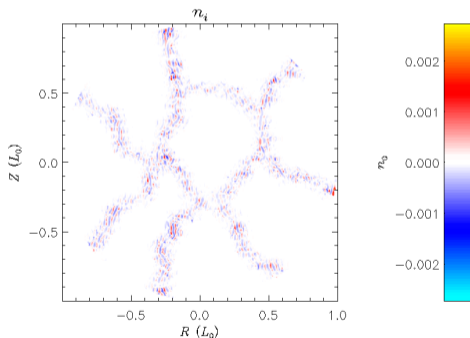
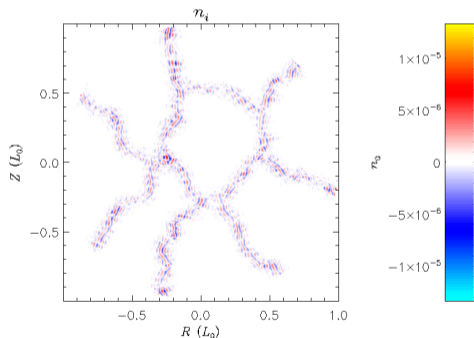


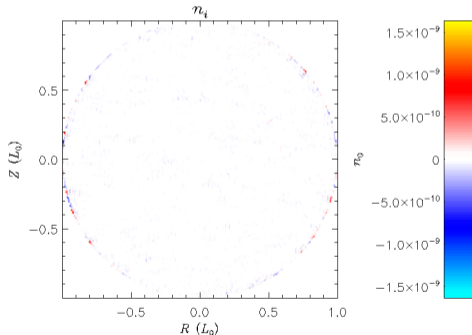
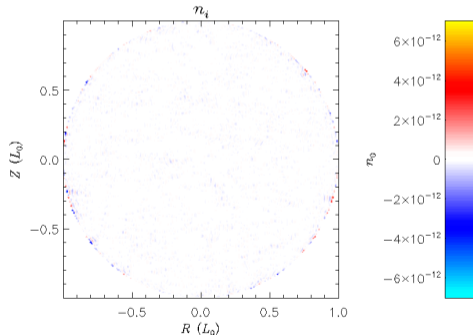
Anomalous errors concentrate near MPI domain boundaries

- ▶ Example: initializing $n(R, Z) = 1$; solved for by inverting mass matrix ('den_eq').
- ▶ 'Baseline': $\partial_R n \sim 10^{-5}$ (left) and $\partial_R^2 n \sim 10^{-3}$ (right). (SuperLU, fgmres, rtol = 10^{-9} .)



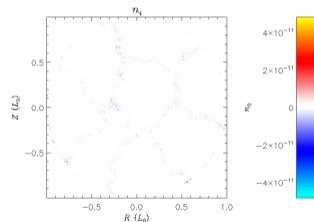
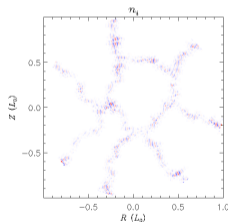
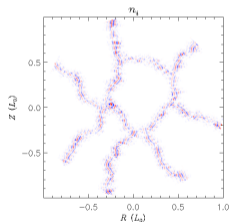
Errors are likely due to iterative solvers

- ▶ Only in (various) 3D nonlinear versions; not in 2D.
- ▶ 2D comparisons: $\partial_R n \sim 10^{-11}$ (left) and $\partial_R^2 n \sim 10^{-9}$ (right).



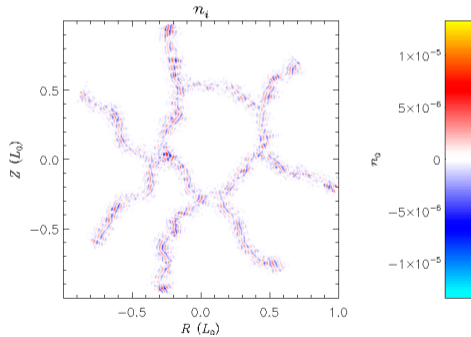
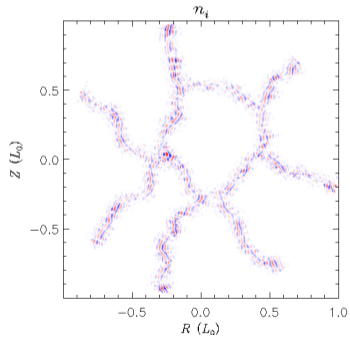
Anomalous error decreases with smaller 'rtol'

- ▶ Left: $\partial_R n \sim 10^{-5}$ for $\text{rtol} = 10^{-9}$, 28 iterations.
- ▶ Middle: $\partial_R n \sim 10^{-8}$ for $\text{rtol} = 10^{-12}$, 41 iterations.
- ▶ Right: $\partial_R n \sim 10^{-11}$ for $\text{rtol} = 10^{-15}$, 54 iterations.
- ▶ Did not see difference changing 'atol' in 'options_bjacobi'.



SuperLU and MUMPS produce very similar results

- ▶ Left: SuperLU, $\partial_R n \sim 10^{-5}$ for $\text{rtol} = 10^{-9}$, 28 iterations.
- ▶ Right: MUMPS, $\partial_R n \sim 10^{-5}$ for $\text{rtol} = 10^{-9}$, 28 iterations.



Error somewhat depends on GMRES options

- ▶ Left: 'fgmres', $\partial_R n \sim 10^{-5}$ for $\text{rtol} = 10^{-9}$, 28 iterations.
- ▶ Middle: 'gmres', $\partial_R n \sim 10^{-6}$ for $\text{rtol} = 10^{-9}$, 38 iterations.
- ▶ Right: 'lgmres', $\partial_R n \sim 10^{-6}$ for $\text{rtol} = 10^{-9}$, 39 iterations.

