17th European Turbulence Conference

TORINO • Italy  September 3 - 6, 2019
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Endorsed by

CAMERA DI COMMERCIO INDUSTRIA ARTIGIANATO E AGRICOLTURA DI TORINO

POLITECNICO DI TORINO

Università di Torino
Dipartimento di Fisica dell’Università di Torino

REGIONE PIEMONTE

CITTÀ DI TORINO

UNIVERSITÀ DEL PIEMONTE ORIENTALE
Welcome to ETC17!

On behalf of the Euromech Committee for the Euromech European Turbulence Conference we welcome you to the 17th European Turbulence Conference.

After 25 years, with this conference we return to Italy. We are thankful to the University and the Politecnico of Torino to host this event and to the local committee for the work in preparation of the conference. Over the years the Euromech European Turbulence Conference has grown to the most visible and prominent place to present results and developments in the research on turbulence, next to the Meetings of the Division of Fluid Dynamics of the American Physical Society.

We are happy to welcome over 500 participants from more than 30 countries, and are looking forward to the 480 oral presentations (of which 200 from PhD students) and of course the 8 keynote lectures.

Dan Henningson
Guido Boffetta
Daniela Tordella
Chairs
Guido Boffetta, Università di Torino, Italy
Daniela Tordella, Politecnico di Torino, Italy

Scientific Secretary
Miguel Onorato, Università di Torino, Italy

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Guido Boffetta, Dipartimento di Fisica, Università di Torino, Italy
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Rich Kerswell, Bristol University, School of Mathematics, UK
Patrice Le Gal, IRPHE-CNRS, Marseille, France
Szymon Malinowski, Institute of Geophysics, University of Warsaw, Poland
Heinz Pitsch, Institut für Technische Verbrennung, RWTH Aachen University, Germany
Federico Toschi, Fluid Dynamics Laboratory, Eindhoven University of Technology, The Netherlands

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Daniela Tordella, Politecnico di Torino
Filippo De Lillo, Università di Torino
Enrico Ferrero, Università del Piemonte Orientale
Massimo Germano, Politecnico di Torino
Daniela Grasso, ISC-CNR and Politecnico di Torino
Michele Iovieno, Politecnico di Torino
Daniele Marchisio, Politecnico di Torino
Andrea Mazzino, Università di Genova
Luca Mortarini, ISAC-CNR
Miguel Onorato, Università di Torino
Lamberto Rondoni, Politecnico di Torino
Silvia Trini Castelli, ISAC-CNR
Marco Vanni, Politecnico di Torino
Eckart Meiburg  
Mechanical Engineering, University of California, Santa Barbara, USA  

h.16:00 • Instabilities and high-resolution simulations of particle-laden flows

The talk will survey some current research directions in the field of particle-laden flows, such as double-diffusive sedimentation, settling-driven instabilities, and grain-resolving simulations of cohesive and non-cohesive sediment transport.

Claudia Cenedese  
Woods Hole Oceanographic Institution, USA  

h.16:45 • Enhanced mixing and entrainment in turbulent plumes and gravity currents

Turbulent plumes and gravity currents often occur in geophysical settings, like subglacial discharge buoyant plumes rising on the face of a marine terminating glacier and dense currents descending the continental slope in the ocean. Understanding the mechanisms regulating the entrainment and mixing in these flows is essential to formulate correct and physically driven parameterizations of these processes which are not resolved in general circulation and climate models. The amount of mixing with surrounding waters in dense currents dictates the final properties of these currents, and thus is of fundamental importance to the understanding of the formation of deep water masses. Turbulent subglacial discharge plumes entrain ambient warm water hence enhancing the glacier face melting.

Novel laboratory experiments have highlighted mechanisms by which mixing and entrainment in turbulent plumes and gravity currents can be enhanced by the presence of particles and bottom rough topography, respectively.
Dwight Barkley  
*Mathematics Institute, University of Warwick, UK*

**h.8:30 • The subcritical route to turbulence**

Understanding the route to turbulence has been a long and tortuous journey. After years of missteps, controversies, and uncertainties, we are at last converging on a unified and fascinating picture of transition in flows such as pipes, channels, and ducts. Classically, subcritical transition (such as in a pipe), was thought to imply a discontinuous route to turbulence. We now know that this is not the case - subcritical shear flows may, and often do, exhibit continuous (second-order) transition. I will discuss recent developments in experiments, simulations, and theory that have established a deep connection between transition in subcritical shear flows and a class of non-equilibrium statistical phase transitions known as directed percolation. I will then focus on what takes place above the percolation transition and discuss in detail the persistent controversy over the physical mechanisms underlying the transitions process. Finally, I will end with thoughts on outstanding open questions in the field.

Sylvain Joubaud  
*Laboratoire de Physique, ENS Lyon*

**h.9:15 • Toward internal gravity wave turbulence: an experimental approach**

Internal gravity waves play an important role in various geophysical flows. Oceans or atmospheres are indeed stratified in density and support the propagation of such waves. They significantly contribute in the mixing of the ocean, the redistribution of energy and momentum in the middle atmosphere or the transport of sediments and plankton. The subsequent mechanism for the energy transfer from large scales of the injected energy to small scales where dissipation occurs is therefore a critical issue in the dynamics of the ocean or the atmosphere, and also an important fundamental question. In this talk, we will present recent experimental development of the non-linear interaction of internal gravity waves. More precisely, we will discuss the triadic resonant instability (TRI). This process corresponds to the destabilization of a primary wave with the spontaneous emission of two secondary waves of lower frequencies and different wavelengths. Furthermore, we will focus on the fate of internal gravity waves in a trapezoidal geometry of the confined fluid domain. The peculiar dispersion relation of these waves lead to strong variation of the wave beam upon reflection on a slope. In such a configuration, the focusing of internal waves prevails, leading to convergence of internal wave rays toward closed loops, the internal wave attractors. The high concentration of energy in attractors make them prone to instabilities and, in particular, the TRI. We will show that this experimental set-up models a cascade of triadic interactions and provide an efficient energy pathway from global scale motions to small scale overturning events, which induces significant mixing. This energy cascade will finally be investigated within the framework of wave turbulence.
Olga Shishkina  
*Max Planck Institute for Dynamics and Self-Organization, Goettingen, Germany*

**h.8:30 • Structures and scalings in natural thermal convection**

Wind dynamics and boundary layers in natural convection are studied by examples of Rayleigh-Benard, vertical and horizontal convection. For particular flow configurations, it is possible to derive the scaling relations for the mean heat and momentum transport and also the mean flow field profiles from the boundary-layer equations. The obtained theoretical results are illustrated by direct numerical simulations of turbulent natural convection with a particular focus on low-Prandtl-number fluids.

Jerry Westerweel  
*Technical University, Delft, The Netherlands*

**h.9:15 • Experimental investigation of turbulence and complex flows**

Over the last 30 years, particle image velocimetry, or PIV, has developed into an experimental tool that is common in almost every experimental fluid mechanics laboratory. Initial applications could only provide partial velocity information in a planar cross section of with a resolution of only about a thousand data points. Nowadays, with high-speed lasers and multiple high-speed cameras it is possible to capture the fully instantaneous velocity field in a volumetric domain with a high spatial and temporal resolution, which also allow experimental access to the instantaneous spatial distribution of vorticity. These qualities have enabled new insights into turbulent flows, and several examples will be discussed. But beyond turbulent flows, PIV has also been applied to other complex flows, such as biological flows, and a few examples will be presented as well.
Luca Brandt  
*KTH Mechanics, Stockholm, Sweden*

**h.8:30 • Turbulent channel flow laden with finite-size particles**

We will present recent numerical and experimental results on the turbulent channel and pipe flow of a suspension of rigid particles of different size and shape, all larger than the smallest turbulent eddies. Simulations have been performed via an immersed boundary method, whereas experimental data concern fluid and particle velocities obtained flowing hydrogel refraction index matched particles in a square duct and pressure drop in pipes. We will relate the turbulent drag to the particles dynamics, rotation rates and wall-normal migrations and discuss the modulation of turbulence induced by the particles, in particular the quenching of fluctuations at the channel core. Results on flows over elastic wall will also be used to reveal the role of the near-wall fluid-solid interactions. The stress budget will be examined to define different flow regimes. Finally, we will consider heat transfer in a particle suspension and show how the presence of a suspended phase alters the turbulent heat transport in a way surprisingly distinct from the momentum transfer.

Nicholas Hutchins  
*Department of Mechanical Engineering, University of Melbourne, Australia*

**h.9:15 • Turbulent boundary layers developing over rough surfaces: from the laboratory to full-scale systems**

An overview of recent work on the problem of turbulent boundary layers developing over surface roughness will be given. This includes experimental laboratory studies, numerical simulations and recent attempts at full-scale in-situ measurements on the hull of an operating ship. An overarching aim here is to be able to make full-scale predictions of the penalty (economic / environmental / performance) resulting from surface roughness on the hulls of operating ships.
### Tuesday, September 3rd

<table>
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<tr>
<th>Time</th>
<th>Event</th>
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<tbody>
<tr>
<td>15:30 - 16:00</td>
<td>Opening ceremony</td>
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| 16:00 - 17:30 | Invited speaker • Instabilities and high-resolution simulations of particle-laden flows. Eckart Meiburg  
                       Invited speaker • Enhanced mixing and entrainment in turbulent plumes and gravity currents. Claudia Cenedese |
| 18:00      | Welcome cocktail reception (Campus Cittadella, Corte Interrata)        |

### Wednesday, September 4th

<table>
<thead>
<tr>
<th>Time</th>
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| 8:30 - 10:00 | The subcritical route to turbulence. Dwight Barkley  
                       Toward internal gravity wave turbulence: an experimental approach. Sylvain Joubaud |
| 10:00      | Coffee break                                                          |
| 10:45 - 12:45 | Multiphase Flows 1  
                       Instability, Transition and Control of Turbulent Flows 1  
                       Wall Bounded Turbulence 1  
                       Turbulent Convection 1  
                       Intermittency and Scaling 1  
                       Rotating Flows 1  
                       Numerical Methods and Data Analysis 1  
                       Two-dimensional Turbulence 1  
                       Complex and Active Flows |
| 12:45      | Lunch                                                                 |
| 14:00 - 15:45 | Multiphase Flows 2  
                       Instability, Transition and Control of Turbulent Flows 2  
                       Wall Bounded Turbulence 2  
                       Turbulent Convection 2  
                       Boundary Free Turbulence 1  
                       Stratified Flows 1  
                       Turbulence, Waves and Instabilities in Plasmas  
                       Transport and Mixing 1  
                       Non-Newtonian Flows 1 |
| 15:45      | Coffee break                                                          |
| 16:15 - 18:15 | Multiphase Flows 3  
                       Instability, Transition and Control of Turbulent Flows 3  
                       Wall Bounded Turbulence 3  
                       Turbulent Convection 3  
                       Boundary Free Turbulence 2  
                       Stratified Flows 2  
                       Numerical Methods and Data Analysis 2  
                       Transport and Mixing 2 |
<p>| 18:00      | Cocktail reception at the University Rectorate                        |</p>
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<tr>
<th>Time</th>
<th>Activity</th>
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<td>8:30 - 10:00</td>
<td>Invited speaker • Structures and scalings in natural thermal convection. Olga Shishkina&lt;br&gt;Invited speaker • Experimental investigation of turbulence and complex flows. Jerry Westerweel</td>
<td>AULA MAGNA</td>
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<td>10:00</td>
<td>coffee break</td>
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<td>10:45 - 12:45</td>
<td>Multiphase Flows 4, Non-Newtonian Flows 2, Wall Bounded Turbulence 4, Compressible Flows 1, Boundary Free Turbulence 3, Wave Turbulence, Vortex Dynamics and Structure Formation 1, Two-dimensional Turbulence 2</td>
<td>ROOM 1, ROOM 3, ROOM 5, ROOM 7, ROOM 9, ROOM 2, ROOM 8, ROOM 10, ROOM 4</td>
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<tr>
<td>12:45</td>
<td>lunch / Industry Symposium</td>
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<td>14:00 - 15:45</td>
<td>Multiphase Flows 5, Instability, Transition and Control of Turbulent Flows 4, Wall Bounded Turbulence 5, Turbulent Convection 4, Intermittency and Scaling 2, Rotating Flows 2, Numerical Methods and Data Analysis 3, Transport and Mixing 3, Quantum and Superfluid Turbulence, Geophysical and Astrophysical Turbulence 1, Mini Symposium. Turbulence in the heliosphere and in the local interstellar medium 1</td>
<td>ROOM 1, ROOM 3, ROOM 5, ROOM 7, ROOM 9, ROOM 2, ROOM 8, ROOM 10, ROOM 4</td>
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<td>15:45</td>
<td>coffee break</td>
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<td>16:15 - 18:15</td>
<td>Multiphase Flows 6, Instability, Transition and Control of Turbulent Flows 5, Quantum and Superfluid Turbulence, Turbulent Convection 5, Intermittency and Scaling 3, Rotating Flows 3, Numerical Methods and Data Analysis 4, Geophysical and Astrophysical Turbulence 1, Mini Symposium. Turbulence in the heliosphere and in the local interstellar medium 2</td>
<td>ROOM 1, ROOM 3, ROOM 5, ROOM 7, ROOM 9, ROOM 2, ROOM 8, ROOM 10, ROOM 4</td>
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<td>19:00</td>
<td>Conference dinner at the National Car Museum</td>
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## Friday, September 6th

### AULA MAGNA

**8:30 - 10:00**

- Invited speaker • Turbulent channel flow laden with finite-size particles. *Luca Brandt*
- Invited speaker • Turbulent boundary layers developing over rough surfaces: from the laboratory to full-scale systems. *Nicholas Hutchins*

**10:00**

**coffee break**

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**10:45 - 12:45**

**12:45**

- Lunch / Young Investigators Awards Ceremony

**14:00 - 15:45**

- Multiphase Flows 8
- Instability, Transition and Control of Turbulent Flows 7
- Fluid-structure Interaction 2
- Turbulent Convection 6
- Intermittency and Scaling 5
- Stratified Flows 4
- Numerical Methods and Data Analysis 5
- Transport and Mixing 4
Welcome cocktail reception
The welcome cocktail reception will take place on Tuesday September 3 at the end of the opening session at the campus Cittadella Politecnica, Corte Interrata area (access from the entrance at Corso Castelfidardo 34/A, see Politecnico map at page 16).
A nice ice-breaking occasion to meet old and new colleagues.
Admittance will be limited to badge holders.

Cocktail reception at the University Rectorate
The University Rectorate, housed in a beautiful XVIII palace located in the heart of the city centre, will host this nice networking event. which will take place on Wednesday September 4 at 19:00. Access will be reserved to all regularly enrolled participants.
Invitation cards can be collected at the registration desk.

Social dinner
The social dinner will be held on Thursday September 5 at the MAUTO (National Car Museum, www.museauto.it), a fascinating, interactive museum which was recently renovated with a modern, innovative design.
A real architectural work of art. A jewel for all car lovers.
This social event will be a fantastic occasion to discover one of Torino’s most interesting cultural and touristic sites and enjoy the well-known Italian food and wine tradition.
Admittance will be limited to ticket holders. Regularly enrolled participants can collect their invitation card at the conference registration desk.
Free visit to the Museum will be included.
Bus shuttle service will be provided (departure from the conference venue, Campus Cittadella, corso Castelfidardo 34/A at 18:30).
The conference areas

The conference will be held at the Politecnico di Torino. Conference facilities will be located both in the Politecnico main campus (pedestrian access from corso Duca degli Abruzzi 24 entrance) and in the Aule I (Rooms I) of the new campus Cittadella Politecnica, Corte Interrata area (pedestrian access via Corso Castelfidardo 34/A entrance) situated at a few minutes’ walking distance from the main building.

CONFERENCE VENUE MAP

1. POLITECNICO DI TORINO
   MAIN CAMPUS
   AULA MAGNA (Plenary Session)
   Corso Duca degli Abruzzi, 24

2. POLITECNICO DI TORINO
   CAMPUS CITTADELLA POLITECNICA
   CORTE INTERRATA
   ROOMS I (Parallel Session)
   Corso Castelfidardo, 34/a

From 1 to 2, five minutes’ walking distance
Meeting rooms
Daily plenary sessions, including the opening ceremony and session on Tuesday September 3, will be held at the Aula Magna, the main university conference room located in the Politecnico main campus.
Parallel sessions will take place in the Rooms I located at the new campus Cittadella Politecnica, Corte Interrata area (pedestrian access from Corso Castelfidardo 34/A entrance). This area will also host catering areas, exhibit spaces and child-care service.

CORTE INTERRATA FLOOR MAP

Instructions for presenters
Speakers are required to be in the meeting room at least 10 minutes before their session begins. Sessions are tightly scheduled, the allotted time (12 minutes + 2 for discussion) must be strictly observed. Each conference room will be equipped with computers.
Presentations on USB stick must be loaded in advance (e.g. during breaks) on the conference room laptops.
For further information, presenters are required to apply to session chairs or conference staff at the session meeting rooms.
For organizational reasons, use of personal laptops for presentations is discouraged.

Registration
Pre-registered participants can collect their conference kit and personal name badge at the organizing secretariat desk located in the foyer of the Aula Magna (Politecnico main campus, ground floor, entrance at corso Duca degli Abruzzi 24) as of Tuesday September 3, 12:00.
A secretariat desk will also be available in the lobby of the Corte Interrata (Rooms I).

Badges
All delegates and exhibitors are kindly requested to always wear their name badge.
Enterance to meeting rooms will be limited to regularly enrolled participants.
Language
Official language will be English. No simultaneous translation will be provided.

Child-care service
ETC17 provides professional child-care facilities in the conference centre free of charge. A separate area is available in the same location used for the conference parallel sessions (Campus Cittadella Politecnica, Corte Interrata, see map at page 17).
The service will be provided in the afternoon of Tuesday, September 3 (14:00-18:00, first day of the conference), and in the following days, September 4-5-6, from 8:00 to 18:00. The service will be open for children from a few months of age to 13 years.
For more information, please contact the nannies at the child-care area. The service is provided by stronaidea.it Cooperative, the company that coordinates Policino, the child-care services for the Politecnico di Torino.

Coffee breaks and lunches
Coffee points will be located close to the parallel session rooms at the Corte Interrata (Rooms I).
Buffet lunches will be served in the catering area (outside courtyard or building lobbies) at the Corte Interrata (Rooms I).
See conference programme for exact coffee break and lunch times.

Tourist information
An information point of the city tourist agency TurismoTorino will be available at the conference venue on Tuesday September 3 from 14:00 to 19:00 and on Wednesday September 4 from 10:00 to 17:00.
The main tourist information point is located in the city centre (Piazza Castello) and it is open from Monday to Sunday from 9.00 to 19.00.
Phone: +39 011 535181.

How to get to...
... the conference venue
The Politecnico is located close to the city centre. It can be reached from the city centre in a short time by metro or bus.
The closest metro station is Vinzaglio (about 10 minutes’ walking distance from both the Politecnico main building and the parallel sessions’ venue the new campus Cittadella Politecnico). Many bus and tram lines have stops at the Politecnico.
Bus lines 58, 33, 12 and tram line 10 stop near the Politecnico main building entrance (corso Duca degli Abruzzi 24).
Bus line 12 stops in front of the Cittadella Politecnico entrance (corso Castelfidardo 34/A).
Bus line Star 1 stops at about 300 metres from the same entrance.
Other bus or tram lines (e.g. lines 33, 42 and 15) have also stops not far from the Politecnico.
And if you like to walk, it takes about 30 minutes from Porta Nuova railway station in the city centre.

... the social dinner venue, the MAUTO, National Car Museum
The MAUTO-National Automobile Museum “Giovanni Agnelli” Corso Unità d’Italia, 40 can be reached on foot in about 10-15 minutes from the closest subway station Lingotto one. Bus shuttle service from the conference venue will be provided (departure from the Cittadella Politecnico entrance, corso Castelfidardo 34/A, at 18:30).
For taxi, call 011 5730 or 011 5737.
Currency
The Euro is the national currency. Automatic cash dispenser and bank exchanges are plentiful. Most hotels, restaurants and shops accept the usual credit cards.

Banks
The nearest bank with cash dispenser is the Banca Unicredit located inside the Politecnico main building. Opening times, from Monday to Friday: from 8.30 to 13.30 and from 14.40 to 16.10.

Post office
The nearest post office is located inside the Politecnico main building. Opening times from Monday to Friday: from 8:30 to 13:30.

Medical service
A medical service for first aid (infermeria) is available in the Politecnico main building. Opening times, from Monday to Friday: from 8:00 to 18:00.

Shopping
Torino offers both luxury and characteristic shops. Most of the luxury shops are located in the city centre on via Roma: fashion boutiques, jewelry shops, perfume shops and food and wine stores which feature the best of the regional products. Then there are the characteristic shops in the little alleys of the inner city, full of cafes and craftshops. Torino has a little bit (or, as is often the case, a lot) of everything and for all budgets as well.

Eating
Torino is well known for its local cuisine, which is considered among the best in Italy. Restaurants are usually open from 12:00 to 14:30 and from 19:30 to 22:30. For those who prefer something different to the classic menus, Torino proposes a most pleasant alternative: wine bars. Torino is also renowned for the ability of its pastrycooks.

Museums
Torino offers a wide choice of museums: from the Egyptian Museum, the most important collection in the world after Cairo, to the Sabauda (Savoyard) picture gallery, from the Cinema Museum, located in the Mole Antonelliana the 167-metre tower symbol of Torino, to the recently renovated Automobile Museum. Besides its collections of old and modern art, Torino is also an important centre for contemporary art. Museums are usually open from Tuesday to Sunday and closed on Mondays.

Liability • Registered conference participants agree that neither the Organizing Committee nor the conference Secretariat are liable or assume any responsibility for damage or injuries to persons or property during the conference. Participants are advised to arrange for their own health, travel and personal insurances. The conference organization does not cover individuals against cancellation of bookings, theft or damage to belongings.

Disclaimer • All best endeavours will be made to present the conference programme as published. However, the conference Organizing Committee and the Secretariat reserve the right to alter or cancel, without prior notice, any arrangements, timetables, plans or other items relating directly or indirectly to the conference, for any cause beyond our reasonable control. The conference Organizing Committee and the Secretariat are not liable for any loss or inconvenience caused as a result of such alteration.
Exhibitor list:
1. Ubertone
2. APS
3. Photron
4. Dantec Dynamics
5. Lexma Technology
6. Cambridge University Press
7. Evolution Measurement
8. Cineca
1. POLITECNICO DI TORINO
   MAIN CAMPUS
   AULA MAGNA
   Corso Duca degli Abruzzi, 24
   Conference venue

2. POLITECNICO DI TORINO
   CAMPUS CITTADELLA
   CORTE INTERRATA ROOMS I
   Corso Castelfidardo, 34/a
   Conference venue and welcome cocktail reception venue

3. RECTORATE
   UNIVERSITÀ DI TORINO
   Via Po, 15
   Cocktail reception venue

4. MAUTO • MUSEO DELL’AUTOMOBILE
   (National Car Museum)
   Corso Unità d’Italia, 40
   Social dinner venue