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New insights into adverse pressure gradient boundary layers
WILLIAM K. GEORGE, MICHEL STANISLAS, JEAN-PHILIPPE LAVAL, Laboratoire de Mécanique de Lille, Univ Lille Nord de France — In a recent paper Shah et al. 2010 (Proc. of the WALLTURB Meeting, 2009), Lille, FR, Springer, in press) documented a number of adverse pressure gradient flows (APG's), with and without wall curvature, where the turbulence intensity peak moved quite sharply away from the wall with increasing distance. They further suggested that this peak was triggered by the adverse pressure gradient and had its origin in an instability hidden in the turbulent boundary layer, developing soon after the change of sign of the pressure gradient. They then offered that this may explain the difficulties encountered up to now in finding a universal scaling for turbulent boundary layers. We build on these observations, and show that in fact there is clear evidence in the literature (in most experiments, both old and new) for such a development downstream of the imposition of an adverse pressure gradient. The exact nature of the evolution and the distance over which it occurs depends on the upstream boundary layer and the manner in which the APG is imposed. But far enough downstream the mean velocity profile in all cases becomes an inflectional point profile with the location of the inflection point corresponding quite closely to the observed peak in the streamwise turbulence intensity. This does not seem to have been previously noticed.

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