THE LARGE SCALE STRUCTURE OF WALL-BOUNDED TURBULENCE WITH EMPHASIS ON PIPE AND CHANNEL FLOWS

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Recently, the high Reynolds number turbulence community has experienced a renewed enthusiasm for turbulent fluid flow through pipes and channels. This enthusiasm arose following significant advances made over the past decade, including the Princeton “superpipe” experiments [1], and high Reynolds number Direct Numerical Simulations of channel flow (e.g. Jiminez *et. al.* [2]). An important product of this duct flow resurgence is the proposal for a very high Reynolds number, large diameter pipe flow facility in Bologna, Italy (Prof. A. Talamelli from the University of Bologna heads a large international collaboration proposing this facility).

Although turbulence in ducts has received much scientific attention for centuries, there remain many unanswered questions regarding even fundamental aspects of the flow. For example, the length of pipe/channel required for full flow development has never been well-understood. Further, the large-scale structure of turbulence in pipes and channels requires further attention, and is the subject of this article. Recent Particle Image Velocimetry experiments by Adrian *et. al.* [3] have given support to the hairpin vortex model of turbulence in boundary layers. The arrangement of such vortices into packets was also proposed by [3] with further support from Marusic [4]. Recent hot-wire studies in turbulent boundary layers have confirmed the existence of extremely long structures in the logarithmic layer [5].

Here the behaviour and development of large structures in pipe and channel flows is further investigated through single and multiple hot-wire experiments conducted in large diameter/height ducts having more than sufficient length for full flow development. Instantaneous velocity fields, streamwise energy spectra, autocorrelations and two-point correlations are all analysed. Comparisons are made with similar measurements recently taken in the high Reynolds number boundary-layer wind-tunnel at Melbourne. The results highlight the important structural similarities and differences between the various wall-bounded flows and provide further valuable insights into the coherent structure of wall-bounded turbulence.

References

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