Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

Symmetry-breaking bifurcations and enhanced mixing in microfluidic cross-slots ROB POOLE, University of Liverpool, SIMON HAWARD, University of Porto, PAULO OLIVEIRA, Universidade da Beira Interior, MANUEL ALVES, University of Porto — We investigate, both experimentally and numerically, a new subcritical bifurcation phenomenon for a Newtonian fluid flowing through three-dimensional cross-slot geometries. At low Reynolds numbers the flow remains steady and symmetric. For the case of square inlets and outlets, at a critical Reynolds number of approximately 40 (based on average velocity) a pitchfork bifurcation is observed beyond which the unstable symmetrical solution is replaced by a pair of steady asymmetric solutions. Sensitivity of this critical Reynolds number to the initial conditions of the simulation, resulting in a small degree of hysteresis, suggests a subcritical instability. At higher flowrates the flow becomes unsteady. The effects of channel aspect ratio are investigated on the critical conditions and excellent agreement is found between three-dimensional finite volume simulations and flow visualisation experiments in microfluidic channels. Finally we suggest this new flow bifurcation could be an effective method of enhancing mixing in microfluidic channels as significant increases in mixing quality are observed beyond the bifurcation. This enhancement occurs at flowrates more than a factor of two smaller than those observed in the well-known T-channel micromixer.

Rob Poole
University of Liverpool

Date submitted: 31 Jul 2014 Electronic form version 1.4