Abstract Submitted
for the DFD12 Meeting of
The American Physical Society

Drag reduction in Turbulent Channel Flow with Longitudinal Arrays of Slip/no-slip Stripes on the Walls AMIRREZA RASTEGARI, RAYHANEH AKHAVAN, University of Michigan, Dept. of Mechanical Engineering, Ann Arbor, MI 48109-2125 — Drag reduction in channels covered with longitudinal arrays of slip/no-slip stripes on the walls has been investigated using DNS with the lattice Boltzmann method. Computations were performed in channels of size $5h \times 2.5h \times 2h$ at a $Re_b = 3600$ ($Re_{\tau 0} \approx 230$) with stripes of size $0.02 \leq g/h = w/h \leq 0.56$ corresponding to $4 \leq g^{+0} = w^{+0} \leq 128$ where $g = w$ denotes the widths of the slip/no-slip stripes and h is the channel half-width. Unlike in laminar flow, where the magnitude of DR is controlled by geometrical parameters g/h and w/h, in turbulent flow the magnitude of DR is found to scale with $g^{+0} = w^{+0}$, independent of Reynolds number. DRs of $5\%, 11\%, 18\%, 23\%, 38\%, 47\%$, and slip velocities of $U_s/U_b = 0.06, 0.10, 0.15, 0.23, 0.32, 0.37$ were observed for $g^{+0} = w^{+0} = 4, 8, 16, 32, 64, 128$, respectively. Analysis of the mechanism of DR reveals that in the LDR regime ($DR < 25\%$, $g^{+0} \leq 32$, $U_s/U_b < 0.25$), DR is due to a combination of wall-slip and change in the anisotropy structure of turbulence near the wall, while in the HDR regime ($DR > 30\%$, $g^{+0} \geq 64$, $U_s/U_b > 0.3$), DR is primarily due to cessation of turbulence production over the slip stripes due to the large slip velocities over these regions.

Rayhaneh Akhavan
University of Michigan, Ann Arbor, MI 48109-2125

Date submitted: 31 Jul 2012 Electronic form version 1.4