

TIME TABLE

TIME	Monday	Tuesday	Wednesday	Thursday	Friday
	July 6	July 7	July 8	July 9	July 10
9.00 - 9.45	Registration	Van Heijst	Clercx	Bourgoin	Bouffard
9.45 - 10.30	Van Heijst	Van Heijst	Clercx	Bourgoin	Bouffard
11.00 - 11.45	Van Heijst	Bourgoin	Riley	Clercx	Meiburg
11.45 - 12.30	Riley	Bourgoin	Riley	Riley	Meiburg
14.00 - 14.45	Riley	Linden	Linden	Bouffard	
14.45 - 15.30	Linden	Linden	Meiburg	Bouffard	
16.00 - 16.45	Linden	Clercx	Meiburg	Meiburg	

ADMISSION AND ACCOMMODATION

The registration fee is of 575,00 Euro + VAT taxes*, where applicable (bank charges are not included).

The registration fee includes a complimentary bag, four fixed menu buffet lunches (Friday subject to numbers), hot beverages, downloadable lecture notes and wi-fi internet access.

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.

Applicants may cancel their course registration and receive a full refund by notifying CISM Secretariat in writing (by email) no later than two weeks prior to the start of the course.

If cancellation occurs less than two weeks prior to the start of the course, a Euro 50,00 handling fee will be charged. Incorrect payments are subject to Euro 50,00 handling fee.

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 or students' dormitories, if available.

Requests should be sent to CISM Secretariat by **May 6, 2015** 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.

* Italian VAT is 22%.

For further information please contact:

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 Piazza Garibaldi 18
 33100 Udine (Italy)
 tel. +39 0432 248511 (6 lines)
 fax +39 0432 248550
 e-mail: cism@cism.it



MIXING AND DISPERSION IN FLOWS DOMINATED BY ROTATION AND BUOYANCY

Advanced School
coordinated by

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Eindhoven University
of Technology
The Netherlands

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Eindhoven University
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The Netherlands

Udine July 6 - 10 2015

MIXING AND DISPERSION IN FLOWS DOMINATED BY ROTATION AND BUOYANCY

Rotation and buoyancy play an essential role in many astrophysical, geophysical, environmental and industrial flows. They influence the transition to turbulence, strongly affect large-scale (turbulent) flow properties by inducing anisotropy, and also affect boundary-layer dynamics and inertial-range turbulence characteristics. Moreover, rotation and buoyancy may have a strong impact on the dispersion of passive and active tracers and of (inertial) particles and droplets in such flows. The impact of buoyancy or rotation on transport may be direct (gravitational, centrifugal or Coriolis forces on fluid parcels or particles/droplets) or indirect by the modified flow characteristics. These impact significantly heat and mass transfer in many natural systems. Examples are (large-scale) convection processes,

transport of sediment in coastal flows, dispersion of suspended particulate matter in estuarine flows, in lakes and reservoirs, and dispersion of aerosols and pollutants in the atmospheric boundary layer. Increasing computational capabilities and the rapid development of advanced experimental measurement tools, for example optical diagnostics and particle tracking, provide highly resolved temporal and spatial data sets. This allows the exploration and analysis of more complex flow phenomena and the associated transport processes in more depth. The aim of the course is to present a state-of-the-art overview of current developments in this exciting field in a way accessible to attendees coming from a variety of fields. Relevant example are, turbulence research, (environmental) fluid mechanics,

lake hydrodynamics and atmospheric physics. Topics to be discussed during the lectures range from the fundamentals of rotating and stratified flows, mixing and transport in stratified or rotating turbulence, transport in the atmospheric boundary layer, the dynamics of gravity and turbidity currents eventually with effects of background rotation or stratification, mixing in (stratified) lakes, and the Lagrangian approach in the analysis of transport processes in geophysical and environmental flows. We have composed a team of lecturers who are able to address these topics from fundamental, experimental and numerical points of view. Moreover, part of the lectures cover fundamental aspects including a number of the basic dynamical properties of rotating and or stratified (turbulent) flows, the mathematical description of

these flows, some applications in the natural environment, and the Lagrangian statistical analysis of turbulent transport processes and turbulent transport of material particles (including, for example, inertial and finite-size effects). Four lectures are dedicated to specific topics such as transport in (stratified) lakes, transport and mixing in the atmospheric boundary layer, mixing in stratified fluids and dynamics of turbidity currents. The course is addressed to doctoral students and postdoctoral researchers, but also to academic and industrial researchers and practicing engineers, with a background in mechanical engineering, applied physics, civil engineering, applied mathematics, meteorology, physical oceanography or physical limnology.

INVITED LECTURERS

Damien Bouffard - Ecole Polytechnique Fédérale, Lausanne, Switzerland
4 lectures on: [Mixing in stratified lakes and reservoirs](#). The main mixing processes occurring in lakes and reservoirs covering aspects as density stratification in lakes, basin-scale internal wave dynamics, turbulence and mixing processes in stratified lakes, convectively driven turbulence, and small-scale measurements in lakes.

Michael Bourgoin - Université de Grenoble, France
4 lectures on: [Lagrangian dispersion of particles in turbulence](#). The Lagrangian description of turbulence, Lagrangian statistics of fluid particles, and turbulent transport of material particles. These aspects will be presented in a general framework, and will be also connected to relevant geophysical and environmental applications.

Herman Clercx - Eindhoven University of Technology, The Netherlands
4 lectures on: [Mixing and transport in rotating turbulence](#). The role of rotation on transport in turbulence with emphasis on two cases: homogeneous rotating turbulence and rotating thermally driven turbulence. Additionally, coherent structures, waves and boundary layers in rotating turbulent flows will be discussed.

GertJan van Heijst - Eindhoven University of Technology, The Netherlands
4 lectures on: [Introduction in geophysical and environmental fluid dynamics](#). Fundamental dynamical aspects of geophysical and environmental flows, which are often dominated by the planetary rotation and by density stratification. Topics include the dynamics of rotating flows, effects of stratification, turbulence and vortex structures.

Paul Linden - University of Cambridge, UK
5 lectures on: [Turbulence and mixing in flows dominated by buoyancy](#). Mixing processes in stratified fluids and gravity currents with emphasis on transition to turbulence in stratified shear flows, turbulent structures at high buoyancy Reynolds numbers, mixing efficiency and application to gravity currents.

Eckart Meiburg - University of California at Santa Barbara, CA, USA
5 lectures on: [Density and turbidity currents with applications to geophysical and environmental flows](#). Topics include: properties, simplified models, and DNS/LES studies of density/turbidity currents, mixing and dissipation, turbidity currents interacting with the seafloor and/or pipelines, density currents in stratified ambients, and double-diffusive sedimentation.

James Riley - University of Washington, Seattle, WA, USA
5 lectures on: [Mixing and transport in stratified turbulence, including transport in the atmospheric boundary layer](#). Transport and mixing in turbulent stably-stratified flows, with focus on the (stably-stratified) atmospheric boundary layer: properties of stratified turbulence, Monin-Obukov and related theories for atmospheric boundary layers, experiments and modelling results on transport and mixing in stratified flows.

PRELIMINARY SUGGESTED READINGS

B. Cushman-Roisin, Geophysical Fluid Dynamics. Prentice-Hall (1994).

S.A. Thorpe, The Turbulent Ocean. Cambridge University Press (2005).

E. Meiburg and B. Kneller, Turbidity currents and their deposits. Annu. Rev. Fluid Mech. 42, 135-156 (2010).

F. Toschi and E. Bodenschatz, Lagrangian properties of particles in turbulence. Annu. Rev. Fluid Mech. 41, 375-404 (2009).

G.N. Ivey, K.B. Winters, and J.R. Koseff, Density stratification, turbulence, but how much mixing? Annu. Rev. Fluid Mech. 40, 169-184 (2008).

L. Mahrt, Stably stratified atmospheric boundary layers. Annu. Rev. Fluid Mech. 46, 23-45 (2014).

A. Wuest and A. Lorke, Small-scale hydrodynamics in lakes. Annu. Rev. Fluid Mech. 35, 373-412 (2003).

LECTURES

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

**MIXING AND DISPERSION IN FLOWS DOMINATED
BY ROTATION AND BUOYANCY**

Udine, July 6 - 10, 2015

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 is 575,00 Euro + 22% Italian VAT taxes, where applicable (bank charges are not included).

I shall send a check of Euro _____

Payment will be made to CISM - Bank Account No. 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 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 _____