

04-3 IUTAM Symposium on Size Effects on Non-Uniqueness of Solutions to the Navier-Stokes Equations and their Connection with Laminar-Turbulent Transition
Manchester, UK, August 09-11, 2004

a) Scientific Committee

T. Mullin (UK, Chair), O. Dauchot (France), B. Eckhardt (Germany), D.S. Henningson (Sweden), R.R. Kerswell (UK), W. Schliehler (Germany), F.A. Waleffe (USA)

b) Short summary of scientific progress achieved

The aim of the Symposium was to bring together theoreticians and experimentalists to discuss recent developments in the study of transition to turbulence in shear flows. Over 3 days and 21 lectures (13 invited + 8 contributed), various groups from around the world presented their latest results ranging from identifying the initial optimal disturbances which can trigger transition, through to pattern formation in transitional flows and self-sustaining processes in shear flows. Issues such as how a turbulent flow can re-laminarise and transition processes in non-Newtonian flows were also discussed. Theoretical approaches involved both low-order models and full numerical simulation of the Navier Stokes equations. The experimental work was primarily concerned with plane Couette and pipe flows and there was considerable overlap with the reported theoretical work. The overarching achievement of the symposium was to highlight the increasing evidence for the appearance of alternative solutions to the Navier-Stokes equations which are not connected in any simple way to the well known exact solutions for pipe and Couette flows i.e. they are disconnected states. Evidence reported at the meeting suggests that they may be important for structuring laminar-turbulent transition in shear flows. The clear challenges identified in the meeting are to extend the theoretical support and experimental evidence for this idea and to explore whether it can be developed to make predictions about when transition will occur and what form it will take.

c) Countries represented and number of participants

32 registered participants from engineering, physics and applied mathematics communities attended the symposium. The geographical representation was as follows: 9 from the UK, 7 from France, 6 from the US, 3 from Sweden, 2 from Japan, 2 from Holland, 1 each from Germany, Belgium and Italy.

d) Publication of Proceedings of the Symposium

Full papers from the lectures are going to be published as Symposium Proceedings by Springer Science and Business Media (former Kluwer). Each submitted paper has been reviewed by either a member of the Scientific Committee or another contributing participant. There are 17 articles which will produce a proceedings volume of

approximately 250 pages. The planned publication date is August 2005 and we are on schedule to meet this.

e) Financial supports

Some funds were made available by IUTAM, the London Mathematical Society and Kluwer. The LMS funds were particularly helpful in inviting younger participants.

f) Scientific program

Monday, August 9

P. Manneville, *What can we learn from models about the direct transition to turbulence in plane Couette flow*

A. Prigent, *Turbulent-laminar versus laminar-turbulent transition: the Couette flow case*

S. Toh, *Co-supporting cycle: sustaining mechanism of large-scale structures and near-wall structures in channel flow turbulence*

D. Desmidts, *Low-dimensional dynamics of the POD eigenfunctions in the autonomous minimal channel flow*

D. Barkley, *Computational study of turbulent-laminar patterns in Couette flow*

B. Hof, *First observation of travelling waves in experimental pipe flow*

F. Waleffe, *On the scaling of the lower branch exact coherent states of plane Couette flow*

M. Graham, *Interactions between polymer dynamics and self-sustaining coherent flow structures: a model for turbulent drag reduction*

A. Morozov, *Nonlinear instabilities in flows of visco-elastic fluids*

Tuesday, August 10

J. Stuart, *The role of Reynolds' stresses, nonlinearity and vortex stretching in the evolution of singularities*

B. Eckhardt, *Strange saddles in the transition to turbulence*

L. Tuckerman, *Computational study of turbulent-laminar patterns in Couette flow: part II*

P. Cvitanovic, *Hopf's last hope: spatiotemporal chaos in terms of unstable recurrent patterns*

D. Henningson, *Thresholds and linear mechanisms in shear flow transition*

A. Bottaro, *Minimal defects*

C. Cossu, *On the minimum threshold energy and the nonlinearly-optimal perturbations in subcritical instabilities*

V. Shrira, *A bypass scenario of laminar-turbulent transition in the wind-driven free-surface boundary layer*

Wednesday, August 11

S. Tavener, *The effect of cylinder rotation on vortex shedding*

P. Alfredsson, *Instability, transition and turbulence in plane Couette flow with system rotation*

M. Nagata, *Nonlinear solutions of simple plane shear layers with and without a system rotation*

P-Y. Longaretti, *Subcritical turbulence in rotating shear flows*

Report composed by Tom Mullin and Rich Kerswell