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Global Description of Bifurcation Branches and Nonlinear Dynamics of Vortex Flow in a Pipe[1] ANSHUMAN MISHRA, GILEAD TADMOR, Northeastern University, BERND R. NOACK, Berlin Institute of Technology, ZVI RUSAK, Rensselaer Polytechnic Institute — Details of the global dynamics of the transition to vortex breakdown in the high Reynolds number, high swirl, axisymmetric vortex flow in a finite pipe, are investigated. A first global map of fixed point branches that bifurcate from the columnar flow is revealed, along with a detailed characterization of the nonlinear, local dynamics near fixed points. The description includes the fixed point states, linear and nonlinear stability analysis modes that dominate the fluctuations near fixed points, secondary bifurcations along branches, and dynamic interconnections between them. A central role in the investigation is played by low and least order, mean-field Galerkin models of the local dynamics near bifurcation branches. Indeed, as this is a first case study of mean field Galerkin models in a flow configuration with multiple coexisting attractors, the technical and conceptual aspects of these models and of their identification, are of independent interest. The unveiled picture is that of an inertial manifold that is well approximated with only few dominant coherent structures, or modes that are well characterized by temporal and spatial frequencies, and that continuously deform with changes in the operating conditions.

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