



THE UNIVERSITY OF
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Melbourne School of Engineering

Tewksbury Seminar

2010

Professor Ronald J. Adrian

Ira A. Fulton Professor of Mechanical & Aerospace Engineering
School for Engineering of Matter, Transport & Energy
Arizona State University
Tempe, Arizona
USA

3pm, Thursday 27th May

Mechanical Engineering Lecture Theatre
Level 3
Mechanical Engineering, Building 170

Physics and Compact Synthesis of Proper Orthogonal Decomposition.

MORE INFORMATION

For more Mechanical Engineering seminar information contact:

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POD uses two-point spatial correlations obtained empirically to generate a set of orthogonal eigenfunctions (modes) that can be used to expand a random process in an energetically optimum manner. Physical interpretation of the POD modes usually focuses on their energy spectrum and their rapid convergence property. Deeper analysis reveals a new way to identify the essential physics embedded in the modal structures. We consider POD in the inhomogeneous directions of two canonical turbulent flows: channel flow and thermal convection between parallel plates. Representing the POD modes, which resemble modulated sine waves, as an amplitude function and a phase function, it is found that there is a self-similar group of modes having similar phases functions as distance from the wall; and a non-similar group consisting of the first several most energetic (and largest scale) modes. With increasing modal order, properly scaled self-similar phase functions asymptotically approach a function that is characteristic of each type of flow, suggesting that they contain the essence of the growth of length scale from the wall. Further analysis relates this property to the distribution of dissipation.

A method of synthesizing an infinite set of orthogonal modes that is near-optimal for each type of canonical turbulent flow is developed using only the asymptotically similar phase function that characterizes that flow. In turn, the asymptotic phase function can be determined simply from the dissipation making it possible to approximate the full set of POD modes using a one-dimensional scalar function instead of the much larger two-dimensional spatial correlation function.

Ronald J. Adrian is the Ira A. Fulton Professor of Mechanical and Aerospace Engineering at Arizona State University. Professor Adrian received his Ph.D. from the University of Cambridge, in 1972 and was for many years a Professor at the University of Illinois at Urbana-Campaign, where he held the Hoeft Chair of Engineering.

Professor Adrian has made landmark contributions in the development of laser Doppler velocimetry, particle image velocimetry, stochastic estimation techniques, and in the study of turbulent flows. He is a recipient of the most prestigious awards in the field including the APS Fluid Dynamics Prize in 2005, the Nusselt-Reynolds Prize in 2001, and the AIAA Fluid Dynamics Award in 2007, amongst many others. Professor Adrian is a Fellow of the American Physical Society, Fellow of the American Institute of Aeronautics and Astronautics, Fellow of the American Academy of Mechanics, and Fellow of American Society of Automotive Engineers. Since 1996 he has been an elected member of the US National Academy of Engineering.