IUTAM SYMPOSIUM ON TURBULENT/NON-TURBULENT INTERFACE IN TURBULENT SHEAR FLOW

2024 IUTAM-TNTI

SYMPOSIUM MANUAL

OCTOBER.8th —— 11th 2024

BEIJING CHINA

HOST: BEIHANG UNIVERSITY

2024

BEIHANG UNIVERSITY

IUTAM

-TNTI

CONTENTS

IUTAM SYMPOSIUM ON TURBLENT/ NON-TURBULENT INTERFACE IN TURBULENT SHEAR FLOW (IUTAM-TNTI)

The turbulent/non-turbulent interface (TNTI) is an irregular boundary between turbulent and irrotational flow, which widely exists in various flow types, such as turbulent boundary layer, combustion flame front, turbulent patches in the atmosphere, ocean, pollutant dispersion, etc. Due to its importance in affecting the intermittent characteristic and the mixing and entrainment process of turbulent flows, TNTI has become one of the most active branches of turbulent research in the past decades. Nevertheless, the scientific community still faces various challenges that hinder the ultimate characterization and modelling of TNTI. The unresolved problems, to name a few, spread from the lack of a well-accepted definition of TNTI to the intriguing origin of its fractal multi-scale nature. The dynamics of TNTI, which is the key to the mechanism of the exchange of mass, momentum, and energy between turbulence and irrotational outflows, also deserve an interpretation from the perspective of turbulent structures.

This symposium aims to provide a platform for active researchers worldwide to anchor the state-of-the-art knowledge of TNTI and envision this field's future direction. The focus includes but is not limited to the scaling for the geometries, kinematics, and dynamics of TNTI, the role of turbulent structures in the entrainment process, multiphase flow with TNTI, high-fidelity turbulent model that accounts for the intermittency of TNTI, and reduce-order-model-based prediction for engineering application. A further attempt is to synthesize the insight and common interest from multiple disciplines, including aerospace science, chemical engineering, geophysics, and environmental science, to promote the setup of a global cooperation network that will benefit the whole community.

Jinjun Wang

Ivan Marusic

SYMPOSIUM ORGANIZER

Symposium Organizer

- International Union of Theoretical and Applied Mechanics (IUTAM)

Host

- School of Aeronautic Science and Engineering, Beihang University

Co-organizer

- Chinese Society of Theoretical and Applied Mechanics (CSTAM)
- Beijing Society of Theoretical and Applied Mechanics (BSTAM)

COMMITTEE

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Chair	Co-Chair	Secretary
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VENUE

Address

Zhenshun Yunfang Tangquan Art Hotel, No. 666 Zhenshun Village, Cuicun Town, Beijing

ACCOMMODATION HOTEL

Address

Yaotai Hot Spring Hotel, Beijing (Address: North of Mianshan Village, Cuicun Town, Beijing)

SYMPOSIUM AGENDA

October 8th

Time	Activity
14:00-21:00	Symposium Registration

October 9th

Time	Activity	Session Chair
08:30-08:50	Opening Ceremony Address	Yuan Xiong
Time	**Plenary Lecture (35 Min. Talk, 5 Min. Q&A)**	
08:50-09:30	Turbulent/Non-turbulent Interfaces and The Definition of Boundary Layer Thickness Ivan Marusic, University of Melbourne, Australia	Chong Pan
09:30-10:10	Space-Time Correlation and Its Implication to Time-Accurate Large Eddy Simulations Guowei He, Chinese Academy of Science, China	
10:10-10:30	**Coffee Break and Group Photo**	
10:30-11:10	Entrainment Across a Turbulent/Turbulent Interface: Points of Distinction From the Turbulent/Non-turbulent Interface Oliver Buxton, Imperial College London, U.K	Christian J. Kähler
11:10-11:50	Turbulent/Non-Turbulent Interface in an Adverse Pressure Gradient Turbulent Boundary Layer Hyung Jin Sung, Korea Advanced Institute of Science and Technology, Korea	
11:50-12:30	Turbulent/Non-turbulent Interface in Free Shear Fows: Synthetic Jet and Separated Shear Layer Jinjun Wang, Beihang University, China	
12:30-13:30	**Lunch Break**	
13:30-14:10	Relating Turbulent Interfaces to Coherent Structures Jerry Westerweel, Delft University of Technology, Netherlands	Hyung Jin Sung
14:10-14:50	Challenges in the Detection of Turbulent / Non-turbulent Interfaces in Air Fows Christian J. Kähler, University of the Bundeswehr Munich, Germany	
14:50-15:30	The Effect of Background Turbulence on the Dynamics of Turbulent Jets and Entrainment Processes Across the Turbulent/Turbulent interface Susan Gaskin, McGill University, Canada	

Time	Activity	Session Chair
15:30–15:50	Coffee Break	
15:50–16:30	Local properties of the turbulent/non-turbulent interface John Christos Vassilicos, French National Centre for Scientific Research, France	
16:30–17:10	Universal Features of Turbulent/Non-turbulent and Turbulent/Turbulent Interfaces Carlos B. da Silva, University of Lisbon, Portugal	Qi Gao
17:10–17:50	Enhancement of Passive Scalar Mixing in a Shear-Free Turbulent Front Tomoaki Watanabe, Kyoto University, Japan	
18:10 – 20:00	Gala Dinner	Yang Xu

October 10th

Time	Invited Lecture (15 Min. Talk, 5 Min. Q&A)	Session Chair
08:30–08:50	Bubble Size Distribution in Hydrodynamic Cloud Cavitation Benlong Wang, Shanghai Jiao Tong University, China	
08:50–09:10	The Quiescent Core in Compressible Turbulent Channel Flows Jie Yao, Beijing Institute of Technology, China	
09:10–09:30	Turbulent/Non-Turbulent Interface in a Spatially Developing Turbulent Boundary Layer Laden with Small Heavy Particle Ping Wang, Lanzhou University, China	Hengdong Xi
09:30–09:50	On Low-Scalar Patches in Turbulent Wakes With and Without Free-Stream Turbulence Susan Gaskin, McGill University, Canada	
09:50–10:10	Coffee Break	
10:10–10:30	Turbulent/Non-turbulent Interface in Water Jet with Polymer Additives Hengdong Xi, Northwestern Polytechnical Univeristy, China	
10:30–10:50	Similarity for Dissipation-Scaled Wall Turbulence Shunlin Tang, Harbin Institute of Technology, China	
10:50–11:10	Speed of the Downstream Turbulent Front in Pipe Flow Baofang Song, Peking University, China	Ping Wang
11:10–11:30	On the Identification of Wall Pressure Pattern Within the Trailing Edge Turbulent Boundary Layer of a NACA 0012 Airfoil Qingqing Ye, Zhejiang University, China	

Time	Invited Lecture	Session Chair
11:30–14:00	**Lunch Break**	
14:00–14:20	Vortex-Flame Interactions in Jet Diffusion Flames Xi Xia, Shanghai Jiao Tong University, China	
14:20–14:40	Characterization of Atmospheric Turbulence and Particulates Using UAV-Based Holography and Sonic Anemometry with Multi-Scale PINNs for Sparse Data Reconstruction Cheng Li, Guangdong Technion – Israel Institute of Technology, China	
14:40–15:00	Conditional Mean Velocity and Vorticity Fields in the Vicinity of the Turbulent/Turbulent Interface of a Planar Wake Jiangang Chen, Imperial College London, U.K.	Benlong Wang
15:00–15:20	Baroclinic Vorticity Generation Near the Turbulent/Non-turbulent Interface of a Boundary Layer with Non-premixed Combustion Chuhan Wang, Tsinghua University, China	
15:20–15:40	**Coffee Break**	
15:40–16:00	Experimental Investigation of Roughness Effects for the Hypersonic Boundary Layer Wanting Liu, Huazhong University of Science and Technology, China	
16:00–16:20	Frequency Effect on Properties of Turbulent/Non-turbulent Interface in Separated and Reattaching Flows Past an Oscillating Fence Sicheng Li, Beihang University, China	
16:20–16:40	Entrainment Mechanism Analysis of Oblique Shock-wave/Boundar-Layer Interactions Fanzhao Meng, Beihang University, China	Qingqing Ye
16:40–17:00	Connecting the Temporal Evolution of the Turbulence Interface to the Entrainment and Detrainment in a Turbulent Plane Jet Yuanliang Xie, Nanjing University of Science and Technology, China	
17:00–17:20	Interfacial Morphology of a Bubble Moving in Confined Channel Filled with Viscoelastic Fluid Yidi Zhang, Beijing Institute of Technology, China	
17:30–19:30	**Dinner**	

October 11th

Time	Activity
09:00–12:00	Departure

PLENARY LECTURE

Speaker: Ivan Marusic
Affiliation: University of Melbourne
Speech Title: Turbulent/Non-turbulent Interfaces and The Definition of Boundary Layer Thickness

Abstract: In this talk, the definition of boundary layer thickness is revisited in the context of the TNTI and measurements of the skewness of streamwise velocity. A range of datasets is considered, including simulations (DNS and LES) and experiments (PIV and hot wires). This includes particle image velocimetry experiments in high Reynolds number turbulent boundary layers for zero and moderately strong streamwise pressure gradients.

Curriculum Vitae: Ivan Marusic is a Pro Vice-Chancellor and Redmond Barry Distinguished Professor at the University of Melbourne. His research is in the field of fluid mechanics, with emphasis on turbulent flows. Over his career, he has received a number of prestigious awards, including the Stanley Corrsin Award from the American Physical Society. He is a Fellow of the Royal Society of London, American Physical Society, Australian Academy of Technology and Engineering and the Australian Academy of Science.

Speaker: Guowei He
Affiliation: Chinese Academy of Science
Speech Title: Space-Time Correlation and Its Implication to Time-Accurate Large Eddy Simulations

Abstract: Space-time correlation is a staple method for investigating the dynamic coupling of spatial and temporal scales of motion in turbulent flows. In this talk, I will introduce our resent work on space-time correlations for turbulent flows and time-accurate large eddy simulation (LES) of turbulence-generated noise: the Taylor, Kraichnan-Tennekes and elliptic approximation (EA) models are re-examined in terms of the picture of turbulent passage; the space-time correlation is introduced to evaluate the subgrid scale (SGS) models and data-driven SGS models are developed for time-accurate LES; the large-eddy simulation for frequency spectra is used to study the noise radiated by turbulent flows around an axisymmetric body of revolution.

Curriculum Vitae: Dr. Guowei He is a professor and the academic director of Institute of Mechanics, Chinese Academy of Science. He is an elected academician of the Chinese Academy of Science and a fellow of the American Physical Society. He is the associated editor of APS journal “Phys Rev. Fluids”. His research interests include turbulence statistical theory and computational modelling, large eddy simulation of turbulence-generated noise and machine learning.

Speaker: Oliver Buxton
Affiliation: Imperial College London
Speech Title: Entrainment Across a Turbulent/Turbulent Interface:
Points of Distinction From the Turbulent/Non-turbulent Interface

Abstract: We show that the physics of a turbulent/turbulent interface (TTI) are different from those of a turbulent/non-turbulent interface (TNTI), with inertial vorticity stretching being wholly responsible for creating the enstrophy discontinuity in the former, whilst viscous diffusion dominates in the outermost region of the latter. We show how the entrainment velocity evolves spatially across a TTI formed between a planar-wake and turbulent backgrounds of various characteristic turbulence intensities and length scales. Background turbulence is shown to enhance entrainment in the near-wake where both nibbling and engulfment are active, whilst it suppresses entrainment in the far-wake where nibbling is the predominant entrainment mechanism. Finally, we consider the entrainment of streamwise momentum and kinetic energy and show that the presence of background turbulence can modify the e□iciency with which these quantities are entrained with respect to mass but these effects are only important in the near-wake.

Curriculum Vitae: Oliver Buxton is a professor of fluid mechanics at Imperial College in London in the UK. He is a fellow of the Royal Aeronautical Society, an advisory committee member to the UK Turbulence Consortium, and a former winner of the Europe-wide da Vinci award for young researchers in the fields of flow, turbulence, and combustion. His research interests include wind-turbine wakes, currently supported through an EPSRC fellowship, and cloud microphysics supported through an ERC consolidator grant, both of which are built on his work on fundamentals of turbulence including TNTIs and turbulent/turbulent interfaces.

Speaker: Hyung Jin Sung
Affiliation: Korea Advanced Institute of Science and Technology
Speech Title: Turbulent/Non-Turbulent Interface in an Adverse Pressure Gradient Turbulent Boundary Layer

Abstract: The turbulent/non-turbulent interface (TNTI) in an adverse pressure gradient (APG, $\beta = 1.45$) turbulent boundary layer (TBL) is explored here by using direct numerical simulation (DNS) data; β is the Clauser pressure gradient parameter. For comparison, the DNS data for a zero pressure gradient (ZPG) TBL is included. The interface is extracted with an approach based on enstrophy criteria. Depending on the enstrophy, the outer boundary layer flow can be classified into the free stream, boundary layer wake, and intermittent flow regimes. The fractal dimension of the interface is obtained by using the box-counting algorithm, and was found to be constant over a long range of box sizes. The TNTI shows a monofractal behavior. The geometric complexity of a TNTI can be determined in terms of the genus, which is defined as the number of handles in a geometric object. We examine the volume and projection area of the genus of the TNTI to analyze the entrainment process. The geometric complexity of the APG TBL interface and the local entrainment are greater than those of the ZPG TBL, as is evident in the increases in the genus near the interface. The local entrainment velocity is dominantly affected by the viscous diffusion at the interface.

Curriculum Vitae: Dr. Hyung Jin Sung is a professor at KAIST. In 1984, he joined the faculty at KAIST as an assistant professor, and was promoted as an associate professor in 1990 and a full professor in 1994. He is currently serving as the Director of NSCN (National Science Challenges Support & Networks) under the Ministry of Science and Technology of Korea. Professor Sung has devoted his research career to a variety of research fields in fluid mechanics including turbulence, fluid-structure interaction and acoustofluidics, and flow visualization. He has authored more than 478 SCI journal papers published in prestigious journals. His papers have been cited in more than 20,470 journal papers according to Google Scholar (h-index, 71). His h-index in Web of Science is 67. Based on outstanding research achievements, he was nominated as an American Physics Society (APS) fellow in 2013, a Korea Telecommunication (KT) endowed chair professor in 2015 and received many awards including Sudang Award in 2014, KAIST Grand-Prix Academic Award in 2009.

Speaker: Jinjun Wang
Affiliation: Beihang University
Speech Title: Turbulent/Non-turbulent Interface in Free Shear Fows: Synthetic Jet and Separated Shear Layer

Abstract: This report focuses on the experimental studies of the TNTI in free shear flows, including synthetic jets and separated shear layers. For the synthetic jet, its TNTI is compared with that of a continuous jet. The synthetic jet has a larger radial position, more distorted shape, and higher fractal dimension, resulting in better entrainment performance. Furthermore, vortex ring breakdown in synthetic jet enhanced the small-scale vortex near TNTI, resulting in an increase of enstrophy production, and thus enhanced local entrainment. It was also found that fractal orifices reduce the entrainment performance of the synthetic jet. For the separated shear layer, a quantitative comparison of the contributions of nibbling and engulfment reveals that nibbling is the main entrainment process. Additionally, it is also found that the prograde vortex restrains the entrainment process, while the retrograde vortex promotes it.

Curriculum Vitae: Professor Jinjun Wang is a recipient of the National Outstanding Youth Science Fund, a specially appointed professor of the "Yangtze River Scholar" program of the Ministry of Education, and an academic leader of the National Natural Science Foundation's Innovation Research Group. He has published over 300 journal articles, including more than 180 SCI-indexed papers, has continuously been selected for the Elsevier China Highly Cited Scholars List, and has won one national award and six provincial and ministerial awards. Professor Jinjun Wang's research involves complex flow mechanisms and control in aircraft. He developed new technologies to measure complex flow fields, discovered new boundary layer bypass transition modes, and proposed novel flow control methods. His research results have been applied to experiments and optimization of aerodynamic shape selection for multiple models in China, as well as flow control for increasing lift and reducing drag.

Speaker: Jerry Westerweel
Affiliation: Delft University of Technology
Speech Title: Relating Turbulent Interfaces to Coherent Structures

Abstract: In an experiment on a turbulent jet seeded with fluorescent dye we detect the turbulent- nonturbulent interface in a frame that moves, on average, with the interface. This significantly prolongs the observation time of scalar- and velocity structures and enables the measurement of two coherent structures. We apply the finite-time Lyapunov field (FTLE) to investigate the barriers of diffusive momentum transport. We discuss a novel approach to finding the turbulent-nonturbulent interface from the measured fluorescence field. Conditional averages teach that the turbulent-nonturbulent interface is not associated with the barrier of diffusive momentum transport, but that there is a relation with the large-scale ridges of the FTLE. Inside the turbulent jet other interfaces exist between two regions with approximately uniform dye concentration. It appears that these turbulent-turbulent interfaces discriminate even stronger between the coherent structures.

Curriculum Vitae: Professor Jerry Westerweel's interests are turbulence and instationary flows around objects, among others. His main expertise is in the development and application of experimental methods. I have been an editor for Experiments in Fluids since 2003.

Speaker: Christian J. Kähler
Affiliation: University of the Bundeswehr Munich
Speech Title: Challenges in the Detection of Turbulent / Non-turbulent Interfaces in Air Fows

Abstract: The analysis of the turbulent/non-turbulent interface (TNTI) is of great scientific and technological interest because an understanding of the physical mechanisms that lead to the formation of the characteristic properties of the TNTI is of fundamental importance for mixing processes. A better understanding of the elementary processes that lead to the complex formation of the TNTI can be useful in areas such as combustion, cooling, cleaning and coating. While TNTI analysis based on data generated by Direct Numerical Simulation works reliably, there are numerous challenges in the field of experimental analysis. This is especially true for the analysis of TNTI in gas flows. The lecture will address the particular challenges of analyzing air flows and will present and discuss possible solutions. On the basis of measurement data, it will be shown to what extent valuable insights can be gained. The experimental analysis of the TNTI is important because, in contrast to DNS analysis, flows in complex geometries, with large Reynolds and Mach numbers or complex gas mixtures with phase transitions can be analyzed in principle.

Curriculum Vitae: Christian J. Kähler received his Physics Diplom Degree from the Technical University Clausthal in 1997 and his PhD in Physics from the Georg August University of Göttingen in 2004. From 1996 to 2001 Dr. Kähler worked at the German Aerospace Center (DLR) in Göttingen (Dr. Kompenhans), during which he had research stays at the University of Illinois at Urbana Champaign in 1996 (Prof. Adrian) and at Caltech in 1998 (Prof. Gharib). From 2001 to 2008 he was the head of the research group on Flow Control and Measuring Techniques at the Technical University Brunswick (Prof. Radespiel). He then became Professor for Fluid Dynamics and was appointed director of the Institute of Fluid Mechanics and Aerodynamics of the University at der Bundeswehr Muenchen in 2008. In 2012, he was offered an Einstein professorship for Aerodynamics at the Technical University Berlin (declined) and in 2017 the Technical University Darmstadt offered him to become head of the chair of Fluid Mechanics (declined). His research covers a broad range of topics involving the development of optical measurement techniques on the micro and macro scale in order to further investigate complex phenomenon in turbulent flows at subsonic, transonic, and supersonic conditions.

He is an associate editor of Experiments in Fluids (Springer Nature), an editorial advisory board member of Flow, Turbulence and Combustion (Springer Nature) and editorial board member of Physical Review Fluids (American Physical Society) and a Steering committee member and organizer of the International PIV Challenge (2001 Göttingen, 2003 Busan, 2005 Pasadena, 2014 Lisbon). He was chairman of the national conference on Laser-Methods in Fluid Mechanics (GALA e.V.) in 2013 and 2023, the International Conference on Experimental Fluid Mechanics in 2018 and of the International Symposium on Particle Image Velocimetry in 2019. Since 2022 he is a member of the organizing committee of the International Symposium on Applications of Laser and Imaging Techniques to Fluid Mechanics in Lisbon, Portugal. Furthermore, he is co-author of the 3rd edition of the Springer book on Particle Image Velocimetry. Between 2012 and 2018 he was elected member of the Fluid Mechanics review board of the national research funding organization Deutsche Forschungsgemeinschaft (DFG). Since 2019, he has been an elected member of the Senate Committee on Collaborative Research Centres (SFB) of the DFG, and in 2023, he became a member of the Alexander von Humboldt Foundation's selection committee for the sponsorship of highly qualified scientists from abroad at German universities and research institutions. His research achievements have been recognized by international awards such as the Nakayama's Medal for outstanding contributions in the fields of Fluid Control, Measurement and Visualization.

Speaker: Susan Gaskin
Affiliation: McGill University
Speech Title: The Effect of Background Turbulence on the Dynamics of Turbulent Jets and Entrainment Processes Across the Turbulent/Turbulent Interface

Abstract: Background turbulence disrupts the jet structure resulting in its rapid decay (mean velocity and passive scalar concentration) and a reduced entrainment, before jet breakdown when only turbulent diffusion acts. The effect of the background turbulence is characterized by its relative length scale, L, and turbulence intensity, ξ, with ξ dominating the jet dynamics in the self-similar region. Large scales of the ambient turbulence advect the jet. Jet breakdown occurs at ξ = 0.5, while for ξ < 0.5, entrained small scales cause faster decay of the jet's large vortical structures and transfer of their energy to smaller scales. They also increase the jet rms increasing the radial scalar transport and differential diffusion, thereby increasing the mixing. Entrainment occurs across the turbulent/turbulent interface, the TTI, identified by a larger sharp jump in mean and rms passive scalar concentration, which is longer, more tortuous and has a higher fractal dimension than its quiescent counterpart, the TNTI.

Curriculum Vitae: Susan Gaskin is a Brace Professor in Civil Engineering at McGill University. Her main focus of research is experimental environmental fluid mechanics with a focus on the fundamental processes of turbulent entrainment and mixing, particularly of jets in turbulent ambient flows, turbulent ambient flows being ubiquitous in the environment and common in industrial flows. She is also interested in the hydraulics of hydropower, river engineering, particularly fluvial erosion of cohesive sediments, in water resources management, basin-wide hydrologic modeling, sustainable water supply, and the health impacts of trace metals therein.

Speaker: John Christos Vassilicos
Affiliation: National Centre for Scientific Research
Speech Title: Local Properties of the Turbulent/Non-Turbulent Interface

Abstract: The effect of spatial resolution on local propagation velocity of the Turbulent/Non-Turbulent Interface (TNTI) is documented. A TNTI-local coordinate system and a Reynolds decomposition based on a TNTI-conditional averaging operation are introduced and used to assess the local velocity field and the mass and momentum balances at the TNT layer. A clear jump of the TNTI-averaged Reynolds shear stress exists through the TNTI layer and the TNTI-averaged fluid velocity normal to the TNTI is determined by the correlation between the TNTI normal vector and the fluid velocity fluctuations around the TNTI-average fluid velocity. The TNTI-local fluid velocity field is compressive normal to the TNTI and stretching in the direction tangent to the TNTI, a structure that has important consequences.

Curriculum Vitae: Professor John Christos Vassilicos started his career at the University of Cambridge and was, since 2003, Professor of Fluid Mechanics at Imperial College London. His research is in the fundamentals and applications of turbulent flows. He published significant contributions in many aspects of turbulence theory supported by experimental and numerical data. To cite a few, he introduced the study of turbulent flows generated by fractal/multi-scale objects, discovered a new turbulence dissipation and interscale energy flux law for non-equilibrium turbulence as well as resulting turbulent wake and jet scaling laws, made contributions to the understanding of clustering of inertial particles in turbulent flows, and more recently to wall turbulence. He was awarded an ERC Advanced grant (2013-2018) and has been the PI of many European and UK Grants. He has supervised and trained 34 completed doctoral students and 14 post-doctoral researchers. Since 2019, Professor John Christos Vassilicos joined the Fluid Mechanics Laboratory of Lille (LMFL) and obtained a permanent senior researcher position (Director of Research) at the French National Centre for Scientific Research (CNRS).

Speaker: Carlos B. da Silva
Affiliation: University of Lisbon
Speech Title: Universal Features of Turbulent/Non-turbulent and Turbulent/Turbulent Interfaces

Abstract: The characteristics of turbulent/non-turbulent interfaces and turbulent/turbulent interfaces (TNTI and TTI) are analyzed by new, carefully designed direct numerical simulations (DNS). Whereas TNTIs separate the turbulent from the non-turbulent region in free shear flows and turbulent boundary layers, TTIs appear whenever two regions of distinct turbulent characteristics interact, such as in turbulent jets and wakes surrounded by external turbulent flow or strongly perturbed turbulent boundary layers, i.e., when the external flow is in turbulent condition. Direct numerical simulations (DNS) of temporally evolving and spatially evolving TTIs are carried out to analyze the conditional mean profiles of enstrophy. Preliminary results suggest that, if properly normalized using the mean local Kolmogorov velocity and length scale, these conditional mean profiles are universal.

Curriculum Vitae: Carlos B. da Silva graduated in Mechanical Engineering at Instituto Superior Técnico (IST), then part of the Technical University of Lisbon (now University of Lisbon UL) in 1996 and after this worked in CFD development/simulations in several Industrial and European research projects. In 1998 he moved to the Laboratoire des Écoulements Géophysiques et Industriels (LEGI) in Grenoble (France), attached to the Institut polytechnique de Grenoble (now Grenoble Institute of Technology), where he defended his Doctoral thesis in grid/subgrid-scale interactions in jets (2001). After several post-doctoral and researcher appointments in Grenoble, Porto, and Lisbon, he became permanent staff at Instituto Superior Técnico/University of Lisbon in 2009, where he is now a Full Professor in Fluid Mechanics at the Department of Mechanical Engineering. His research interests include, among other topics, i) the physics of turbulence, ii) turbulent entrainment and, iii) turbulence in complex and non-Newtonian fluids.

Speaker: Tomoaki Watanabe
Affiliation: Kyoto University
Speech Title: Enhancement of Passive Scalar Mixing in a Shear-Free Turbulent Front

Abstract: Small-scale vortex tubes and shear layers within the turbulent/non-turbulent interface (TNTI) layer play a pivotal role in the process of entrainment. Shear layers in turbulence are known to be unstable against perturbations with wavelengths approximately 30 times the Kolmogorov scale. This study conducts numerical experiments aimed at investigating the potential for enhancing turbulent mixing through the excitation of small-scale shear instability. Direct numerical simulations are conducted for a turbulent front with a passive scalar transfer evolving in the absence of mean shear, where solenoidal velocity perturbations of constant wavelength are introduced outside the turbulent region. These perturbations are found to enhance the entrainment rate significantly when their wavelength coincides with the unstable mode of shear layers. The prompted instability also causes the amplification of the mean scalar dissipation rate, facilitating faster mixing at small scales. The present results prove the potential of small-scale shear instability to efficiently enhance passive scalar mixing in turbulent flows.

Curriculum Vitae: Tomoaki Watanabe, Ph.D., is currently an Associate Professor in the Department of Mechanical Engineering and Science at Kyoto University. After earning my Ph.D. in Mechanical Engineering from Nagoya University in 2014, I began my academic career as a JSPS Research Fellow at the same institution, subsequently serving as a visiting researcher at University of Washington and Instituto Superior Técnico. Later, I joined Nagoya University as an Assistant Professor. My recent research focuses on the experimental and numerical investigation of small-scale shearing motions in various turbulent flows, including compressible and density-stratified flows.

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BEIJING CHINA

HOST: BEIHANG UNIVERSITY