#### Wilkinson Fellowship

# 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**

ERGY

- 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 ٠ orders of magnitude viscosity contrasts using 2D and 3D finite element discretizations and adaptive meshes

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Viscoplastic model with lateral compression; narrow beams are induced by local nonlinear effects



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Johann Rudi (ANL), Y. Shih and G. Stadler (NYU) [Geochemistry, Geophysics, Geosystems 21] [arXiv: 2003.11115]