TIME TABLE

TIME	Monday September 9	Tuesday September 10	Wednesday September 11	Thursday September 12	Friday September 13
9.00 - 9.45	Registration				
9.45 - 10.30	Vassilicos	Peinke	Y. Sakai	Peinke	S. Sakai
11.00 - 11.45	Vassilicos	Peinke	Vassilicos	Peinke	S. Sakai
11.45 - 12.30	Peinke	Lindstedt	Lindstedt	Vassilicos	Nicolleau
14.00 - 14.45	Lindstedt	Lindstedt	Lindstedt	Nicolleau	Nicolleau
14.45 - 15.30	Y. Sakai	Y. Sakai	Y. Sakai	Nicolleau	Lindstedt
16.00 - 16.45	Vassilicos	Y. Sakai	Y. Sakai	Nicolleau	

ADMISSION AND ACCOMMODATION

Applicants must apply at least one month before the beginning of the course. Application forms should be sent on-line through our web site: http://www.cism.it or by post.

A message of confirmation will be sent to accepted participants. If you need assistance for registration please contact our secretariat.

The 700,00 Euro registration fee includes a complimentary bag, four fixed menu buffet lunches (Friday not included), hot beverages, on-line/downloadable lecture notes and wi-fi internet access.

A limited number of participants from universities and research centres who are not supported by their own institutions can be offered board and/or lodging in a reasonably priced hotel. Requests should be sent to CISM Secretariat by **July 9, 2013** along with the applicant's curriculum and a letter of recommendation by the head of the department or a supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries that sponsor CISM.

Information about travel and accommodation is available on our web site, or can be mailed upon request.

Please note that the centre will be closed for summer vacation the first three weeks in August.

For further information please contact:

CISM
Palazzo del Torso
Piazza Garibaldi 18
33100 Udine (Italy)
tel. +39 0432 248511 (6 lines)
fax +39 0432 248550
e-mail: cism@cism.it
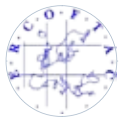
FRACTAL FLOW DESIGN: HOW TO DESIGN BESPOKE TURBULENCE AND WHY

Advanced CISM-ERCOFTAC School
coordinated by

J. Christos Vassilicos
Imperial College, London
UK

European Research Community
On Flow, Turbulence And Combustion

Udine, *September 9 - 13,* 2013

FRACTAL FLOW DESIGN: HOW TO DESIGN BESPOKE TURBULENCE AND WHY

After more than a century of exhaustive research on the aerodynamics and hydrodynamics of geometrically simple shapes, whether streamlined as in wings or bluff as in spheres and cylinders, it is blindingly natural to expect much of the future in fluid mechanics to lie in the aerodynamics and hydrodynamics of geometrically complex, and thereby multiscale, shapes. There has of course been work over the past decades on how to model and simulate complex turbulent flows, but the emphasis here is on working out the rules for the design of multiscale objects so as to obtain, by passive flow manipulation, desired effects for particular applications and for fundamental research into turbulent flows.

The simplest cases of multiscale shapes are fractal and fractal-like shapes, which is why they have been a good start in this new research area. These are multiscale shapes with a complex appearance which can nevertheless be defined with only a small number of scaling parameters.

The study of turbulent flows generated in multiscale/fractal ways includes multiscale/broadband forcings as well as multiscale/fractal boundary and/or inlet conditions. One of the ideas is to interfeer with the multiscale dynamics and inner multiscale geometry and topography of the turbulence itself or engineer a multiscale arrangement of wakes and/or jets for mixing and heat transfer enhancement. In particular, fractal grids led to the discovery of a hithero unknown non-equilibrium turbulence regime with very unusual but well-defined dissipation properties. These new dissipation properties have led to current studies of interscale transfers and vorticity-strain dynamics in spatially developing turbulent flows and a re-examination of the classical Kolmogorov (1941) equilibrium theory of turbulence. There are also reasons to expect new turbulent diffusion laws in turbulent flows generated by multiscale/fractal grids. They are therefore opening a vast scope for fruitful research.

Apart from fundamental studies there are many potential applications, including use of multiscale/fractal grids in combustion, mixing and heat transfer, fractal mixers having been refered to as super-mixers by some workers in the field. There are also flow meter applications, aerodynamic and aeroacoustic applications (fractal spoilers and wings), applications to fences and flow profilers and even fractal sunshade roofs.

The aim of this course is to present the state-of-the-art in most current aspects of this new multifaceted area of research, including experiments, theory and computer simulations. The course will include accounts of the various scientific and engineering experiments carried out in this emerging field over the past few years as well as direct numerical simulations and other computer simulation techniques which have been applied to such problems, including aeroacoustic simulations.

The target audience are graduate students, PhD candidates, Post Doctoral Researchers in Aeronautical, Chemical, Mechanical, Environmental and Civil Engineering, Applied Mathematics and Physics as well as Research Engineers working in industry. The participants are expected to have a background in some area of or involving fluid mechanics. It is hoped that everybody will be willing to participate in open debate and discussion.

INVITED LECTURERS

Peter Lindstedt - Imperial College London, UK
5 lectures on: The role of turbulence generation in combustion.
fractal and conventional turbulence generation in canonical geometries.
Flames in fractal grid generated turbulence.
Conditional flow field statistics.
Future outlook - Where do we go from here?

Franck Nicolleau - University of Sheffield, UK
5 lectures on: Introduction, presentation of existing variety of flow meter technology (eg frequency flowmeters).
Use of fractal geometry in pipes and basics of fractal geometry required, fractal flow meter concept, manufacturing techniques and issues (electric discharge machining), fractal foam.
Fractal orifices: laboratory experiments, results and analysis.
Fractal orifices: numerical simulations, results and analysis.
Numerical issues and strategies.
Main conclusions from comparisons between laboratory experiments and computations and future prospects.

Joachim Peinke - Carl-von-Ossietzky University, Oldenburg, Germany
5 lectures on: How universal is turbulence?
Fractal and active grid flow.
How turbulent is wind?
The turbulent power production of wind turbines.

Satoshi Sakai - Kyoto University, Japan
2 lectures on: History of the urban heat island.
Fractal Sunshade - How it works.

Yasuhiko Sakai - Nagoya University, Japan
6 lectures on: Wind tunnel experiments, Part 1 (Velocity field).
Wind tunnel experiments, Part 2 (CO_2 diffusion field).
Water channel experiments, Part 1 (PIV and PLIF).
Water channel experiments, Part 2 (PIV and PLIF).
DNS of regular/Fractal grid turbulence and scalar mixing, Part 1.
DNS of regular/Fractal grid turbulence and scalar mixing, Part 2.

J. Christos Vassilicos - Imperial College London, UK
6 lectures on: Parameters to design and characterise a fractal grid and its resulting flow.
Fundamentals of turbulence; dissipation and interscale transfers.
Using fractal and regular grids to study turbulence dissipation and interscale dynamics. Laboratory experiments.
Using fractal and regular grids to study turbulent vortex-strain rate dynamics. Laboratory experiments and computer simulations.
Fractal grids for energy-efficient and effective mixing and scalar transfers. Computer simulations.
Overview of fractal spoilers, low Mach number acoustic signatures of fractal grids, fractal wings and their potential applications including wind turbines. Laboratory experiments and computer simulations.

PRELIMINARY SUGGESTED READINGS

Geipel, P., Goh, K.H.H. & Lindstedt, R.P. 2010 Fractal-generated turbulence in opposed jet flows. Flow Turbul. Combust. vol. 85, 397-419.

Keylock, C.J., Nishimura, K., Nemoto, M. & Ito, Y. 2012 The flow structure in the wake of a fractal fence and the absence of an "inertial range". Environ. Fluid Mech. vol. 12 (3), 227-250.

Laizet, S. & Vassilicos, J.C. 2009 Multiscale generation of turbulence. J. Multiscale Modelling vol. 1(1), 177-196.

Nicolleau, F.C.G.A., Salim, S.M.M. & Nowakowski, A.F. 2011

Experimental study of a turbulent pipe flow through a fractal orifice. J. Turbulence vol. 12, 637046.

Suzuki, H., Nagata, K., Sakai, Y. & Ukai, R. 2010 High-Schmidt-number scalar transfer in regular and fractal grid turbulence. Phys. Scr. T142, 014069.

Valente, P. & Vassilicos, J.C. 2012 Universal dissipation scaling for non-equilibrium turbulence. Phys. Rev. Lett. vol. 108, 214503.

LECTURES

All lectures will be given in English. Lecture notes can be downloaded from CISM web site, instructions will be sent to accepted participants.

FRACTAL FLOW DESIGN: HOW TO DESIGN
BESPOKE TURBULENCE AND WHY

Udine, September 9 - 13, 2013
Application Form
(Please print or type)

Surname _____

Name _____

Affiliation_____

Address_____

_____

E-mail _____

Phone _____Fax_____

Method of payment upon receipt of confirmation (Please check the box)

The fee of Euro 700,00 includes IVA/VAT tax and excludes bank charges

❏ *I shall send a check of Euro _____*

❏ *Payment will be made to CISM - Bank Account N° 094570210900, VENETO BANCA - Udine (CAB 12300 - ABI 05035 - SWIFT/BIC VEBHIT2M - IBAN CODE IT46 N 05035 12300 09457 0210900). Copy of the receipt should be sent to the secretariat*

❏ *I shall pay at the registration counter with check, cash or VISA Credit Card (Mastercard/Eurocard, Visa, CartaSì)*

IMPORTANT: CISM is obliged to present an invoice for the above sum.
Please indicate to whom the invoice should be addressed.

Name _____

Address _____

_____

_____

C.F.*_____

VAT/IVA* No. _____
(*) Only for EU residents or foreigners with a permanent business activity in Italy.

Only for Italian Public Companies
❏ *I ask for IVA exemption (ex law n. 537/1993 - art. 14 comma 10).*

Privacy policy: I understand that data received via this form will be used only to provide information about CISM and its activities, within the limits set by the Italian legislative decree no. 196/2003 and subsequent amendments.
Complete information on CISM's privacy policy is available at www.cism.it.

I have read the "Admission and Accommodation" terms and conditions and agree.

Date _____   Signature_____