SCALING APPROACHES TO WALL-INDUCED TURBULENCE

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Multiscaling methods, relying on the largeness of a Reynolds number and Reynolds averaged equations, have for many decades been used as a guide to understanding, and even deriving approximate analytic expressions for, averaged flow quantities in turbulent flows bounded by walls. These efforts, which have often been very successful, have at least one feature which radically distinguishes them from more traditional multiscale problems: the fact that the differential equations from which they proceed are underdetermined and therefore incapable of yielding, by themselves, unique solutions [1]. Any analysis must supplement them with additional information, in the form of well grounded assumptions or empirical data.

Within this scenario, various approaches to gaining theoretical understanding of wall-bounded flows will be explained and compared. The newest such approach [1]–[4] involves the search for ”scaling patches”, and attention will be given to contrasting it with previous methods.

References

[1] P. Fife, J. Klewicki, P. McMurtry, and T. Wei “Multiscaling in the presence of indeterminacy: wall-induced turbulence,” *Multiscale Modeling and Simulation*, Vol. 4, No. 3, 2005, pp. 936-959.
[2] T. Wei, P. Fife,J. Klewicki and P. McMurtry, “Properties of the mean momentum balance in turbulent boundary layer, pipe and channel flows,” *Journal of Fluid Mechanics*, Vol. 522, January, 2005, pp. 303-327.
[3] P. Fife, T. Wei, J. Klewicki and P.McMurtry, “Stress gradient balance layers and scale hierarchies in wall bounded turbulent flows,” *Journal of Fluid Mechanics*, Vol. 532, May, 2005, pp. 165-189.
[4] T. Wei, P. Fife, J. Klewicki and P. McMurtry, “Scaling heat transfer in fully developed turbulent channel flow” *International Journal of Heat & Mass Transfer*, Vol. 48, December, 2005, pp. 5284-5296.

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