Abstract Submitted
for the DFD14 Meeting of
The American Physical Society

A comprehensive investigation of exact coherent states in Newtonian channel flow[1] JAE SUNG PARK, University of Wisconsin-Madison, RASHAD MOARREF, BEVERLEY J. MCKEON, California Institute of Technology, MICHAEL D. GRAHAM, University of Wisconsin-Madison — Exact coherent states have been intensively investigated for better understanding of the transition to turbulence and the complex dynamics in shear flows. Here, we present five families of nonlinear traveling wave solutions in Newtonian channel flow. A Prandtl-von Kármán plot is used to characterize the solutions, in comparison to previously discovered solutions in the same geometry. One solution family shows very intriguing behavior in terms of mean profiles: its upper and lower branches appear to approach the classical Newtonian and viscoelastic turbulent profiles, respectively. On the lower branch of this solution, a spatially subharmonic bifurcation arises, giving rise to period doubling. The solutions are then considered in state space to identify connections to turbulent flow trajectories and paths of an intermittent bursting phenomenon. Lastly, a low-order representation of our exact coherent states is obtained using the resolvent mode decomposition of McKeon & Sharma (JFM, 2010). While lower branch solutions can be approximated by a few resolvent modes, typically one dominant mode, upper branch solutions need a larger number of modes. The dominant features of leading resolvent modes and the dependence of Reynolds number on those modes are further discussed.

[1]This work was supported by the Air Force Office of Scientific Research through grants FA9550-11-1-0094 and FA9550-12-1-0469.

Jae Sung Park
University of Wisconsin-Madison

Date submitted: 01 Aug 2014 Electronic form version 1.4