Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Mesoscaling of Reynolds Shear Stress in Turbulent Channel and Pipe Flows NOOR AFZAL — The present work deals with the exploration of prominent intermediate or mesolayer, in between traditional inner and outer layers. The Reynolds open equations of mean turbulent motion are analyzed by matched asymptotic expansions (MAE), for large Reynolds numbers. The multiscales analysis gives an additional intermediate or mesolayer in between traditional inner and outer layers, and condition for prominence of the mesolayer is analysed. The three layers asymptotic expansions in inner, meso and outer layer have been matched in two overlap domains by Izakson-Millikan-Kolmogorov hypothesis leading to open functional equations and whose functional solution contains some universal constants, which have been estimated from the extensive experimental data on fully developed turbulent channel and pipe flows. The prominent mesolayer has been analysed in terms of (i) width (in order of magnitude) (ii) Reynolds stress profile its maxima and its location as Reynolds number approaches infinity (iii) velocity profile in mesolayer domain (iv) time period of turbulent burst. The channel and pipe flow data of Zanoun (2003, Phd Thesis), DNS channel data Moser et al (1999, PoF) and pipe data of Toonder and Nieuwstadt (1997, PoF) along with several other data are analysed that supports the mesolayer theory. Comparison with Reynolds shear stress empirical relation of Panton (2005, AMR, 58,10), based on inner and outer layers giving very long expression for velocity profiles, is also presented.

Noor Afzal

Date submitted: 23 May 2005 Electronic form version 1.4