Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Self-similar vorticity apportionment in turbulent wall-flows JOE KLEWICKI, University of New Hampshire and The University of Melbourne — The analytical closure by Fife et al. (*J. Disc. & Cont. Dyn. Sys.* **24**, 2009) allows the mean momentum equation for turbulent wall-flows to be represented by an invariant set of nonlinear ordinary differential equations. With appropriate starting conditions, these equations are integrated over an internal domain specified by the theory, and yield solutions for the mean velocity, Reynolds stress and their derivatives. The present talk primarily investigates the affiliated similarity structure of the mean vorticity field, and, in particular, its development as a function of Reynolds number. Existing data from boundary layers ($300 < \delta^+ < 50,000$), pipes ($180 < \delta^+ < 530,000$) and channels ($180 < \delta^+ < 5,000$) are shown to exhibit the theoretically predicted mean vorticity decay rate scalings. The outward movement of the centroid of the mean vorticity distribution (with δ^+) into a region dominated by turbulent inertia is shown to coincide with the onset of the asymptotic (four-layer) dynamical regime. Evidence supporting the emergence of a self-similar relationship between the mean and rms spanwise vorticity is clarified through their relationships to the length scale distribution intrinsic to the mechanism of turbulent inertia. Overall, the results of the theory and data are discussed relative to two physically distinct mechanisms by which the velocity and vorticity field motions exhibit scale separation with increasing Reynolds number.

Joe Klewicki
University of New Hampshire and The University of Melbourne

Date submitted: 01 Aug 2011 Electronic form version 1.4