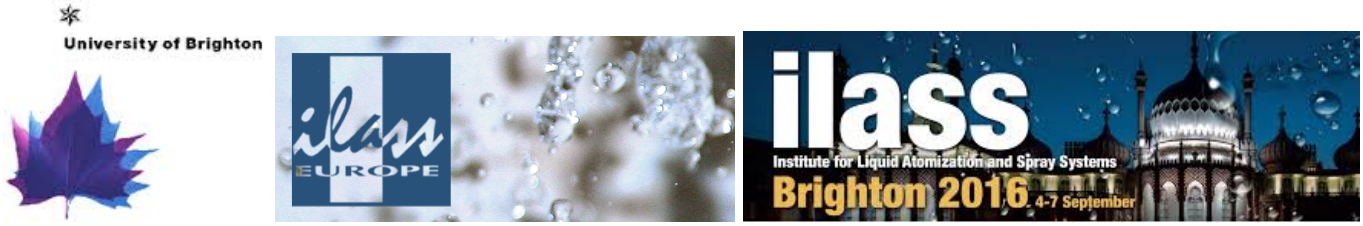

International Advanced Course in Liquid Interfaces, Drops and Sprays (LIDESP IV)

Brighton, UK, 30th Aug – 2nd Sept 2016
www.ilass2016.org

International Course Directors
A. Amirfazli, V. Bertola, M. Marengo

COURSE DESCRIPTION

LIDESP is an International Advanced Course on the Interface, Drops and Liquid Sprays Physics, which is held every year in different locations around the world. The core of the lecture plan is provided by three well-known and highly recognized experts in the field: Prof. Amirfazli, York University, Toronto, Canada, Prof. Bertola, University of Liverpool, UK, Prof. Marengo, University of Brighton, UK. They not only deliver part of the instructional module, but also every year, depending on the venue, different modules of the program are taught by local experts, under the coordination of Host Directors.

The **knowledge** of the physics of liquid drops and sprays is essential for many applications, from aeronautics (icing) to oil extraction (effervescent spray, drop collisions in pipes), from electronics (spray cooling) to agriculture (pesticide distribution), from microfluidics (droplet management) to painting processes (spray coating), from biology (blood droplets, sterilization) to thermal transfer (condensation in heat exchangers), from chemistry (drying tower) to medical applications.
The course **objective** is to provide the participants with today's detailed knowledge on the physics of drops and sprays based on recent research results and the most updated methods for the prediction of dynamic outcomes, heat transfer, wettability effects, and its applications to technological and industrial areas. Specific attention will be paid to the applications in life science, such as microdroplet management. Application to chemical processes will be dealt with special care in view of the industrial interest towards this component, while the very recent application of drop management in microscale, including microstructured surfaces will be treated in detail. In terms of mathematics and physics, the course is at the level of a good Postgraduate and Ph.D. degree.
This time the course has also a special high level part about **engine sprays**, which could be taken as stand alone and paid as **1-day module**.

The course is addressed to scientists, professionals, company engineers, R&D managers and graduate students in the fields of Engineering, Chemistry, Biology, Medicine, Applied and Fundamental Sciences. This course is especially of interest to those dealing with phenomena involving drops and sprays, in order to get acquainted with the traditional background and the most recent developments of this discipline.

The pre-requisites are a preparation in Mathematics and Physics equivalent to a Master Degree in Engineering. Physics or Chemistry and a good university preparation in fluid-dynamics and heat transfer.

The course is sponsored by the European Institute of Liquid Atomization and Spray Systems (ILASS EUROPE) and the Advanced Engineering Centre (AEC) of the University of Brighton.

COURSE PROGRAM

	Tue – 30/8	Wed – 31/8	Thu – 1/9	Fri –2/9*	
	Introduction	Drop Physics 1	Drop Physics 2	Liquid Sprays	Engine sprays
8.30-9.00	Registration				
9.10 - 10.00		D2 – MM3	A1 – AA5	S1 – MM6	
10.00-10.50	I1 – AA1	D2 – MM4	A1 – AA6	S1 – MM7	
10.50-11.10	*Coffee break*	*Coffee break*	*Coffee break*	*Coffee break*	
11.10-12.00	I1 – AA2	D3 – VB2	NN1 – VB5	S2 – CC1	
12.00-12.50	I2 – MM1	D3 – VB3	NN1 – VB6	S2 – CC2	
12.50-13.30	*Lunch*	*Lunch*	*Lunch*	*Lunch*	
13.30-14.20	I2 – MM2	D4 – SS1	D7 – AG1	S3 – NN1	ES1 – CC3
14.20-15.15	I3 – VB1	D4 – SS2	D7 – AG2	S3 – NN2	ES1 – CC4
15.15-15.30	*Coffee break*	*Coffee break*	*Coffee break*	*Coffee break*	*Coffee break*
15.30-16.40	D1 – AA3	D5 – VB4	ES2 – SS3	NN3 – VB8	ES3 – NN3
16:40-17.30	D1 – AA4	D6 – MM5	A2 – VB7	A3 – AA7	ES3 – NN4
17.30-18.15	**INDIVIDUAL - GROUP CONSULTATION**			**VISIT TO THE SHRL LABS**	**SOCIAL DINNER**

* In green the 1-day module. The participant can decide which of the two sections would like to join.

CONTENTS

I1 *Introduction and basic concepts.* Gallery of basic phenomena, micro- to macro- scale (molecular dynamics/continuum approaches), contact angle, Young equation, Laplace pressure, Free Gibbs Energy, Marangoni effects – **Amirfazli**

I2 *Introduction to fluid mechanics of liquid interfaces.* Basic equations, Navier-Stokes equations for capillary flows, liquid jet break-up – **Marengo**

I3 *Surface tension & measurement techniques.* Equilibrium and dynamic surface tension. De Nouy/Wilhelmy, sessile drop and pendant drop (ADSA), maximum bubble pressure. – **Bertola**

D1 *Dynamics of drops deposited on a surface.* Sessile drops, spreading law, apparent and real contact angles. Drop shedding, contact angle hysteresis – **Amirfazli**

D2 *Introduction to drop-wall interactions*. Drop impact on dry and wetted surfaces. Morphology. Shallow and thick layers. Splashing correlations. **Marengo**

D3 *Drop impact with a solid surface*. Impact regimes, impact models, drop rebound. **Bertola**

D4 *Heat and mass transfer in drops.* Mono-component droplet heating and evaporation. Abramzon and Sirignano model. **Sazhin**

D5 *Drop impact on heated surfaces.* Introduction to drop impact onto heated surfaces. Impact regime maps. Transitions. Dynamic Leidenfrost temperature. Control of secondary atomization and splashing. – **Bertola**

D6 *Drop-drop collision.* Phenomenology and collision regimes. Survey of modelling and simulation results - **Marengo**

A1 *Superhydrophobicity.* Application of superhydrophobic surfaces. Cassie-Wenzel and competing theories. Types of SHS and manufacturing techniques. Impact on SHS surfaces. Impalement transition – **Amirfazli**

NN1 *Introduction to non-Newtonian fluids*. Constitutive models and practical examples (polymer solutions and melts, gels, etc.). Power-law fluids, viscoplastic fluids, viscoelastic fluids. Non-Newtonian fluid design. Elements of rheological measurements. – **Bertola**

D7 *Survey of Direct Numerical Simulation (DNS) methods for interfacial flow phenomena.* Basic equations. VOF and LS techniques, Interfaces with phase change. **Georgoulas**

NN2 *Impact of non-Newtonian drops*. Formation of non-Newtonian droplets by capillary breakup. Impact of power-law and viscoplastic drops on solid surfaces. Impact of dilute polymer solution drops. Dynamic wetting. – **Bertola**

A2 *Applications of what you learned in the course:* (a) Inkjet technology: Design of printheads, waveforms, ink formulations (b) Metal deposition, (c) 3D printing, (d) Microlens manufacturing, – **Bertola**

S1 *Physics of sprays and applications.* Spray formation, atomization models. Evaporation, gas entrainment, impact. – **Marengo**

S2 *Spray characterization*. Measurement of drop size and drop flux densities. Optical techniques. Counting and integral methods. Point and planar techniques. Advantages and disadvantages. – **Crua**

S3 *VOF modelling.* Wettability models, film splashing and single droplet evaporation. - **Nikolopoulos**

NN3 *Non-Newtonian sprays.* Capillary breakup with non-Newtonian fluids. Characteristics of non-Newtonian sprays – **Bertola**

A3 *Other applications:* (e) Icing and anti-icing techniques. Formation of ice, morphology. Applications (aircraft, helicopter, wind turbine, cables). Anti-icing and de-icing strategies. – **Amirfazli**

ES1 *Fuel sprays*. Nozzle flow, atomization, evaporation, sub- and super-critical mixing of liquid fuels. **Crua**

ES2 *Multi-component droplet heating and evaporation*: application to automotive fuel droplets. **Sazhin**

ES3 *Numerical simulation of spray development*: basics and applications to droplet impacts onto catalytic particles in Fluid Catalytic Crackers - **Nikolopoulos**

LECTURERS

Prof. Alidad Amirfazli

Before joining the York University as the founding Chair of the Department of Mechanical Engineering, Alidad Amirfazli held the Canada Research Chair in Surface Engineering at the University of Alberta, Canada. Amirfazli has produced exciting results in wetting behavior of surfaces, drop adhesion and shedding, understanding and application of superhydrophobic coatings. He has more than 200 scientific contributions, many in prestigious peer reviewed journals; he is the **Editor for the Advances in Colloid and Interface Science**. Dr. Amirfazli has been the recipient of the Martha Cook Piper Research prize, Killam Annual Professorship, and Petro-Canada Young Innovator Award. He also served in the board of Professional Engineers of Alberta, and been a consultant with various companies in USA, Europe, and Canada.

Prof. Volfango Bertola

Joined the University of Liverpool in 2011, after holding a Lectureship at the University of Edinburgh (2004-1011) and a Marie Curie Fellowship at the Ecole Normale Supérieure in Paris (2001-2004). In 2009-10 he was Visiting Professor and Lagrange Fellow at Politecnico di Torino (Italy). He has more than 100 scientific publications in the areas of soft matter, multiphase flows, and thermodynamics, including several contributions on non-Newtonian drops and on the dynamic wetting of complex fluids. He has been the recipient of a Royal Academy of Engineering Global Research Award (2009) and the UIT Young Scientist Prize (2001).

Prof. Marco Marengo

Graduated in Physics at the University of Turin cum laude and completed his Ph.D. studies at the Polytechnic of Milan and University of Erlangen with a thesis about "Drop Impingement on Liquid Film". He was awarded by the Deutscher Akademischer Austauschdienst (DAAD) and by the European Community TMR Program. From 1998 to 2002 he was assistant professor of Thermal Physics at the University of Bergamo and then Associate Professor. From 2003 to 2005 he was the University Responsible for the European Research. Since 2009 he is European Editor of the Journal "Atomization & Sprays". Visiting Professor at the University of Mons-Hainaut since 2005. He published more than 200 scientific papers, many in peer-reviewed journals about liquid sprays, drop impact, heat pipes, building physics. He has received more than 30 invitations for plenary lectures and department seminars. Prof. Marengo is founder of two spin-off companies and holds seven patents.

Prof. Sergei Sazhin

Professor Sergei Sazhin has received his PhD in St Petersburg State University (Russia) in 1977. Currently, he is working as Professor of Thermal Physics in the University of Brighton. He is serving as an editorial member of International Journal of Engineering Systems Modelling and Simulation (2007-present), Journal of Irrigation and Drainage Systems Engineering (2012-present) and Journal of Advances in Mechanical Engineering and Sciences (2015-present) & expert reviewer for numerous international journals and conferences. He has authored of more than 460 publications, including 3 monographs and 216 papers in international refereed journals. His current ISI Web of Science citation index is 27. He has supervised 14 successful Ph.D. completions over the past 15 years. He is a Fellow of the Institute of Physics (UK) since 1994. His current research concerns the development of new physical models applied to fluid dynamics and heat/mass transfer processes in internal combustion engines.

Dr. Cyril Crua

Graduated in Mechanical Engineering and completed his Ph.D. at the University of Brighton with a thesis on "Combustion Processes in a Diesel Engine". He was awarded the Richard Way Memorial Prize for the best Ph.D. Thesis on Automotive Engineering by the UnICEG (UK Universities Internal Combustion Engine Group). Dr Crua is now a Reader at the Sir Harry Ricardo Laboratories within the University of Brighton's Advanced Engineering Centre. He has 17 years' experience with a focus on experimental fluid dynamics, and particularly on the development and application of optical measurement techniques to investigate the physics of complex flows and atomization.

Dr. Nikos Nikolopoulos

Graduated in Mechanical Engineering and completed his Ph.D. at the National Technical Univeristy of Athens with a thesis on "Numerical Investigation of the induced Fluid Flow around a Droplet during its impact". Currently he is working as a Senior Researcher in the Centre for Research and Technology Hellas, Greece. He was awarded two years ago a Marie Cuire Invidual Fellowship by the EC on the subject of droplet impingement onto non-flat surfaces and conducted his research at the CITY University of London. He has 15 years' experience with a focus on numerical fluid dynamics, and particularly on the development of numerical algorithms for the phase change phenomena applicable in liquid droplets and the combustion of solid fuels. He has published more than 85 scientific papers in peer-reviewed journals and conferences about liquid sprays, drop impact, solid fuels and power plants.

Dr. Anastasios Georgoulas

Anastasios N. Georgoulas received a M.Sc. Degree in Structural Engineering in 2003 at Dept. of Civil Engineering, Edinburgh Heriot-Watt University, Scotland, a M.Sc. Degree in Hydraulic Mechanics in 2006 from the Dept. of Civil Engineering, Democritus University of Thrace, Greece, and in 2010 his Ph.D. degree in the Dept. of Civil Engineering, Democritus University of Thrace, Greece in Computational Fluid Dynamics of Multiphase flows. On May 2013, he was appointed as a Marie Curie Fellow at the Laboratory of Thermal Physics, University of Bergamo, in Italy. June 2014 - May 2015 he was seconded to Caterpillar Inc (Peterborough, UK). After a short return-phase as a Marie Curie Fellow at the University of Bergamo, from Sept 2015 he has been appointed as Senior Lecturer at the School of Computing, Engineering and Mathematics in the University of Brighton (UK). He has been involved in various national and international research projects.

REGISTRATION FEES (GBP)

	FULL	ILASS Delegate	1-Day Module
Academic (tenure, post-doc, researcher)	800	600	300
Ph.D students	600	400	300
Industry (VAT exempt)	1,200	800	500

The fees include lunches, social dinner and coffee breaks. Registration is open from 1st February 2016 to **30th June 2016**. Maximum number of participants: **40.** Special requests for accomodation will be considered by the organization staff.

TO REGISTER: Applicants should register online at www.ilass2016.org

VENUE

The workshop will take place at Moulsecoomb Campus, Lewes Road, University of Brighton

How to find us (public transport)
https://www.brighton.ac.uk/about-us/contact-us/maps/brighton-maps/moulsecoomb-campus.aspx

FURTHER INFO: Prof. Marco Marengo, m.marengo@brighton.ac.uk