THE UNIVERSITY OF MELBOURNE

Mechanical Engineering

SEMINAR SERIES 2010

Prof. Dale I. Pullin

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Wednesday 13th October, 3pm

Mechanical Engineering Lecture Theatre
Level 3, Mechanical Engineering
Building 170, Block E, Grattan St

Progress and problems in the LES of wall-bounded flows.

Progress and problems in the large-eddy simulation (LES) of wall-bounded flows will be surveyed. Special requirements for near-wall LES will be outlined and several different approaches will be described including near-wall resolved LES and various forms of near-wall modeling. LES of near-wall turbulent flows using the stretched-vortex, subgrid-scale (SGS) model will be discussed. This approach utilizes a tailored, near-wall model designed to incorporate anisotropic vorticity scales in the presence of the wall.

Specifically, an approximate analytic integration of the stream-wise momentum equation across the near-wall layer, with inner-scaling used to reduce inertial terms, leads to a hyperbolic partial differential equation for the wall shear stress. This is coupled to an SGS model of streamwise, attached vortices in the presence of the wall, constructed to capture the principal dynamical behavior of longitudinal vortices in wall-normal transport of streamwise momentum. The result is an effective slip-velocity boundary condition for the LES at a raised "virtual wall" together with a dynamical calculation of the Kármán constant. Results will be presented for LES of the spatially developing, zero pressure-gradient turbulent boundary layer at Reynolds numbers $Re = 10^3$-10^{12} (based on momentum thickness). These will include comparison with DNS, experiment and empirical extrapolations such as the Coles-Fernholz relation. An ongoing effort to apply the model to adverse-pressure gradient turbulent boundary layers will be described.

Unresolved issues for extending this methodology to moderately complex, wall-bounded turbulent flows including transition, roughness and separation will be discussed.

Professor Pullin received his PhD from Imperial College in 1974. He has held positions at the Aeronautical Research Laboratories, the University of Melbourne and the University of Queensland. His interests are theoretical and computational fluid mechanics, rarefied gas dynamics, vortex dynamics, compressible flow, shock-wave dynamics, hydrodynamic stability, turbulence and turbulent mixing, combustion.

MORE INFORMATION

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