Abstract Submitted
for the MAR06 Meeting of
The American Physical Society

A Transitional Pathway to Turbulence in Elastic Fluids BRUCE SCHIAMBERG, LAURA SHEREDA, HUA HU, RONALD LARSON, University of Michigan — Multiple scenarios have been discovered by which laminar flow transitions to turbulence, where transitions are caused by inertia or temperature, in Newtonian fluids. Here we show in non-Newtonian fluids a transition sequence that is due to elasticity from polymers, with negligible inertia. Multiple states are found linking the stable base flow to "elastic turbulence" in the flow between a rotating and stationary disk, including circular and spiral rolls, and stationary and time-dependent modes. Also, a surprising progression from apparently "chaotic" flow to periodic flow and then to "elastic turbulence" is found. In these experiments, either shear stress or shear rate is incrementally increased and then held at fixed values. The modes we discover have distinct rheological signatures, and we also image the accompanying secondary-flow field kinematic structures. Finally, we have explored how polymer concentration and gap-to-radius ratio affect (and possibly limit) the transitional pathway. The most concentrated solution tested appears to stabilize an additional, time-periodic mode. In conclusion, we have studied an unexplored route, which we hope, in time, will make it possible to compare experimentally and theoretically the routes to purely elastic turbulence with those for inertial turbulence, leading to a richer understanding of both.

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Date submitted: 29 Nov 2005 Electronic form version 1.4