Identifying Vortical Structures and Their Impact from Laboratory Studies of Wall Turbulence

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Planar velocimetry techniques, such as particle image velocimetry (PIV), provide detailed instantaneous velocity information over a plane of interest with a dynamic spatial range sufficient for resolving nearly all dynamically-significant length scales in moderate-Reynolds-number (Re) turbulent flows. Although these techniques only provide a slice through a given flow, such data, in concert with the recent development of novel analysis methods, can provide significant insight into the structural building-blocks of wall-bounded turbulent flows. This talk will highlight various eduction schemes for identifying dominant coherent structures in instantaneous planar velocity fields as well as conditional averaging methods for assessing the 'average' spatial characteristics of these structures. Representative results will be presented from laboratory PIV studies of smooth- and rough-wall zero-pressure-gradient turbulent boundary layers. While identifying the spatial characteristics of the underlying flow structure is important, understanding the role that such structures play in the evolution of wall turbulence is of equal or greater importance, particularly in the development of modeling and control strategies. To this end, the impact of coherent structures on the evolution of wall turbulence will be highlighted using conditional averaging analysis of the aforementioned PIV data sets.