Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Wall-separation and vortex-breakdown zones in a solid-body rotation flow in a rotating pipe ZVI RUSAK, Renssealer Polytechnic Institute, SHIXIAO WANG, Auckland University, New Zealand — The axisymmetric dynamics of perturbations on a solid-body rotation flow with a uniform axial velocity in a rotating, finite-length circular pipe is studied via global analysis methods and numerical simulations. We first describe the bifurcation diagram of steady-state solutions of the flow problem as a function of the swirl ratio ω. We prove that the base columnar flow is a unique steady-state solution when ω is below a critical level, ω_1. This state is asymptotically stable and a global attractor of the flow dynamics. However, when $\omega > \omega_1$, we reveal, in addition to the base columnar flow, the co-existence of states that describe swirling flows around either centerline stagnant breakdown zones or wall pseudo-stagnant zones. The base columnar flow is a min-max point of the energy functional that governs the problem while the swirling flows with wall-separation and breakdown zones are global and local minimizer states and attractors of the flow dynamics. We also find additional min-max states that are transient attractors of the flow dynamics. The wall-separation states have same chance to appear as that of the breakdown states and there is no hysteresis loop between these states.

Zvi Rusak
Renssealer Polytechnic Institute

Date submitted: 31 Jul 2014 Electronic form version 1.4