

## TIME TABLE

registration September 12 at 8.30

TIME	Monday September 12	Tuesday September 13	Wednesday September 14	Thursday September 15	Friday September 16
9.00 - 9.45	Soldati	Crowe	Soldati	Simonin	Berlemont
9.45 - 10.30	Soldati	Crowe	Soldati	Simonin	Berlemont
11.00 - 11.45	Crowe	Simonin	Reeks	Sommerfeld	Squires
11.45 - 12.30	Crowe	Simonin	Reeks	Sommerfeld	Squires
14.30 - 15.15	Reeks	Squires	Wkshop (Elghobashi)	Workshop	
15.15 - 16.00	Reeks	Squires	Wkshop (Elghobashi)	Workshop	
16.30 - 17.15	Sommerfeld	Berlemont	Wkshop (Banerjee)	Workshop	
17.15 - 18.00	Sommerfeld	Berlemont	Wkshop (Banerjee)	Workshop	

## ADMISSION AND ACCOMMODATION

The registration fee is 450,00 € for students and participants on the regular staff of universities and research centres, or 650,00 € for other participants.

Applicants must apply at least one month before the beginning of the course. Application forms can be sent by post or on-line through our web site: <http://www.cism.it>. A letter of confirmation will be sent to accepted participants.

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 12, 2005** together with the applicant's curriculum and a letter of recommendation by the head of the department or supervisor confirming that the institute cannot provide funding. Preference will be given to applicants from countries which sponsor CISM.

The Deutsche Forschungsgemeinschaft offers scholarships to German students (please contact Mr Höfeld, DFG, Kennedyallee 40, 53175 Bonn, +49 (0) 228 885 2321, <http://www.dfg.de/>).

A list of hotels in Udine is available at [http://www.cism.it/cism/hotels\\_2005.htm](http://www.cism.it/cism/hotels_2005.htm), 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

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<http://www.cism.it>

IUTAM



Thirteenth  
IUTAM Advanced School

## *DISPERSION OF PARTICLES IN TURBULENT FLOWS*

Coordinated by

**A. Soldati, University of Udine, Italy**  
**M. Reeks, University Newcastle, UK**

**Udine, September 12 - 16, 2005**

CISM  
International Centre for Mechanical Sciences

IUTAM  
International Union  
for Theoretical and Applied Mechanics

## DISPERSION OF PARTICLES IN TURBULENT FLOWS

Turbulent dispersed particle flows play a part in several technological areas. Indeed since the individual particle motion can involve the transport and exchange of mass, momentum and heat with the carrier fluid, insights into detailed physics of this motion and how it influences and is influenced by its surroundings can lead to significant technological advancements. For instance, control of micron size particle emission and dispersion is now a major concern for the urban and environmental authorities and represents a major challenge for the automotive industry, power industry and in general dusty manufacturing industry. In the pharmaceutical and process industries, many of the processes involved depend critically upon the mixing and dispersion of suspended particles in turbulent flows. Also turbulent dispersion of inertial particles is a crucial process in cloud formation, ocean-atmosphere coupling phenomena, sediment entrainment and many other environmental processes.

The object of this course is to cover the current methodologies for the prediction of turbulent dispersed reacting flows. Specific attention will be devoted to the modelling aspects and to the physical phenomena involved. Turbulent structure and the several "turbulence" simulation methodologies, particle fluid interaction and the several modelling approaches, will be specifically addressed. The course will also be focused and will help to identify the research needs for the advancement of this fundamental discipline in fluid mechanics.

The course is organized to allow time for questions, discussions and profitable interactions among all participants. Specifically, two afternoon sessions will be organized as workshop with main invited lectures by outstanding scientists in the field as Prof. Said Elghobashi and Prof. Sanjoy Banerjee, and invited or open lectures. The course is addressed to scientist, professionals and graduate students in the several fields of Engineering, Applied and Fundamental Sciences with specific interest in these phenomena.

## INVITED LECTURERS

**A. Berlemont** - INSA de Rouen, France

*4 lectures on:* Particle Lagrangian tracking; level set method for interface tracking for coalescence, break up of droplets or liquid layers.

**C. Crowe** - School of Mechanical and Materials Engineering, Washington State, USA

*4 lectures on:* Particle-fluid interaction; the ways by which a particle can exchange mass, momentum and energy with surrounding fluid will be discussed beginning with the single particle equations and moving onto the coupling between phases. Definitions will be given of the coupling parameters as they appear in the mass-momentum and energy equations of either phase.

**M. Reeks** - European Joint Research Centre Institute for the Environment and Sustainability, Ispra, Italy

*4 lectures on:* Derivation of the Eulerian two-fluid equations for dispersed particle flows: particular consideration will be given to methods of averaging for clouds of particles and how these can be used to obtain the averaged equations for both the dispersed and continuous phases. The problem of closure of the equations will be addressed and how these have been resolved using various models for the dispersed phase as a fluid. The problem of boundary conditions / near wall behaviour will also be discussed as necessary adjuncts of the two-fluid equations.

**O. Simonin** - Institut de Mecanique des Fluides de Toulouse, France

*4 lectures on:* Statistical and continuum modelling of turbulent reactive particulate flow: the first part of the lecture will be concerned with the derivation of the Eulerian two-fluid equations using the probability density function kinetic equation including both particle-fluid and particle-particle interactions. The second part will deal with the application of a two-phase second moment transport model for the prediction of turbulent gas-particle flows.

**A. Soldati** - Università di Udine, Italy

*4 lectures on:* Identification and Dynamics of Turbulence Structures. Particle Interactions with Turbulence Structures. Direct Numerical Simulation and Particle Lagrangian Modelling. Dynamics of particles in Turbulent boundary layers.

**M. Sommerfeld** - Universität Halle-Wittenberg, Germany

*4 lectures on:* Recent advances of modelling in the frame of the Euler/Lagrangian approach. Behaviour of non-spherical particles. Lattice-Boltzmann calculations.

**K. Squires** - Arizona State University, USA

*4 lectures on:* Large Eddy Simulations; Particle Collision/Coalescence in the frame of Euler/Lagrange Modelling.

## PRELIMINARY SUGGESTED READINGS

C.T. Crowe, M.Sommerfeld, and Y.Tsuji (1998) Multiphase flows with droplets and particles. CRC Press, NY.

J.K. Eaton, and J.R. Fessler, Preferential concentration of particles by turbulence, International Journal of Multiphase Flow (20) (1994), 169—209.

E.Loeh, Numerical approaches for motion of dispersed particles, droplets and bubbles, Progress Energy Combustion Science (26) (2000), 161—223.

## LECTURES

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

**DISPERSION OF PARTICLES IN TURBULENT  
FLOWS**

**Udine, September 12 - 16, 2005**

**Application Form**

(Please print or type)

Surname \_\_\_\_\_

Name \_\_\_\_\_

Affiliation \_\_\_\_\_

Address \_\_\_\_\_

E-mail \_\_\_\_\_

Phone \_\_\_\_\_ Fax \_\_\_\_\_

**Method of payment upon receipt of confirmation**

(Please check appropriate box)

- I shall send a check of Euro 650,00 / 450,00  
VAT (IVA) included and bank charges excluded
- Payment will be made to CISM - Bank Account N° 094570210900,  
VENETO BANCA - Udine (CAB 12300 - ABI 05418 - SWIFT 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)\* \_\_\_\_\_

(\*) Only for EU residents or foreigners with a permanent business activity in Italy.

**Privacy policy:** I understand that, according to the Italian law 675/96 in defence of privacy, personal data will be used exclusively for CISM's activities; any other use will require my explicit authorisation.

**Cancellation policy:** I have read the "Admission and Accommodation" terms and conditions and agree to the policy.

Date \_\_\_\_\_ Signature \_\_\_\_\_

**Please return to:** CISM, P. Garibaldi 18 - 33100 UDINE (Italy)