Turbulence Colloquium Mediterranea TCM 2013
'How do we foresee the future of turbulence research?'
Sidi Bou Said (Tunisia), 5th-9th September 2013

The **'Turbulence Colloquium Mediterranea TCM2013'** will be held in Sidi Bou Said (Tunisia) from September 5th to 9th 2013. It is a follow up of the **'Turbulence Colloquium Marseille 2011 TCM2011'** celebrating in September 2011 the 50th anniversary of TCM1961.This will also be a satellite meeting of the **'14th European Turbulence Conference ETC14'** that will take place in Lyon (France) from September 1st to 4th 2013.

Honorary president of TCM2013:

Tomomasa TATSUMI, Kyoto University (Japan)

Presidents of TCM2013:

Yukio KANEDA, Aichi Institute of Technology (Japan),
Martin OBERLACK, TU Darmstadt (Germany)
Norbert PETERS, RWTH Aachen University (Germany),
James WALLACE, University of Maryland (USA),
Nobumitsu YOKOI, University of Tokyo (Japan)

Organizers of TCM2013 :

Dalila ELHMAIDI OUESLATI, Université de Tunis El Manar (Tunisia),
Marie FARGE, Ecole Normale Supérieure, Paris (France),
Kai SCHNEIDER, Aix Marseille Université (France)

THURSDAY SEPTEMBER 5th

18h30 ***Welcome dinner***

20h30- 22h *Visit Sidi Bou Said by night*

FRIDAY SEPTEMBER 6th

Session 1 on Homogeneous Turbulence

President:
Yukio KANEDA, Aichi Institute of Technology (Japan)
Scientific secretaries:
Claude CAMBON, Ecole Centrale de Lyon (France)
Katsunori YOSHIMATSU, Nagoya University (Japan)

08h30-09h10 Review lecture by Yukio KANEDA, Aichi Institute of Technology (Japan)
09h10-09h30 Discussion
09h30-09h50 Talk by Tomomasa TATSUMI, Kyoto University (Japan)
09h50-10h00 Discussion
10h00-10h20 Talk by Claude CAMBON, Ecole Centrale de Lyon (France)
10h20-10h30 Discussion

10h 30 Tea, coffee and posters

11h00-11h20 Talk by Katsunori YOSHIMATSU, Nagoya University (Japan)
11h20-11h30 Discussion
11h30-12h00 Round table: questions and perspectives

12h 30 Lunch

14h30-17h30 Visit of the Bardo Museum in Tunis

18h 30 Dinner

Session 2 on Mathematics for Turbulence

President:
Martin OBERLACK, TU Darmstadt (Germany)
Scientific secretaries:
Rodrigo PEREIRA, Universidade Federal do Rio de Janeiro (Brazil)

20h00-20h30 Review lecture by Martin OBERLACK, TU Darmstadt (Germany)
20h30-20h40 Discussion
20h40-21h00 Talk by Rodrigo PEREIRA, Universidade Federal do Rio de Janeiro (Brazil)
21h00-21h10 Discussion
21h10-21h30 Round table: questions and perspectives

SATURDAY SEPTEMBER 7th

Session 3 on Shear and Wall-bounded Flow Turbulence

President:
James WALLACE, University of Maryland (USA)
Scientific secretaries:
Takashi ISHIHARA, Nagoya University (Japan)
Sedat TARDU, Université de Grenoble (France)

08h30-09h10	Review lecture by James WALLACE, University of Maryland (USA)
09h10-09h30	Discussion
09h30-09h50	Talk by Takashi ISHIHARA, Nagoya University (Japan)
09h50-10h00	Discussion
10h00-10h20	Talk by Sedat TARDU, Université de Grenoble (France)
10h20-10h30	Discussion

10h 30 Tea, coffee and posters

11h00-11h20	Talk by Amel SOUALMIA, Institut National Agronomique de Tunisie (Tunisia)
11h20-11h30	Discussion
11h30-12h00	Round table: questions and perspectives

12h 30 Lunch

14h30-17h30 Visit of Carthage archeological site

18h 30 Dinner

Session 4 on Magneto-Hydro-Dynamic Turbulence

President:
Nobumitsu YOKOI, University of Tokyo (Japan)
Scientific secretaries:
Naoya OKAMOTO, Nagoya University (Japan)
Abdelaziz SALHI, Université de Tunis (Tunisia)

20h00-20h30	Review lecture by Nobumitsu YOKOI, University of Tokyo (Japan)
20h30-20h40	Discussion
20h40-21h00	Talk by Naoya OKAMOTO, Nagoya University (Japan)
21h00-21h10	Discussion
21h10-21h30	Talk by Abdelaziz SALHI, Université de Tunis (Tunisia)
21h30-21h40	Discussion
21h40-22h00	Round table: questions and perspectives

SUNDAY SEPTEMBER 8th

Session 5 on Turbulent Mixing and Combustion

President:
Norbert PETERS, RWTH Aachen University (Germany)
Scientific secretaries:
Hafedh BELMABROUK, Université de Monastir (Tunisia)
Toshiyuki GOTOH, Nagoya Institute of Technology (Japan)

08h30-09h10	Review lecture by Norbert PETERS, RWTH Aachen University (Germany)
09h10-09h30	Discussion
09h30-09h50	Talk by Dalila ELHMAIDI OUESLATI, Université de Tunis (Tunisia)
09h50-10h00	Discussion
10h00-10h20	Talk by Toshiyuki GOTOH, Nagoya Institute of Technology (Japan)
10h20-10h30	Discussion

10h 30 Tea, coffee and posters

11h00-11h20	Talk by Jamel CHAHED, Ecole Nationale d'Ingénieurs de Tunis (Tunisia)
11h20-11h30	Discussion
11h30-12h00	Round table: questions and perspectives
12h00-12h30	Conclusions of the five sessions presented by the presidents followed by a final discussion

13h 00 Lunch

14h30-17h30 Visit of Tunis souk

20h Banquet

MONDAY SEPTEMBER 9th

7h Farewell breakfast

ABSTRACTS

Claude Cambon (Ecole Centrale de Lyon, France)

Direct, inverse or transverse cascades? Recent suggestions from rotating stably-stratified turbulence

Abstract: The concept of interscale energy cascade is well used in turbulence, but is often very superficially supported by rationale. What is the cause for the direction of this cascade, direct (towards smallest scales), inverse or other (e.g. transverse, by Horton et al. in homogeneous shear flows)? I propose to discuss two important points, the number of invariants and the anisotropic structure. For instance, it is well known that conservation of both energy and enstrophy is a prerequisite for the inverse cascade in 2D unbounded turbulence, but such inverse cascade is not found in a strongly stratified fluid, in which both energy and potential vorticity (or toroidal mode) are (quasi) invariant: The strong and typical anisotropy of the toroidal cascade gives an explanation. In addition to a review of the problem in my team for rotating stratified turbulence, I will discuss new recent DNS results from Marino, Pouquet and Minnini on the occurrence of a remarkable inverse cascade when the Coriolis parameter f is close to the stratification frequency N. The case $f = N$ merits particular attention, because strict 3D isotropy is permitted by dynamical equations, allowing a simplified analysis.

Jamel Chahed (Ecole Nationale d'Ingénieurs de Tunis, Tunisia)

Review and assessment of turbulence models for gas-liquid bubbly flows

Abstract: The first goal of this presentation is to present a comprehensive review of turbulence closures developed for turbulent bubbly flows in order to achieve a coherent proposal of classification of turbulence models as regards to the physics embedded in their closure formulations. Its second objective is to undertake an assessment of the different models classes by confronting their outcome against to the experimental data available for the homogenous turbulence in bubbly flow. We limit the scope of this presentation to dilute homogeneous bubbly flows in order to avoid the hydrodynamic interactions that occur in relatively high void fraction, which lead to important reduction of the relative velocity and to significant modification of the interfacial transfer. The review of turbulence models by applying them to the simplest turbulent bubbly flow configuration (e.g. uniform and uniformly sheared homogenous turbulence in bubbly flows) constitutes a primary benchmark for establishing the minimum requirements for suitable turbulence closure for bubbly flows.

Dalila Elhmaidi-Oueslati (Université de Tunis El Manar, Tunisia)

Dispersive properties of the Western Mediterranean basin

Abstract: We use a high resolution primitive equation model of the Western Mediterranean basin, to analyze the dispersion properties of a set of homogeneously distributed, passive particle pairs seeded in the model at initial depths of 44 and 500m. The analysis of the model output has shown that the absolute and the relative dispersion asymptotic laws are similar to those of 2D turbulence. The long lifetime and the trapping ability of the Mediterranean vortices induce an intermediate superdiffusive regime for single particle dispersion. For the relative dispersion, this regime tends to the Richardson one as the separation distance becomes smaller. At 500m depth, the intermediate regime becomes narrower than that at 44m depth due to weaker effect of vortices (this effect decreases with depth). The turbulent properties become less intermittent and more homogeneous.

Toshiyuki Gotoh (Nagoya Institute of Technology, Japan)

On the universality of small scale statistics of turbulence and passive scalar

Abstract: Since Kolmogov's theory 1941, many efforts have been devoted to the search for something universal in turbulence and passive scalar convected by it. Expectation in his theory is that the small scale motion in turbulent flow is generated through cascade process during which memories at large scales are lost. Then the 4/5 law for the triple correlation of the velocity increment is asymptotically exact, the Kolmogorov constant and the scaling exponents of the longitudinal velocity increments are very robust to various types of turbulent flows and seem to be universal. However, the situation of the passive scalar is more subtle. The 4/3 law for the scalar-velocity increment also is asymptotically exact, but no exact relation for the statistics of the scalar quantity alone is known. Even the isotropy of the scalar at small scales is questioned. In the talk we will discuss the universality of the passive scalar in turbulence by using the large scale DNS data, which are statistical data of two passive scalar excited by two kinds of method (random injection and uniform gradient) that are convected by the identical velocity field.

Takashi Ishihara (Nagoya University, Japan)

Structure of the turbulent/non-turbulent interface of turbulent boundary layers - DNS results

Abstract: Direct numerical simulations (DNS) of turbulent boundary layers (TBL) along a flat plate are used to study the properties of turbulent/non-turbulent (T/NT) interface of the TBL. The values of the momentum-thickness-based Reynolds numbers used for this study are 500-2200. Analysis of the conditional statistics near the interface of the TBL shows that there is a small peak in the span-wise vorticity, and an associated small jump in stream-wise velocity. It is shown that the interfacial layer has a double structure which consists of a turbulent sub-layer with thickness of the order of the Taylor micro scale and its outer boundary (super layer) with thickness of the order of the Kolmogorov length scale. The velocity jump near the T/NT interface of the TBL is of the order of the rms value of velocity fluctuations near the interface.

Yukio Kaneda (Aichi Institute of Technology, Japan)

Some Lessons from the Statistical Mechanics for Thermal Equilibrium Systems

Abstract: A paradigm of studies of systems involving huge degrees of freedom is the statistical mechanics of systems at or near thermal equilibrium state. It shows that there are universal statistical relations between a few macroscopic variables that are independent from the details in the phase space trajectories. It also shows that there are two kinds of universal relations; those characterizing the equilibrium state itself and those characterizing the response of the system to disturbance added to the equilibrium state. My talk presents a (prejudiced?) review on the history of statistical mechanics for thermal equilibrium systems and on some studies tempted by the analogy of the thermal equilibrium states with turbulent flows.

Martin Oberlack (TU Darmstadt, Germany)

Finally - necessary symmetries identified to compute higher order multi-point statistics for turbulent shear flows

Abstract: Only recently the infinite set of generic statistical symmetries of the multi-point correlation equations derived by the present author in 2010 was finally fully completed for wall-bounded shear flows. Combining them with those from 2010 and the classical symmetries of fluid mechanics led to new symmetry invariant solutions for the higher moments exhibiting an excellent match to a broad variety of wall bounded shear flows such as BL, Poiseuille and Couette flow including those with rotation and transpiration. Other than originally suggested for the mean velocity, higher order moments do not follow the maximum symmetry principle. Instead certain statistical symmetries are only active if the mean velocity in the correspondent direction is non-zero and hence, these new symmetries are of conditional nature.

Naoya Okamoto (Nagoya University, Japan)

Directional multi-scale statistics of quasi-static magnetohydrodynamic turbulence

Abstract: Intermittency and anisotropy of quasi-static magnetohydrodynamic (MHD) turbulence in an imposed magnetic field are examined, using three-dimensional orthonormal wavelet analysis. This analysis is applied to two turbulent MHD flows computed by direct numerical simulation with 512^3 grid points and with different intensities of the imposed magnetic field. It is found that the imposed magnetic field leads to a substantial amplification of intermittency in the velocity field, especially in the direction of the imposed magnetic field. The Eulerian and Lagrangian accelerations are also examined by applying the directional multi-scale analyses.

Rodrigo Pereira (Universidade Federal do Rio de Janeiro, Brazil)

Wavelet methods to eliminate resonances in the Galerkin-truncated Burgers and Euler equations

Abstract: It is well known that solutions to the Fourier-Galerkin truncation of the inviscid Burgers equation (and other hyperbolic conservation laws) do not converge to the physically relevant entropy solution after the formation of the first shock. This loss of convergence was recently studied in detail [S. S. Ray et al., Phys. Rev. E 84 016301 (2011)], and traced back to the appearance of a spatially localized resonance phenomenon perturbing the solution. We propose a way to remove this resonance by filtering a wavelet representation of the Galerkin-truncated equations. A method previously developed with a complex-valued wavelet frame is applied and expanded to embrace the use of real-valued orthogonal wavelet basis, which we show to yield satisfactory results only under the condition of adding a safety zone in wavelet space. This is an important extension that enables the construction of pseudo-adaptive simulations, circumventing the problem of the non-commutativity between the Fourier and the wavelet projection operators. We also apply the complex-valued wavelet based method to the 2D Euler equation problem, showing that it is able to filter the resonances in this case as well.

Norbert Peters (RWTH Aachen University, Germany)

The importance of fine scale turbulence for turbulent combustion

Abstract: Because combustion chemistry introduces many different time scales, when interacting with diffusion, it produces multiple length scales even at laminar conditions. With turbulence added to the problem one therefore has a complex multi-scale problem [1]. This needs to be disentangled by focusing on those regimes where the critical interactions between turbulence and combustion take place. With oxidation reactions taking typically place at the Kolmogorov scales, the layers surrounding a turbulent flame surface extend over regions of fine scale turbulence.

This can be analyzed by decomposing it into dissipation elements, which correspond to Morse-Smale complexes in topology. These elements are elongated structures in one direction with a mean length of 40 Kolmogorov lengths. They are constructed by gradient trajectories between local minimum and maximum points in the scalar field. The joint pdf of the scalar difference ?f at these two points and the length *l* shows Kolmogorov scaling and therefore a close relation to the scaling of structure functions of passive scalars. The marginal pdf of *l* is universal and Reynolds number independent [2].

[1] Peters, N. Multiscale Combustion and Turbulence. Proc. Combust. Inst. 32, 1-25 (2009).

[2] Wang, L., Peters, N., Length scale distribution functions and conditional means for various fields in turbulence, J. Fluid Mech. 608: 113-138 (2008).

Aziz Salhi (Université de Tunis El Manar, Tunisia)

Instability in magneto-gravity-coriolis waves under a periodic shear

Abstract: We study analytically the generation of the instability of the subharmonic resonances in magneto-gravity waves excited by a (vertical) time-periodic shear for an inviscid and non diffusive unbounded conductor fluid. Due to the fact that the magnetic potential induction is a Lagrangian invariant for the magnetohydrodynamic (MHD) Euler-Boussinesq equations, we show that plane waves disturbances are governed by a fourth-dimensional Floquet system in which appear, among others, the parameter ε representing the ratio of the periodic shear amplitude to the vertical Brunt-Väisälä frequency N_3. For sufficiently small ε and when the magnetic field is horizontal, we perform an asymptotic analysis of the Floquet system by using the method of Lebovitz & Zweibel [Astrophys. J. 609, 301 (2004)]. We determine the width and the maximal growth rate of the instability bands associated to the subharmonic resonances. We show that the instability of the subharmonic resonance occurring in the gravity-shear waves has a maximal growth rate of the form $\Delta_m=(3\sqrt{3}/16)\ \varepsilon$. This instability persists in the presence of magnetic fields, but its growth rate decreases as the magnetic strength increases. We also find a second instability involving a mixing of hydrodynamic and magnetic modes that occurs for all magnetic field strengths. On the other hand, we elucidate the similarity between the effect of a vertical magnetic field and the effect of a vertical Coriolis force on the gravity-shear waves considering axisymmetric disturbances. For both the cases, plane waves are governed by a Hill's equation; and, when ε is sufficiently small, the subharmonic instability band is determined by a Mathieu's equation. We find that, when the Coriolis parameter (or the magnetic strength) exceeds $N_3/2$, the instability of the subharmonic resonance vanishes.

Amel Soualmia (Institut National Agronomique de Tunisie (INAT), Tunisia)

Wall parameters of open channel turbulent flow with transverse bottom roughness

Abstract: We present experimental analysis on the structure of the fully developed flow in a straight, rectangular open channel with a sharp transverse variation of the bottom roughness. The contrast of roughness is created by parallelepiped barrettes glued with regular spaces in the central zone of the bed wall, the other parts of the bottom being smooth. In such configurations, the turbulence anisotropy, amplified by wall and free surface interactions, drives secondary motions which affect considerably the structure of the flow. Using a two component laser Doppler anemometer, we obtained a detailed description of the Reynolds tensor and mean velocity fields, including the secondary flows structure. Such a refined definition of the flow is necessary in the determination of the wall parameters such as the roughness function, the origin of the logarithmic law and the friction velocity.

Sedat Tardu (Université de Grenoble, France)

Palm statistics, production and dissipation in low Reynolds number turbulent channel flow

Abstract: Statistical properties at velocity level crossings are analyzed in a low Reynolds number fully developed turbulent channel flow. Different characterizations, such as directional and contour crossings are introduced. Emphasis is placed on local production statistics and dissipation at velocity level crossings, but not exclusively. The results are compared with Gaussian models. The latter predict coincidently the related statistics and only for moderately large crossings thresholds. The streamwise and wall normal velocity components are inherently present in the local production. However, despite the reflectional symmetry, it is the spanwise velocity zero crossings, which contribute most to the mean production in the low buffer layer. The dominating structure is of focus type for the latter components, while the wall normal velocity crossings are partly governed by node-saddle-saddle topology.

Tomomasa Tatsumi (Kyoto University, Japan)

Statistical mechanics of homogeneous isotropic turbulence under the cross-independence closure

Abstract: Succeeding to the previous paper (Tatsumi 2011) which has established statistical mechanics of general fluid turbulence under the cross-independence closure, it is attempted in this paper to apply this statistical mechanical approach to homogeneous isotropic turbulence. Statistics of this turbulence is completely determined by the set of the one and two-point velocity distributions, the latter of which being equivalently represented in terms of the velocity-sum and velocity-difference distributions.

James M. Wallace (University of Maryland, USA)

Highlights of the history of turbulent boundary and shear layer research from the advent of hot-wire anemometry measurements of velocity fluctuations to the present

Abstract: At TCM 2011 the author gave an overview lecture entitled: "Highlights of fifty years of turbulent boundary layer research". This presentation at TCM 2013 will build on the most important aspects of that one with the addition of some of the highlights of research on turbulent shear layers without bounding walls, including simple homogenous shear layers, jets, wakes and planar mixing layers. The research discussed will heavily emphasize experiments and computational studies using DNS and how the evolution of these tools has advanced understanding of these flows. Much of the presentation will describe insights gained over time about the structures of these bounded and unbounded shear flows and their relationship to transport processes within them.

Nobumitsu Yokoi (Institute of Industrial Science, University of Tokyo, Japan)

Transport enhancement and suppression in magnetohydrodynamic turbulence

Abstract: Interactions of the velocity and magnetic fields lead to a variety of interesting phenomena in magnetohydrodynamic (MHD) turbulence. The presence of a magnetic field makes the fluid motions constrained; depending on the physical parameters of MHD flows, fluid motions across the magnetic field are suppressed, turbulence becomes anisotropic with respect to the magnetic field, several modes of MHD waves are invoked, and so on. These processes play important roles in transport phenomena in turbulence. One of the most interesting physical processes appearing at high kinetic and magnetic Reynolds numbers may be turbulent dynamo, where turbulent motions induce a magnetic field, and simultaneously, the induced magnetic field determines the evolution of the flow configurations.

In this talk, how to evaluate the turbulent transport coefficients in the MHD turbulence with large-scale inhomogeneities is discussed. One important point is the effects of pseudoscalars. Global rotation and magnetic field, which are ubiquitous in the real-world MHD phenomena, break the reflectional symmetry of turbulence. A pseudoscalar turbulent quantity such as the turbulent kinetic, magnetic, and cross helicities, which changes its sign under reflection, provides a measure of the breakage of reflectional- or mirror-symmetry. These pseudoscalars are related to transport coefficients that may balance with the enhanced transport due to turbulence, and plays an essential role in suppression of transport due to turbulence. Dynamo is a typical example of such balance between the transport enhancement and suppression, where the presence of the kinetic and current (or magnetic) helicities gives rise to the so-called alpha effect leading to the magnetic-field generation in competing with the field destruction due to the turbulent magnetic diffusivity.

Unlike the usual dynamo arguments where only magnetic induction has been discussed, an emphasis will be made also on the flow induction in MHD turbulence [1]. This subject is definitely of primary importance in several MHD-related phenomena, including the formation of global vortical structures, differential rotation, meridional circulation, and torsional oscillations inside the Sun, zonal flows in fusion plasmas, and the turbulent magnetic reconnection.

[1] Yokoi, N. "Cross helicity and related dynamo," Geophys. Astrophys. Fluid Dyn. 107, 114-184 (2013). http://www.tandfonline.com/doi/abs/10.1080/03091929.2012.754022

Katsunori Yoshimatsu (Nagoya University, Japan)

Predictability of three-dimensional homogeneous turbulence

Abstract: We consider deterministic predictability of three-dimensional incompressible homogeneous isotropic turbulence from a statistical viewpoint. Two turbulent flows, which are statistically identical with each other, are computed by direct numerical simulation. Development of the difference field between the flows, called the error field, is examined, which initially resides only in sufficiently high wave number range. An emphasis is put on two distinct nonlinear effects, the transfer of the error energy and the generation of the error energy.

QUESTIONS

Claude Cambon (Ecole Centrale de Lyon, France)

Question: Is there a future for (theoretical) statistical closures, until three-point, looking at statistical moments, and for multipoint pdf?

Dalila Elhmaidi-Oueslati (Université de Tunis El Manar, Tunisia)

Question: When we will have a complete statistical theory for non homogenous turbulent flows?

Marie Farge (LMD-CNRS, Ecole Normale Supérieure, Paris, France)

Question: Do Eulerian and Lagrangian representations respect the relativity principle?

Can we decouple space and time to describe turbulent dissipation? If not, what would be the most appropriate representation?

Is the fluid incompressibility still an acceptable approximation to describe the physical behaviour of a fully-developed turbulent flow in the vicinity of a wall?

Toshiyuki Gotoh (Nagoya Institute of Technology, Japan)

Question: Where do we find and what do we learn from the universality of turbulence and scalar convected by it ?

Takashi Ishihara (Nagoya University, Japan)

Question: Spectral method vs. finite difference. Which is the better for the studies of high Reynolds number turbulence?

Yukio Kaneda (Aichi Institute of Technology, Japan)

Question: What are the millenium problems in turbulence research? Or equivalently, what do you think are the most interesting or important questions to be challenged in turbulence research in the coming 10 or 100 (or 1000) year time.

Martin Oberlack (TU Darmstadt, Germany)

Question: What determines the numerical values of the group parameter and its combination such as κ in the logarithmic law-of-the-wall?

Naoya Okamoto (Nagoya University, Japan)

Question: There are many types of turbulent flows, HD turbulence, MHD turbulence, quantum turbulence etc. What quantity or way is suitable to characterize how turbulent these flows are?

Rodrigo Pereira (Universidade Federal do Rio de Janeiro, Brazil)

Question: Will we ever make sense of von Kármán's constant appearing on the law of the wall? Do coherent structures have something to do with its value?

Norbert Peters (RWTH Aachen University, Germany)

Question: 1. The origin of the stretched exponential shape of gradient pdfs.
2. For which flows is the Taylor scale rather than the Kolmogorov scale the appropriate length scale and why?

Kai Schneider (Aix Marseille Université, France)

Question: Can the spatio-temporal intermittency of fully-developed turbulence be used to design fully-adaptive DNS?

Sedat Tardu (Université de Grenoble, France)

Question: Are the Very Large Structures passive?

Tomomasa Tatsumi (Kyoto University, Japan)

Question: "Fluid turbulence" associated with the randomness of motion and the dissipation of fluid is usually considered to be one of the most difficult subjects in "physical science".
Even so, I believe that the final theory of fluid turbulence must be "simple and complete" as a solution of physical science.

James M. Wallace (University of Maryland, USA)

Question: How can the insights about the physics of turbulent flows from the very large and ever growing number of studies about their structure be incorporated into LES computations for practical engineering applications?

Nobumitsu Yokoi (Institute of Industrial Science, University of Tokyo, Japan)

Question: How the regions with high and low turbulent transports can be globally localized in MHD turbulence?
- The solar magnetic fields are always observed in a fiber state. How such localized structures can be generated and persistently sustained in highly turbulent media?
- How microphysics of magnetic reconnection can be connected with the global MHD phenomena typically observed in the solar flare eruption?

Katsunori Yoshimatsu (Nagoya University, Japan)

Question: What quantities do characterize statistical law of flow predictability?