TIME TABLE

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	April 18	April 19	April 20	April 21	April 22
9.00 - 9.45	Registration	Colonius	Morris	Jordan	Roger
9.45 - 10.30	Hirschberg	Colonius	Morris	Camussi	Roger
11.00 - 11.45	Hirschberg	Hirschberg	Morris	Camussi	Roger
11.45 - 12.30	Hirschberg	Hirschberg	Jordan	Camussi	Roger
14.30 - 15.15	Hirschberg	Morris	Jordan	Camussi	
15.15 - 16.00	Colonius	Morris	Jordan	Roger	
16.30 - 17.15	Colonius	Morris	Jordan	Roger	
17.15 - 18.00	Colonius	Morris	Jordan	Roger	

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 universitites 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 **February 18, 2011** 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.

The Deutscher Akademischer Austausch Dienst (DAAD) and the Deutsche Forschungsgemeinschaft (DFG) offer support to German students. Please contact:

DAAD, Kennedyallee 50, 53175 Bonn
tel. +49 (228) 882-0
e-mail: postmaster@daad.de
web site: http://www.daad.de/de/kontakt.html

DFG, Kennedyallee 40, 53175 Bonn
tel. +49 (228) 885 2655
e-mail: ing4@dfg.de
web site: http://www.dfg.de

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

For further information please contact:

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33100 Udine (Italy)
tel. +39 0432 248511 (6 lines)
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ACADEMIC YEAR 2011
The Germain Session

Centre International des Sciences Mécaniques
International Centre for Mechanical Sciences

NOISE SOURCES IN TURBULENT SHEAR FLOWS

Advanced School
coordinated by

Roberto Camussi
Università di Roma Tre
Italy

Udine, *April 18 - 22,* 2011

NOISE SOURCES IN TURBULENT SHEAR FLOWS

The knowledge of the physical mechanisms underlying the generation of noise in turbulent shear flows remains a challenging task despite over 50 years of intensive research in the field. The interest into this topic is considerable since turbulent shear flows are encountered in many engineering applications including, for example, turbulent boundary layers with and without pressure gradients, compressible and incompressible jet flows and wakes behind streamlined or bluff bodies. The accurate knowledge of the noise generation mechanisms is a fundamental step for both theoretical modelling and practical applications leading, for instance, to the development of flow/noise manipulation techniques and noise suppression devices. Recent developments in terms of our capacity to both numerically and experimentally analyse the physics of turbulent shear flows have opened up new possibilities to improve our knowledge about the noise generation and propagation mechanisms. The aim of the course is to present a state-of-the-art review of on-going activities in noise prediction, simulation and measurement and to indicate current research directions in a way that is accessible to attendees coming from both academic and industrial areas. To this purpose, introductory lectures on fundamentals of aeroacoustics will be followed by up-to-date reviews of topics of specific interest for engineering applications. The first part of the course is denoted as "Fundamentals" and includes two lectures. The first one, opening the course, is devoted to general concepts of aeroacoustics. The second one, is again dealing with general issues but more directly correlated with the need for simulating numerically aeroacoustic problems. This lecture will deal with computational aspects but elucidates more general issues spanning from noise generation mechanisms to noise propagation in turbulent flows.

In the second part of the course, denoted as "Specific Topics", particular emphasis will be put over topics of relevant interest for engineering applications and aircraft design. These topics will include:

- Self-sustained oscillations generated, for examples, in cavity flows as a result of feed-back resonance mechanisms.
- Fundamentals and modelling of jet noise, including some references to the problem of jet noise control.
- Experimental aspects dealing with aeroacoustics measurements with emphasis not only to measurement techniques and post-processing procedures but also to methods commonly adopted for noise sources identification.
- Noise from moving surfaces, such as airfoils (self-noise and trailing edge noise) or turbine blades.
- Duct acoustics and acoustic wave propagation in closed domains.
- Boundary layer noise with particular emphasis on theoretical aspects related to the statistical modeling of wall pressure fluctuations in attached and separated wall flows.

All these arguments will be treated extensively with the inclusion of many examples of practical applications. The main objective of this course is therefore to allow an information transfer between well-known scientists, leaders in the field of aeroacoustics, and industries and laboratories. Indeed, the lecturers, coming from European countries and from US, are all leading experts in the field of aeroacoustics covering both basic theoretical aspects and the state-of-the-art in industrial high-end applications.

PRELIMINARY SUGGESTED READINGS

W.K. Blake (1986) Mechanics of Flow induced Sound and Vibration Volume II Complex Flow-Structure Interactions, New York, Academic Press.

G.M. Corcos (1964) 'The structure of the turbulent pressure field in boundary layer flows', Journal of Fluid Mechanics 18, 353-378.

W.R. Graham (1997) 'A comparison of models for the wavenumber-frequency spectrum of turbulent boundary layer pressures', Journal of Sound and Vibration 206, 541-565.

M.J. Lighthill (1952) 'On sound generated aerodynamically: general theory' , Proc. Roy. Soc 211, 564-587.

D. Crighton (1975) 'Basic principals of aerodynamic sound generation', Progress in Aerospace Sc. 16, 31-96.

P. Jordan & Y. Gervais (2008) 'Subsonic jet aeroacoustics: associating experiment, modelling and simulation', Experiments in Fluids, 44, 1-21.

T. Colonius & S.K. Lele (2004) 'Computational aeroacoustics: progress on nonlinear problems of sound generation', Progress In Aerospace Sciences , 40, 345-416.

D.J. Bodony & S.K. Lele 'Current status of jet noise predictions using large-eddy simulation', AIAA Journal, 46, 364-380.

M. Wang, J.B. Freund & S.K. Lele (2006) 'Computational prediction of flow-generated sound',

Annual Review of Fluid Mechanics, 38, 483-512.

A.D. Pierce (1989) Acoustics, Acoustical Society of America.

A.P. Dowling & J.E. Ffowcs Williams (1983) Sound and Sources of Sound, Ellis Horwood Pub., Chichester, UK.

S. Tempkin (2001) Elements of Acoustics, Acoustical Society of America.

S.W. Rienstra & A. Hirschberg (2001) An Introduction to Acoustics, report IWDE 92-06, Technische Universiteit Eindhoven, Pdf available : http://www.win.tue.nl/~sjoerdr/

G. M. Lilley (1995) 'Jet Noise Classical Theory and Experiments' in Aeroacoustics of Flight Vehicles, Vol. 1, Ed. H. H. Hubbard, Acoustical Society of America, 211_290.

C.K.W. Tam (1995) 'Supersonic Jet Noise', Annual Review of Fluid Mechanics, 27, 17_43.

C.K.W. Tam, K. Viswanathan, K.K. Ahuja & J. Panda (2008) 'The sources of jet noise: experimental Evidence', J. Fluid Mechanics, 615, 253_292.

INVITED LECTURERS

Avraham Hirshberg - Technische Universiteit Eindhoven, The Netherlands
6 lectures on: Introduction to aeroacoustics and Self-sustained oscillations of internal flows. Using the analogy of Lighthill, the basic concepts of acoustics and aeroacoustics will be introduced. The instability of internal flows due to coupling between shear layer instability and acoustic resonance will be discussed. Various industrial applications will be considered such as the role of closed side branches and diffusers.

Tim Colonius - California Institute of Technology, Pasadena, CA, USA
5 lectures on: Computational Aeroacoustics.These lectures focus on the development and application of high-fidelity computational approaches to sound generation by turbulent flows. The material will include discretization of the compressible Navier-Stokes equations and Fourier Analysis of discretization errors. Applications to jet noise, airframe noise, and cavity tones will be discussed.

Peter Jordan - Université de Poitiers, ENSMA, France
*6 lectures on: Experimental aeroacoustics and noise source identification.*The lectures will include a brief overview of aeroacoustic theory, as well as a survey of modern data-processing techniques and the information which these have provided. The lectures will be structured so as to give a sense of where we currently stand in terms of our understanding of jet noise.

Roberto Camussi - Università degli Studi Roma Tre, Italy
4 lectures on: Boundary layer noise.
The structure and relevant features of turbulent boundary layers. Mechanism of noise generation in a turbulent boundary layer. Surface-pressure fluctuations induced by boundary-layer flow and relevant predicting. Spectral features of wall pressure fluctuations in case of separation and effects of roughness and compressibility. Recent advances on wall pressure data analysis.

Philip J. Morris - Pennsylvania State University, University Park, PA, USA
7 lectures on: Jet noise: fundamentals and modeling. Following an introduction on the application of the acoustic analogy to jet noise, simple scaling laws are derived. The effects of the jet mean flow on the noise radiation are described including methods of prediction. The identification of noise sources in jets and numerical/experimental observations of jet noise are described.

Michel Roger - Ecole Centrale de Lyon, France
7 lectures on: Noise from moving surfaces. Duct acoustics. Mechanisms of generation of noise generated by rigid moving surfaces interacting with flows are described. Basic principles are discussed together with examples including rotating blades and applications to open rotors. Duct acoustic is described mainly considering simplified geometries in order to emphasise basic physical mechanisms.

LECTURES

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

NOISE SOURCES
IN TURBULENT SHEAR FLOWS

Udine, April 18 - 22, 2011
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 05418 - SWIFT/BIC AMBPIT2M - IBAN CODE IT83Z 05418 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, CartaSi)*

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 _____