Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Non-Universality of Kármán Constant. HASSAN NAGIB, IIT, KAPIL CHAUHAN, IIT, USA, PETER MONKEWITZ, EPFL, Switzerland — Flat plate boundary layer experiments at high Reynolds numbers, Re_θ >10,000, in presence of adverse and favorable pressure gradients are studied to evaluate the mean velocity profiles in the overlap region. The profiles exhibit logarithmic behavior analogous to the well documented case of zero-pressure gradient (ZPG). In contrast to the ZPG case, the pressure gradient cases exhibit systematic variations in the Kármán Coefficient κ and the additive term B, which were believed to be constant based on classical arguments. The changes in κ and B are also confirmed by very good agreement between the calculated skin friction coefficient calculated from velocity profiles utilizing relations for two-dimensional self similar flows, and that measured directly using oil-film interferometry. The variations in κ and B are not only exhibited for the clearly non-equilibrium cases of strong favorable pressure gradient (SFPG; $\beta \approx$-0.15), but also for the mild adverse and favorable pressure gradient cases, APG ($\beta \approx$0.1 to 0.3) and FPG ($\beta \approx$-0.09 to -0.15) respectively, where the skin-friction coefficient behavior is equilibrium like. The conclusions are supported by the observed changes in the shape factor H and the Coles wake parameter Π. The variations for APG and FPG are opposite in nature when referenced to the equilibrium state of a ZPG. The results are also self-consistent and in agreement with fully developed pipe and channel flows where κ values higher than in ZPG are found: $\kappa \approx$0.41 compared to 0.384.

Hassan Nagib
IIT, Chicago, USA

Date submitted: 04 Aug 2005 Electronic form version 1.4