



THE UNIVERSITY OF  
MELBOURNE

# Mechanical Engineering

SEMINAR SERIES 2008

## Prof Dale I Pullin

Theodore von Kármán Professor of Aeronautics,  
Graduate Aeronautical Laboratories, California  
Institute of Technology, CA, USA.

Monday 18th August, 3pm

Theatre 3, Level 1

Alan Gilbert Building, 161 Barry St, Carlton.

4pm, Refreshments

Conference Room, Level 4, Bldg 170

Mechanical Engineering

## Large-eddy simulation of turbulent channel flow at large Reynolds numbers.

Large-eddy simulation (LES) of turbulent channel flow will be discussed.

These LES neither resolve nor partially resolve the near-wall region. Instead, a special near-wall subgrid-scale (SGS) model is developed based on wall-normal averaging of the streamwise momentum equation, combined with local inner scaling for the mean-flow streamwise velocity. This gives an ordinary differential equation (ODE) for the wall shear stress at every wall location that is coupled to the LES. An extended form of the stretched-vortex SGS model, which incorporates the production of near-wall Reynolds shear stress produced by the winding of streamwise momentum by near-wall, attached, SGS vortices, then provides a log-like relation for the streamwise velocity at the top boundary of the near-wall, averaged domain. This allows calculation of an instantaneous slip velocity that is then used as a "virtual-wall" boundary condition for the LES. A Kármán-like constant is calculated dynamically as part of the LES.

With this closure, LES of turbulent channel flow will be presented for Reynolds numbers  $Re_\tau$ , based on the friction velocity  $u_\tau$  and the channel half-width  $\delta$ , in the range  $2 \times 10^3 - 2 \times 10^7$ . Results, including SGS-extended longitudinal spectra, will be compared with the direct numerical simulation (DNS) data of Hoyas and Jiménez at  $Re_\tau = 2003$ . Some applications of the LES code that investigate second-order velocity statistics for turbulent flow in a channel of length  $96\delta$  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

For more Mechanical Engineering seminar information contact:

Professor Ivan Marusic

Department of Mechanical Engineering

E: [imarusic@unimelb.edu.au](mailto:imarusic@unimelb.edu.au)