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Canonical Nonlinear Viscous Core Solution in pipe and elliptical geometry[1] OZGE OZCAKIR, Monash University — In an earlier paper (Ozcakir et. al.(2016)), two new nonlinear traveling wave solutions were found with collapsing structure towards the center of the pipe as Reynolds number $R \to \infty$, which were called Nonlinear Viscous Core (NVC) states. Asymptotic scaling arguments suggested that the NVC state collapse rate scales as $R^{-1/4}$ where axial, radial and azimuthal velocity perturbations from Hagen-Poiseuille flow scale as $R^{-1/2}$, $R^{-3/4}$ and $R^{-3/4}$ respectively, while $(1-c) = O(R^{-1/2})$ where c is the traveling wave speed. The theoretical scaling results were roughly consistent with full Navier-Stokes numerical computations in the range $10^5 < R < 10^6$. In the present paper, through numerical solutions, we show that the scaled parameter free canonical differential equations derived in Ozcakir et. al.(2016) indeed has solution that satisfies requisite far-field conditions. We also show that these are in good agreement with full Navier-Stokes calculations in a larger R range than previously calculated (R upto 10^6). Further, we extend our study to NVC states for pipes with elliptical cross-section and identify similar canonical structure in these cases.

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