Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Turbulence in supersonic boundary layers at moderate Reynolds number[1] SERGIO PIROZZOLI, MATTEO BERNARDINI, Università di Roma "La Sapienza" — We study the organization of turbulence in supersonic boundary layers through direct numerical simulations at $M_\infty = 2$, $200 \le Re_\tau \le 1120$. Comparison of the velocity statistics up to fourth order shows collapse on reference incompressible data, provided the mean velocity and the velocity fluctuations are scaled to incorporate the effects of mean density variation, as postulated by Morkovin's hypothesis. Strict wall scaling is lost at high Reynolds for the "attached" flow variables, whose inner peak is found to increase with Re_τ. The modifications of the structure of the flow field that underlie this change of behavior are highlighted through flow visualizations, which substantiate the formation of large jet-like and wake-like motions in the outer part of the boundary layer, which extend their influence to the near-wall region. It is found that the typical size of the attached eddies roughly scales with the local mean velocity gradient, rather than being proportional to the wall distance, as dictated by the attached eddy hypothesis. The interactions of the large eddies in the outer layer with the near-wall region are quantified through the two-point amplitude modulation covariance, which characterizes the modulating action of energetic outer-layer eddies on other points in the same streamwise/wall-normal plane.

[1]The computational resources to perform the study were provided by CINECA.

Sergio Pirozzoli
Università di Roma "La Sapienza"

Date submitted: 11 Aug 2011 Electronic form version 1.4