Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Non-equilibrium layers in rough-wall channel flow[1] JONATHAN MORRISON, Imperial College, DAVID BIRCH, University of Surrey, UK — Streamwise and wall-normal velocity statistics in a fully- developed turbulent channel flow over large relative roughness are examined, for $k/h = 3.9\%$, and $Re_\tau = 5130$. The surface is fully rough, $k^+ = 200$, and the appearance of a log region is demonstrated by an overlap region with inner and outer scaling, where the procedure defines a roughness lengthscale and a zero-plane displacement, $d^+ = 130$ for $\kappa = 0.41$. Although the zero-plane displacement is somewhat smaller than the roughness height, it is large relative to the thickness of the log region, $205 < (y-d)^+ < 308$. The zero-plane displacement obtained by the matching to the log law is somewhat smaller than that required for the measured shear-stress gradient to match the linear variation required by the momentum equation, and the latter does not provide a convincing log law. The reasons for this are discussed and the behaviour of the turbulence in the log region is examined, with particular reference to the maximum in the Reynolds shear stress which appears above the outermost extent of the log region. The effect of the roughness offset on the energy balance is examined: despite the appearance of the log law, it does not conform to the local-equilibrium approximation. Scaling of the velocity spectra and second- and third-order structure functions is examined: the energy balances in the log region and at the centre-line where estimates of the dissipation rate can be made are examined.

[1]EPSRC Grant EP/D037166

Jonathan Morrison
Imperial College

Date submitted: 04 Aug 2011 Electronic form version 1.4