Old and new turbulent structures

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Streamwise vortices are the main flow structures of an equilibrium turbulent flow. The size of these structures scale with the Reynolds number, and becomes smaller at high Re number. When the turbulent flow is subjected to temporal acceleration, turbulent structures no longer scale with Re. The response to temporal acceleration of turbulent flow consists of two stages: the destruction of the initial turbulence, followed by the generation of *new* turbulence associated with a higher Re number. Turbulent structures become weakened initially with temporal acceleration, and gradually disappear from a large area. As the Reynolds number increases, more than half of the channel wall is devoid of active turbulent structures before the generation of new turbulence takes place. The remaining *old* turbulent structures at this Re number have a much weaker strength than in the equilibrium steady flow. The study of this flow is very challenging because the *old* and *new* turbulent structures have different sizes and strengths whilst they coexist. The interaction between the old and new turbulent structures is still not fully understood, and therefore, is the topic of this project. In this project, the characteristics of the old and new turbulent structures will be studied using a high quality turbulent channel flow database generated with DNS. The area for active new turbulence will also be measured.

In the PhD study, the turbulence generation process as well as the destruction process will be investigated using various structure analysis techniques including the λ_2 criterion of Jeong et al. (1997). The effect of the acceleration and deceleration strength on turbulent flow structures will also be investigated.

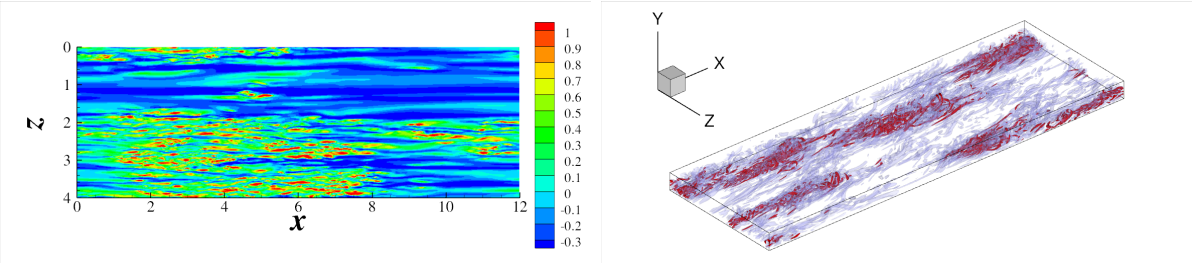

Figure 1: a) Low speed streaks, and b) iso-surfaces of λ_2 at different stages of acceleration.

References

J. Jeong, F. Hussain, W. Schoppa, and J. Kim. Coherent structures near the wall in a turbulent channel flow. *Journal of Fluid Mechanics*, 332:185–214, 1997.