Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Structural Characteristics of Transitional Flow in Microscale Capillaries K.T. CHRISTENSEN, V.K. NATRAJAN, University of Illinois — Microscopic particle image velocimetry measurements of flow through a 536 μm capillary for Reynolds numbers in the range $1900 < \mathrm{Re} < 4500$ are utilized to study the maturation of the flow from a laminar to a fully-turbulent state. Examination of the instantaneous velocity fields reveals that transitional capillary flow is composed of patches of disordered motion that are bounded by regions of flow that are nominally laminar. Consistent with that noted for transitional wall-bounded flows at the macroscale, the non-laminar fraction of the flow increases progressively with increasing Re. Further, the intensity of these disordered motions grows with Re and quadrant analysis supports a gradual maturation of the instantaneous Reynolds-shear-stress-producing events as the flow transitions toward a fully-turbulent state. Proper orthogonal decomposition of the transitional datasets indicates that the large-scale structures embedded within the disordered motions play a dominant role in the transport of both kinetic energy and Reynolds-shear-stress. Visualization of these large-scale structures reveals spatial signatures consistent with hairpin- like vortices that organize to form larger-scale hairpin vortex packets that are commonly noted in studies of transitional and turbulent wall-bounded flows at the macroscale.

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Date submitted: 04 Aug 2008

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