details
- We study solvability of viscoplastic Stokes flow in theory and with numerical algorithms such as Newton’s and Picard fixed-point methods
- Propose novel Newton-type method that demonstrates significantly improved convergence properties relative to state-of-the-art algorithms
- Efficiently solve Stokes problems with viscoplastic flow behaviors and 7 orders of magnitude viscosity contrasts using 2D and 3D finite element discretizations and adaptive meshes