Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Nonlinear growth (and breakdown) of disturbances in developing Hagen Poiseuille flow PETER DUCK, University of Manchester — The effect of disturbances on developing Hagen-Poiseuille flow is investigated for large Reynolds numbers. In this developing region (which is long - $\mathcal{O}$(Reynolds number) $\times$ the pipe diameter), assuming uniform flow at the inlet, then boundary layers develop on the walls of the pipe, which then eventually merge downstream. Boundary layers are known to be susceptible to three-dimensional algebraic growth in the streamwise direction. In this study, non-axisymmetric disturbances are imposed on the developing flow through two alternative mechanisms: (i) the imposition of eigenstates at the pipe inlet and (ii) by means of forcing the azimuthal velocity on the pipe wall. Fully nonlinear, steady disturbances (which are known in the linear context to be the most 'dangerous') are considered. If the disturbance amplitude is sufficiently large, a solution 'breakdown' is observed, associated with a rapid growth of the high-order azimuthal modes, suggesting a possible and alternative mechanism for pipe-flow transition. Comparison is also made with the analogous effect on planar (Blasius-type) boundary layers.

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Date submitted: 28 Jul 2005 Electronic form version 1.4