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Prof. Haris J. Catrakis, University of California, USA
Dr. Nikolai Kobasko, IQ Technologies Inc., USA
Prof. Sarka Necasova, Czech Academy of Sciences, Czech Republic
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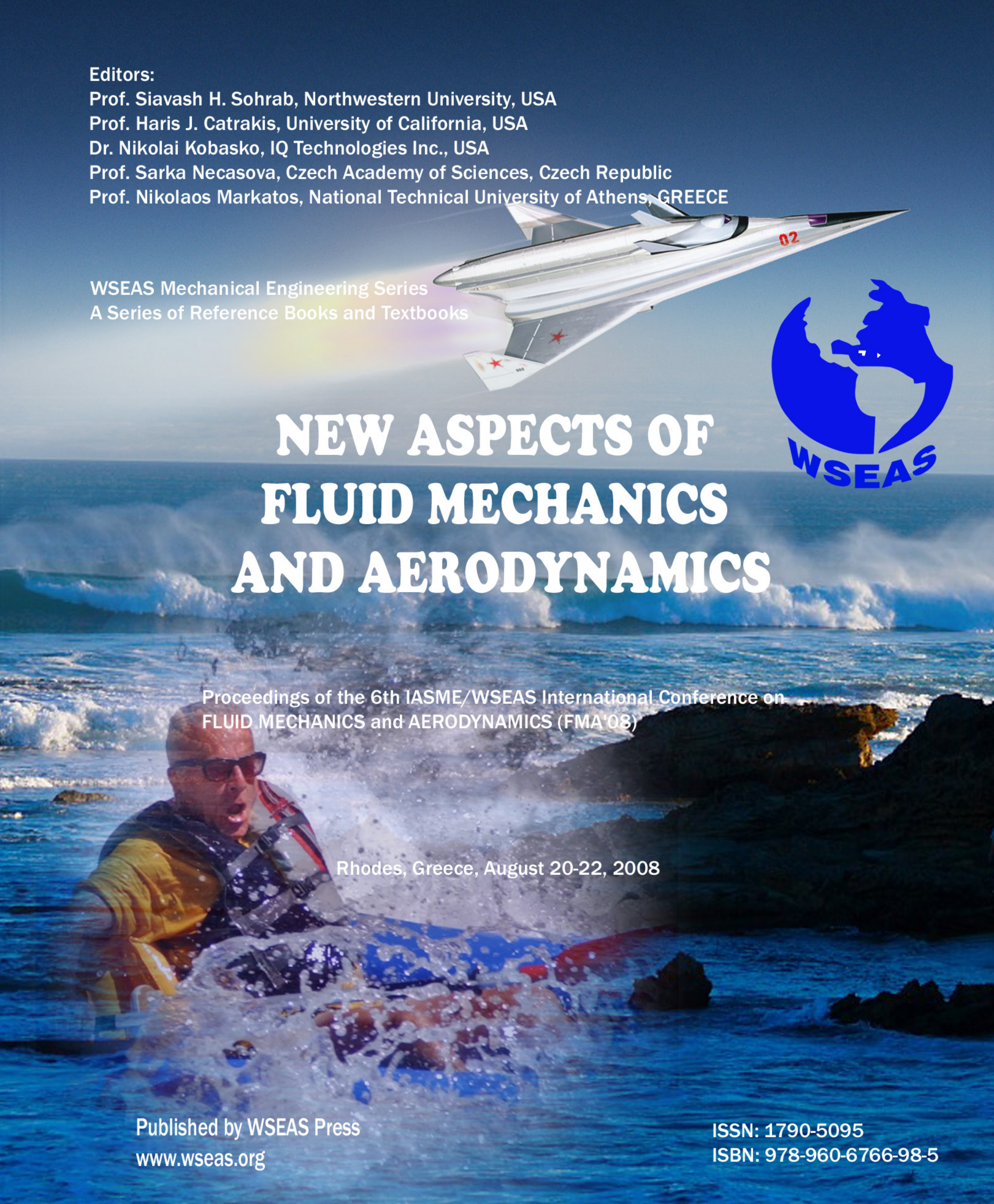

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NEW ASPECTS OF FLUID MECHANICS AND AERODYNAMICS

Proceedings of the 6th IASME/WSEAS International Conference on
FLUID MECHANICS and AERODYNAMICS (FMA'08)

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Preface

This book contains the proceedings of the 6th WSEAS International Conference on FLUID MECHANICS and AERODYNAMICS (FMA'08) which was held in Rhodes, Greece, August 20-22, 2008. This conference aims to disseminate the latest research and applications in Mathematical Modeling in Fluid Mechanics, Simulation in Fluid Mechanics, Numerical Methods in Fluid Mechanics, Convection, Heat and Mass Transfer, Environmental Problems, Water Resources Management, Environmental Fluid Dynamics, Waste Management, Wave Modeling, Hydraulic and Thermal Turbomachines, Mathematical Models and other relevant topics and applications.

The friendliness and openness of the WSEAS conferences, adds to their ability to grow by constantly attracting young researchers. The WSEAS Conferences attract a large number of well-established and leading researchers in various areas of Science and Engineering as you can see from **http://www.wseas.org/reports**. Your feedback encourages the society to go ahead as you can see in **http://www.worldses.org/feedback.htm**

The contents of this Book are also published in the CD-ROM Proceedings of the Conference. Both will be sent to the WSEAS collaborating indices after the conference: **www.worldses.org/indexes**

In addition, papers of this book are permanently available to all the scientific community via the WSEAS E-Library.

Expanded and enhanced versions of papers published in this conference proceedings are also going to be considered for possible publication in one of the WSEAS journals that participate in the major International Scientific Indices (Elsevier, Scopus, EI, ACM, Compendex, INSPEC, CSA .... see: www.worldses.org/indexes) these papers must be of high-quality (break-through work) and a new round of a very strict review will follow. (No additional fee will be required for the publication of the extended version in a journal). WSEAS has also collaboration with several other international publishers and all these excellent papers of this volume could be further improved, could be extended and could be enhanced for possible additional evaluation in one of the editions of these international publishers.

Finally, we cordially thank all the people of WSEAS for their efforts to maintain the high scientific level of conferences, proceedings and journals.

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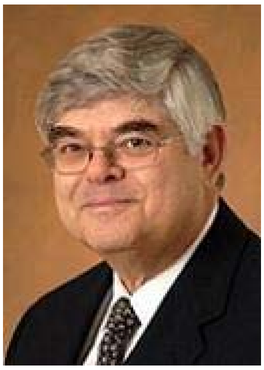
Plenary Lecture I

Scalar Dispersion and Turbulent Mixing in Grid Turbulence, More Complex Flows, and on Geophysical Scales



Professor Paul E. Dimotakis
John K. Northrop Professor of Aeronautics and Professor of Applied Physics
California Institute of Technology
Pasadena, CA 91125
Tel/Fax: USA (626) 395-4456/-4447
USA
E-mail: dimotakis@caltech.edu

and

Chief Technologist
Jet Propulsion Laboratory, M/S 180-601
4800 Oak Grove Drive
Pasadena, CA 91109-8099
Tel/Fax: (818) 393-7600/-1554
USA
E-mail: Paul.E.Dimotakis@jpl.nasa.gov

Abstract: Scalar dispersion and mixing in turbulent flows are important phenomena in a variety of contexts. These range from internal combustion in general and chemical air-breathing propulsion, to local atmospheric pollution and dispersion, to Earth system transport and climate modeling. The first part of the discussion will focus on the structure of the scalar dispersion field originating from a continuous release point in moderate Reynolds number flow in grid turbulence. Using laser-induced fluorescence techniques, laser-volume scanning, a custom-designed fast-readout CCD focal plane array, and high-speed digital-imaging/-acquisition/-storage techniques, the instantaneous three-dimensional structure of a passive scalar in flow in water will be presented. The instantaneous three-dimensional topology of scalar structures and their persistence in the self-similar grid-turbulence regime where the present three-dimensional scalar-field measurements were conducted will also be discussed. The second part will focus on scalar transport and mixing in a complex recirculating flow, in which molecular mixing is quantitatively measured in chemically reacting flows using hydrogen and fluorine as reactants in the mixing-limited (high Damkohler number) chemical reaction regime. Finally, recent space observations of the concentration of carbon dioxide at a pressure height of 500 mbar in the atmosphere will be presented and discussed, along with their implications to global transport and dispersion in the northern and southern hemispheres.

Brief Biography of the speaker: Paul E. Dimotakis received his degrees at the California Institute of Technology (Physics, Nuclear Engineering 1969, and Ph.D. in Applied Physics). He stayed on at Caltech where he is presently the John K. Northrop Professor of Aeronautics and Professor of Applied Physics. Starting in January 2006, he also serves as the Jet Propulsion Laboratory (JPL) Chief Technologist.

Following work on liquid helium and superfluidity, his research focused on investigations of turbulent-flow phenomena, with an emphasis on turbulent transport and mixing in chemically reacting as well as non-reacting flows and combustion, in both subsonic and supersonic flows. He and his co-workers have developed several experimental facilities, diagnostic methods, introduced advances in signal processing, high-speed digital temporal- and image-data acquisition techniques, high-speed CCD imager design, and image-data processing. His research has also included work on active control of separated flows, studies of cavitation, hydrodynamic stability and gasdynamic simulations, image-correlation techniques for velocity-field (optical-flow) measurement, multi-dimensional measurements, aerooptics effects as well as work on adaptive optics. In work outside Caltech as a consultant, he has participated in the development of pilotless drones, high-power chemical lasers, the stealth fighter, the development of the Space Shuttle aerodynamics, assisted in the internal aerodynamics of sealed computer (Winchester) disks, helped with the fluid mechanics design of the "Leap-Frog fountain" at Disney's Epcot Center in Florida, and participated in experiments in the Lawrence Livermore's laser facilities. Also a sailor, he was a member of the AMERICA3 sail-design team in their successful defense of the Americas Cup in 1992. Paul Dimotakis has served as Associate Editor for the J. Fluid Mechanics, is presently a Fellow of the American Physical Society, an Associate Fellow of the AIAA, and was recently elected Fellow of the AAAS.

He has served on National Academy of Science panels on Inertial Confinement Fusion and High-Energy Density Physics, and has led studies on space-launch options, space propulsion, hypersonics, high-speed ships, thermal management of high-energy lasers, fossil-fuel use by the Department of Defense, long-endurance UAVs, and on other topics.

Plenary Lecture II

Rotor-Stator Interactions in Centrifugal Diffuser Pumps

Professor F.-K. Benra
University of Duisburg-Essen
Faculty of Engineering Science
Institute of Energy and Environmental Engineering
Chair of Turbomachinery
Lotharstr. 1
47048 Duisburg,
GERMANY

Abstract: The flow in vaned diffuser pumps is dominated by strongly unsteady interactions due to the relative motion and close proximity between the rotating impeller and the stationary diffuser. This phenomenon is known as rotor-stator interaction, resulting in pressure and velocity fluctuations both upstream and downstream. In the past, some research work was conducted to investigate impeller-diffuser interactions both numerically and experimentally. LDV (Laser Doppler Velocimetry) and PIV (Particle Image Velocimetry) were applied to measure the unsteady flow field. Here important work was done for example by Hajem et al., Akhras et al., Sinha et al., and Wuibaut et al.. Some other work was performed to study the pressure fluctuations in the diffuser region. For example, Qin and Tsukamoto calculated pressure fluctuations in the diffuser region by a two-dimensional singularity method. Wang and Tsukamoto developed a two-dimensional vortex method to investigate pressure fluctuations both in the impeller and diffuser regions. Shi and Tsukamoto studied pressure fluctuations in the diffuser region by a CFD code. Furthermore, experiments were conducted to measure pressure fluctuations in centrifugal diffuser pumps by Arndt et al., Furukawa et al., Guo and Maruta. All the above mentioned experimental and numerical investigations contribute to a better understanding of rotor-stator interactions in centrifugal diffuser pumps; however the amount of available data is still not sufficient. Particularly, most research on the unsteady pressure fluctuations has been conducted only in the diffuser region, but less for the impeller region. At the chair of turbomachinery of University Duisburg-Essen recently the unsteady phenomena induced by rotor-stator interactions have been investigated in a centrifugal diffuser pump which had a small specific speed. The pressure and velocity fluctuations and also associated unsteady effects were investigated numerically and experimentally in a wide range of flow rates and for different radial gaps and blade number configurations. Experimental results for some cases were compared with numerical results and discussed in detail, in order to enhance the comprehension of rotor-stator interactions in centrifugal diffuser pumps.

Brief Biography of the speaker: Dr. Benra graduated with a diploma degree in Mechanical Engineering at University of Duisburg in 1979. Afterwards he worked as a research assistant at the University of Duisburg and obtained his doctoral degree in Mechanical Engineering in the field of Turbomachinery in 1986. From 1986 to 1989 he was chief of the department for design and development of radial compressors at Mannesmann Demag Company and from 1989 to 1993 he was chief of department for research and development of centrifugal pumps at company Pleiger. Since 1993 he is full Professor for Mechanical Engineering at University Duisburg-Essen in the field of Turbomachinery and since 2002 he is the head of the Chair for Turbomachinery at University Duisburg-Essen, Germany. His area of expertise in teaching are: Thermofluid Engineering and Energy Conversion in all kinds of Turbomachines. His current research topics are: Numerical and experimental investigation of time-variant flow in Turbomachines (rotor/stator interaction, fluid/structure interaction, flow along rough or structured surfaces).

Plenary Lecture III

Mixed Convection in Ducts

Professor Nicolas Galanis
Professeur titulaire
Chaire CRSNG en efficacité énérgetique industrielle
Departement de genie mécanique
Université de Sherbrooke
Sherbrooke (QC) CANADA J1K 2R1

Abstract: Mixed convection in ducts occurs in many industrial installations when heat transfer rates are high and mass flow rates are low. In such cases, the buoyancy force influences the velocity and temperature profiles which are very different from those for forced convection or isothermal flows. Furthermore, flow reversal takes place in many cases and turbulent flow may occur for Reynolds numbers as low as 1000.

The presentation will review experimental, analytical and numerical results for different Prandtl, Grashof and Reynolds numbers. It will illustrate the axial evolution of velocity and temperature as well as those of the Nusselt number and friction coefficient for both conventional fluids and nanofluids. The production of entropy due to heat transfer and viscous effects will also be presented and discussed.

Brief Biography of the speaker: Dr. Nicolas Galanis received his engineering degree from the National Polytechnic of Athens, Greece and his Ph.D. from Cornell University of Ithaca, N.Y., U.S.A. He is Professor of Mechanical Engineering at Universite de Sherbrooke, Quebec, Canada where he is the senior chairholder of the NSERC Chair in industrial energy efficiency. His research activities deal with energy conversion, renewable energies, refrigeration, fluid mechanics as well as heat and mass transfer. He is the author of more than 250 papers published in peer reviewed journals or conference proceedings. In 2005 the Canadian Society of Chemical Engineering and the Canadian Society of Mechanical Engineering awarded the Jules Stachiewicz Medal to Dr. Galanis for "…outstanding contributions to heat transfer in Canada".

Dr. Galanis has participated in research projects in Australia, France, Morocco and Tunisia. He has taught intensive courses at the University of Porto in Portugal and at Ecole Nationale d'Ingenieurs de Monastir in Tunisia. He is the cofounder of the Colloque Inter-Universitaire Franco-Quebecois which takes place every second year since 1993 alternatively in France and Quebec.

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Plenary Lecture IV

The Optimization of CUMULUS Micro Aerial Vehicle Aerodynamics by using the Adaptive Flexible Wing Tip Concept

Professor Boscoianu Mircea
Co-authors: Adrian Coman, Pahonie Radu
Aircraft Department
Military Technical Academy
81-83, G. Cosbuc street, 5 sector, Bucharest
ROMANIA

Abstract: We propose a numerical analysis for improving the aerodynamic, dynamic performances and the quality of flight of Cumulus fixed flying wing MAV. The aim is to extend the flight envelope (efficient reducing of minimum speed and a better behavior at high angles of attack near stall) by using a special flexible configuration at the tip of the wing. This adaptive flexible wing solution was propose for the first time at University of Florida (US) although not in this form. This solution utilized a combination of biological concepts and composite material to produce a thin undercambered, flexible wing and then analyzed the effects of the morphing mechanism in the wind tunnel. For Cumulus the central planform remains rigid but the tips will be modified for a flexible solution. We propose also an innovative deep stall maneuver for emergency landing by using this adaptative flexible concept for Cumulus flying wing MAV previously developed and designed. A morphing MAV is generally accepted to be a small aircraft whose shape changes during flight to optimize performances especially in critical regimes. The morphing of the wing tips investigated here essentially acts like a control effector in that their shapes are changed to alter the flight dynamics. So we use the simple form of morphing: a twist of the wing tips. The solution to generate this twist at the tips is to modify the membrane of the wing with a simple mechanism which is easily achieved by using standard actuation schemes. Twist can be achieved by connecting parts of the wing to a servo in the semi flexible fixed wing. Twist can also be achieved by embedding carbon fiber torque rods into the structure. Any method is good considering the small loading of the wing tips generated by the low flight speeds. Miniature airplanes are extremely sensitive to wind gusts, but the using of the flexible wing tip concept produce an efficient improving of stability of flight and the capacity to react at critical regimes, typical for a MAV mission. This is achieved by the washout effect that takes place as the wing tip deforms when excessive load is applied during windy conditions. The span of the flexible wing tip is an important factor that is also taken under consideration and study. After experiencing a wind gust, the wing tip will return to its original shape. The washout effect reduces the induced drag on the wing tips of the wing and creates a higher lift to drag ratio . We are able to prove that the (semi) flexible wing has the ability to generate washout during aerodynamic loading. Having washout on a wing reduces the induced drag of the wing, and raises the lift to drag ratio of the aircraft. The extent of washout is determined by calculating the negative angle between the root chord and the tip chord.

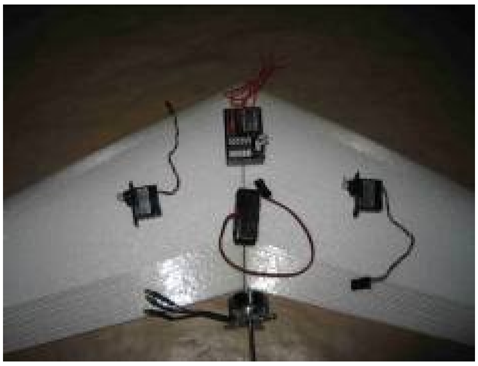

Fig.1 Cumulus flying semi flexible fixed wing MAV

This paper demonstrates that this solution with morphing membrane wing tips is particularly suitable for this class of small UAV. The morphing of the wing tips can be done with little power but with significant benefits on performances and quality of flight. Also high-agility maneuvering can be obtained by effective exploitation of the stall characteristics.

Plenary Lecture V

A Modified Scale Invariant Statistical Theory of Turbulence

Professor Siavash H. Sohrab
Robert McCormick School of Engineering and Applied Science
Department of Mechanical Engineering
Northwestern University, Evanston, Illinois 60208
USA

Abstract: A scale-invariant model of statistical mechanics is applied to derive the invariant forms of the conservation equations for mass, energy, and linear and angular momentum. The connection between the modified and the classical Navier-Stokes equation of motion will be described and the historical evolution of important features of the latter will be critically examined. The modified form of the equation of motion will be shown to lead to a modified statistical theory of turbulence. General aspects of the modified invariant statistical theory of turbulence will be described and its predictions will be compared with the existing experimental data. In addition, the phenomena of super-fluidity, super-conductivity, and super-luminosity (laser-action) will be discussed in terms of transitions from turbulent (highly dissipative) to laminar (weakly dissipative) flows for the statistical fields respectively corresponding to molecular-dynamic, electro-dynamic, and chromo-dynamic scales. It will be shown that the notion of Reynolds stresses and their role in the closure problem of turbulence is harmonious with the modified theory. The implications of the modified theory to the phenomenon of turbulent energy spectra, energy dissipation, Kolmogorov length scale, and the inertial subrange will also be discussed.

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Plenary Lecture VI

Engine-Structure Interactions during the Powered Flight of Atmospheric Vehicles

Professor Radu D. Rugescu
Chair of Aerospace Sciences "Elie Carafoli"
University "Politehnica" of Bucharest
Spl. Independentei 313 sector 6, 060042 Bucuresti,
ROMANIA

Abstract: While the base drag developed during the atmospheric flight is a well-known factor in the balance of forces that act upon the vehicle structure, its action as a thrust induced drag is less considered in flight optimization technology. The effect of that drag component over the performances of space vehicles is considerable however and stands as the main focus in the optimal flight control and thrust programming during the atmospheric ascent. The most impacting difficulty in this approach resides in the discontinuous effect of the engine-structure interaction at engine cut-off and re-start into the aerodynamic drag. The omission of this discontinuity is ubiquitous within professional flight optimization algorithms and codes. This interaction is effective up to medium altitudes of about 40 km, still they produce the entire atmospheric drag during the usual ascent to space. Consequently the analytical methods of optimization, including the variational approach, which require up to fourth order continuity of the integrand in the functional, cease to be applicable at all. A new type of variational method is presented that overcomes these discontinuities and offers a solid means of solving more general optimization problems with weak and strong discontinuities as well. Numerical results show important mass savings for Earth atmosphere ascent and especially during Titan escape ascent for return to Earth in far missions of the future.

Brief Biography of the Speaker: Dr. Radu D. Rugescu, Romania, is affiliated with University "Politehnica" of Bucharest, Chair of Aerospace Sciences "Elie Carafoli", Space Sciences Division since 1969, successively as Assist. Prof. and Professor. With interests and expertise in Astronautics, Propulsion Systems, Robotics, Optimization and Statistics, he teaches courses in Romanian, English and German on "Numerical methods", "Manufacturing technology of aerospace systems", "Astrodynamics", "Turbomaschinen". His research firsts include a Genuine Rocket Solid Propellant in 1959, The first Romanian liquid propellant rocket engine in 1969, the first Capture of freezing temperature of water-gas reaction in 1982, the first Romanian air-breathing rocket engine in 1987, a New variational method for discontinuous integrands in 1997, a new technology for Air captured imaging and TV live transmission from high altitude airplanes of solar eclipse in 1999, non-Keplerian gravity coupling of very large space structures in 2004.

Participates in EU funded research projects in space technology as Romanian Director. Conducts a five-year collaborative research with Texas A&M University, USA, where had performed a Fulbright research grant under sponsorship of the State Department in Space Ecology. He is known for 175 publications, including nine books. He is active member of the Astronautics Commission of the Romanian Academy since 1975, member of the International Institute for Acoustics and Vibrations since 2002 and in other societies.

Plenary Lecture VII

Modeling Nonlinear Flow during Alloy Solidification

Professor Daniel N. Riahi
Professor Emeritus of Mechanical Science and Engineering at the University of Illinois at Urbana-Champaign,
Professor of Mathematics at the University of Texas-Pan American, U.S.A.
Department of Mathematics, 1201 West University Drive,
University of Texas-Pan American,
Edinburg, Texas78539-2999 U.S.A.
E-mail: driahi@utpa.edu

Abstract: We consider the problem of nonlinear buoyant convection in horizontal mushy layers during the solidification of binary alloys. We present and validate a new model to understand such flow that can be used, in particular, for flow control purposes to reduce tendency for chimney formation within the mushy layers. The chimneys produce undesirable freckles in the final form of the solidified alloys, which are imperfections that reduce the quality of the material. Methods of control aiming at eliminating the convective flow in the chimneys also serve to eliminate the presence of chimneys thereby result in producing higher quality crystals. For the new model, no assumption is made on the thickness of the mushy layer, and a number of simplifying assumptions made in previous theoretical investigations of the problem are relaxed here in order to study the problem based on a more realistic model. Using both analytical and numerical methods, we determine the solutions for the nonlinear problem in a range of the Rayleigh number R near its critical value. We found that depending on the range of values of the parameters, bifurcation to convective flow can be either supercritical or subcritical. However, among all the computed solutions in particular range of values of the parameters that are mostly relevant to those of experiments and in contrast to all the previous studies, only particular form of the convective flow, which has been observed in the experiments, was found realizable, in the sense that its amplitude increases with R.

Brief Biography of the Speaker: Daniel N. Riahi joined Dept of Theoretical and Applied Mechanics (TAM) of The University of Illinois at Urbana-Champaign (UIUC) in 1980 and later affiliated with Dept of Mechanical and Industrial Eng (MIE) at UIUC. He served as Full Professor at UIUC from 1995 to 2005 and as Professor Emeritus at UIUC since 2005 with the Home Dept of Mechanical Science and Eng (MechSE) after joining MIE & TAM as a combined MechSE Dept at UIUC in 2006. Professor Riahi also was appointed as Full Professor in the Dept of Math at University of Texas-Pan American since 2006. Dr. Riahi was a Cambridge Univ. (U.K.)-Visiting Scholar in 1986. Earlier than 1980, Dr. Riahi worked at UCLA, Winthrop Univ. and a three-year Post-Doctoral position at the Florida State Univ. (FSU). His academic degrees are Ph.D. in Applied Math (Fluid Mech.) from FSU in1974, M.S. in Math from FSU in 1970 and B.S. in Math from Tehran Univ. in 1966.

Dr. Riahi's research work & interest in the last four decades include studies in convection, flow instabilities & turbulence, flow during solidification & crystal growth, and math modeling and theoretical developments with applications to eng and physical sciences. Professor Riahi received UIUC-MechSE &UIUC-TAM Service Appreciation Letters in 2006, a UIUC Service Recognition Certificate in 2006, a UIUC Honorific Title Award in 2005, a UIUC-TAM Recognition Award in 2005. He was included in a UIUC List of Teachers Rank as Excellent by their Students. He is member of over seven professional societies and a Fellow of Wessex Institute of Great Britain. He is author of Chapters in a book on Centrifugal Processing that won the Best Basic Science Book-Award by International Academy of Aeronautics in 1997. Dr. Riahi also received a UIUC-COE Research Award in 1994 and an Outstanding UIUC Service Recognition Certificate in 1987. He is author of over 310 publications mostly published in rigorously referred journals, including books, invited articles and chapters of books. Dr. Riahi's Professional Activities include Chairman of Applied Math at Winthrop Univ. (1977-78), and UIUC Eng Mech Coordinator and Chief Advisor (1985-86). He was awarded NSF Grants and supervised NASA Sponsored Res. Projects. He also received several UIUC-RB Research Grants and NCSA Awards. He is ABI's Research Board

Advisor, Member of the Program Committee of the 4th Int. Workshop on Materials Processing in High Gravity, Member of the Int. Scientific Committees of the 5th and 6th Int. Conferences on Advances in Fluid Mechanics and Member of Int. Scientific Advisory Board of Advances in Fluid Mech. He is Editor & Editorial Board Member of over 15 Technical Journals and Book Series.

Research Accomplishment of Daniel N. Riahi: Dr. Riahi's research accomplishments include new theories, such as those for flow in mushy layers, shear flow over wavy walls, rough turbulence and convective flow in the presence of imperfections, uncovering new types of flow patterns for simple- or mixed-modes and multi-modal cases, and a number of discoveries in fundamental areas of convective and shear flows, some of which were already confirmed by the experimental studies. These include, in particular, flow structure during alloy solidification, roughness roles in turbulent shear flow, flow patterns in layers with finite conducting boundaries and non-monotonic dependence of the heat flux with respect to the rotation rate.

Complete Affiliation:

(a) Professor Emeritus, Department of Mechanical Science and Engineering, University of Illinois at Urbana-Champaign, U.S.A. (http://www.mechse.uiuc.edu/)

(b) Professor, Department of Mathematics, University of Texas-Pan American, U.S.A. (http://www.math.panam.edu/driahi.html)

Mailing address: Department of Mathematics, THE UNIVERSITY OF TEXAS-PAN AMERICAN, #1201 West University Drive, Edinburg, Texas 78541-2999; Telephone: 956-316-7063 (E-mail: driahi@utpa.edu) (http://myprofile.cos.com/riahi).

Plenary Lecture VIII

Plasma-Assisted Aerodynamics: Approach and New Results

Professor Sergey B. Leonov
ProLaboratory of Experimental Plasma Aerodynamics,
Dept. Plasma and MHD,
Joint Institute for High Temperature Russian Academy of Science,
Izhorskaya str., 13/19, Moscow, 125412,
Russia
E-mail: leonov@ihed.ras.ru

Abstract: The paper considers several distinctive ideas of the “Plasma Aerodynamics”. A general approach is based on the reveal of main physical mechanisms of electrical discharges interaction with a high-speed gas flow: heating, electro-dynamic, magneto-dynamic, and chemical activation. The results of lab-scale experiments are discussed: drag reduction by in-front-of-body plasma generation; supersonic flow structure control by near-surface discharge; boundary layer actuation by dielectric barrier discharge (DBD); high-speed combustion intensification. Typically, in-flow generated plasma appears as a non-uniform and unsteady formation. At some important cases unsteady plasma manipulation can give a large benefit in power consumption. The idea of plasma strong non-uniformity in space structure, non-equilibrium composition, and unsteady temporal behavior gives chance to decrease required energy deposition down to reasonable level at quite sufficient effect. Close problems are typical at attempts of plasma applications in a field of internal flows governing and high-speed combustion enhancement. In each specific case the problem is arisen of suitable diagnostics application. In comparison with a gasdynamic test a quantity of parameters to be measured in plasma-assisted experiment is larger significantly. The conditions for diagnostic are more complex and some widely used methods are not applicable due to high level of EM noise, contaminations, extra radiation, high-amplitude electric field, and so on. The most used methods are applied in non-standard configurations or require a special adjustment.
The results of several experiments are presented to demonstrate abilities of electrical discharges for flow control. Specific experimental technique in Plasma-Assisted Aerodynamics is discussed as well.

Brief Biography of the Speaker:

Name: Sergey B. Leonov
Born: 16 May 1958, Russia
Post box: Izhorskaya str., 13/19
Moscow, 125412, Russia
Joint Institute for High Temperature RAS
Phone: +7(495) 484 1811 (business hours)
+7(916) 684 1304 (cell)
Fax: +7(495) 483 2285
E-mails: Leonov@ihed.ras.ru
sleo58@gmail.com

URL: http://www.plasmaero-ivtan.ru

Education:
Master Degree 1981 Moscow State University physics
PhD 1990 Baltic State University mechanics of gases and plasmas

DSc 2006 Institute for High Temperature physics and mathematics

Affiliation:

From – To:
1976-1981 Moscow State University Student (CARS measurements in MW Discharge)
1981-1985 Institute of Atomic Power Stations Scientist (Diagnostics of Fusion Plasma)
1985-1997 State Institute of Aviation Systems Senior Scientist (Plasma Generation, Gasdynamics)
1996-1998 Moscow Technical Company Deputy Director on Science
1998-now Joint Institute for High Temperature Head of Laboratory (Experimental Plasma Aerodynamics)

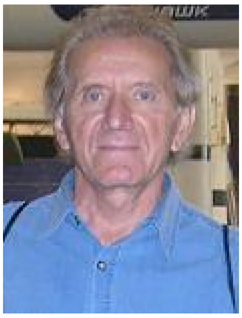
Fields of Expertise:
Gasdynamics and Aerodynamics
High-Speed Combustion
Plasma Science
Experimental Plasma Aerodynamics
Measurements (gasdynamic, electrical, optical)

Present Position:
Joint Institute for High Temperature Russian Academy of Science
Head of Laboratory of Experimental Plasma Aerodynamics

Others:
AIAA Associate Fellow
IEEE Member
2001 Awarded by “Who is Who in Science and Engineering”
Publications: more than 100
Married, 3 children

Plenary Lecture IX

The Structure of Stratfied Boundary Layers: Study with Of Nonlocal Turbulence Model



Professor Albert Kurbatskiy
Institute of Theoretical and Applied Mechanics
Russian Academy of Sciences, Siberian Branch,
Novosibirsk State University
630090, Novosibirsk,
Russia
E-mail: kurbat@nsu.ru

Abstract: Two types of vertical turbulence structure have been identified, one the "traditional" boundary layer, in which turbulence is generated at the surface and transported upward, in contrast to the second type, where turbulence is transported downward from a primary source aloft in the boundary layer. The latter has been referred to as an "upside-down boundary layer". In this case the turbulence may burst downward toward the surface as an event process. In this study, the boundary layer is upside down if turbulence increases with height and the transport of turbulence energy is downward toward the surface. Presumably, a similar structure can be developed in flow of air from warm area (urban heat island, for example) to cool land surfaces, where the horizontal gradient of temperature between air above the city and air above the rural area generates thermal turbulent circulation. If this turbulence generation is substantially larger than the generation of turbulence due to surface processes, then the vertical transport of turbulence is downward toward the surface. In present study the vertical profiles of wind speed, temperature and turbulent quantities in nocturnal urban boundary layer, calculated by means of improved мesoscale model, is analyzed toward the aim of understanding the vertical structure of the nocturnal urban boundary layer. A large set of field and laboratory measurements, and large eddy simulation (LES) data indicates that in stably stratified flows turbulent mixing exists up to Ri ~ *O*(100), meaning that there is practically no Ri(cr). On the other hand, traditional local turbulence models entail a critical Ri(cr) ~*O*(1) above which turbulence ceases to exist and are therefore unable to explain the above data. In this study it is shown, that the discussed here the nonlocal turbulence model is capable to reproduce the above data for arbitrary Ri

Brief Biography of the Speaker:

Field of research: Fluid dynamics, turbulence modeling, numerical simulation, environment flows.

Surname: Kurbatskiy First name: Albert Date of birth: March 9, 1937

Affiliation: Laboratory of Turbulence Modeling, Institute of Theoretical and Applied Mechanics (ITAM SB RAS) Russian Academy of Science, Siberian Branch and Professor at the Department of Physics, Novosibirsk State University (NSU).

Address: Institutskaya Street, 4/1, 630090 Novosibirsk, Russia

Phone: +7(383)3307805 Fax: +7(383)3307268 E-mail: kurbat@nsu.ru

Education: Graduated from Physics Department of Novosibirsk State University (NSU), 1963.

Brief description of professional career (including the title of the dissertation work, the year and the Institution where it has been defended):

1. Junior, Senior, Leading Principal Scientific Researcher, Principal Scientific Researcher of ITAM SB RAS, January, 1964 – till now.

2. Professor at the Department of Physics, Novosibirsk State University (NSU), 1987-till now.

Ph.D. Thesis: "Modeling of turbulent mixing layer with a chemical reaction», 1975, Institute of Thermophysics of Russian Academy of Sciences, Siberian Branch.

Degree of Doctor (Physics and Mathematics): «Mathematical modeling of non-local turbulent transport of the momentum and heat», 1984, Institute of Thermophysics of Russian Academy of Sciences, Siberian Branch.

Other fields: The membership on the Academic council of the Department of Physics at the NSU, the member of the editorial board of the Thermophysics and Aeromechanics International Journal (Russian Academy of Sciences, Siberian Branch, Novosibirsk).

List of recent grants for fundamental research: Grant INTAS-OPEN-97-2022 (1998-2001, investigator); Grants of Russian Foundation for Basic Research (1997-99, 2000-02, 2003-05, 2006-08; team leader).

Publications: Number of communications to scientific meetings: 49. Number of papers in refereed journals: 75. Number of all science papers (including reprints): 104.

Plenary Lecture X

Instability and Receptivity of a Compressible Boundary Layer

Professor **Sergey A. Gaponov**
Institute of Theoretical and Applied Mechanics (ITAM),
SB RAS, 630090, Novosibirsk,
RUSSIA
Fax: +7(383)3307268
E-mail: gaponov@itam.nsc.ru
Web site: http://www.itam.nsc.ru/

Abstract: A strong international interest in problems receptivity and stability exists in connection with studies of the laminar- turbulent transition in wall-bounded shear layers of gas-turbine-engine blades and vanes, low-Reynolds-number vehicles, submarines and torpedoes, subsonic and supersonic civil transports and reentry vehicles. The onset of turbulence in the boundary layer comprises three main stages: (a) receptivity, (b) linear stability, and (c) nonlinear breakdown.

During the first stage, in the region of relatively low local Reynolds number, instability waves are generated. The problem of generating these waves by perturbations (which include acoustic, vortical, temperature) is referred to as the problem of boundary-layer receptivity to external disturbances. This aspect of the transition process was clearly formulated for the first time by Morkovin as the problem of transformation of external disturbances into eigen boundary-layer oscillations.

The second stage of transition corresponds to the propagation of small-amplitude instability waves down the boundary layer, which are either amplified, if the flow is unstable to them, or attenuated. This stage is described by linear hydrodynamic stability theory.

The objective of this paper is to provide a critical evaluation of stability and receptivity for the compressible boundary layer (mainly for supersonic flows).

Receptivity of supersonic boundary layer to acoustic, vorticity and thermal disturbances is considered too. Boundary layer internal eigen oscillations are mostly excited by acoustic waves with finite angles of incidence whose wave fronts are parallel to plate leading edge. For angle of incidence equals to zero, the most intensive fluctuations are excited by oblique waves. The exact value of this angle slowly depends on basic flow and acoustic wave parameters. The intensity of internal disturbances exceeds much the amplitude of external acoustic wave. As concern to the boundary layer interaction with external perturbations, which are transferred by a mean flow, it was found that the efficiency of the eigen boundary layer disturbances excitation is much higher for three-dimensional (3D) waves comparing to 2D one and it is increasing with decreasing frequency. So the maximal flow distortion was found for steady disturbances, which induce stream-wise structures inside the boundary layer.

The linear stability analysis of supersonic boundary layers uncovers some differences between supersonic instability and the subsonic one. The extension of the Rayleigh inflection-point criterion to compressible boundary layers has an important change from incompressible boundary layers. Lees & Lin and Mack classified the disturbance according to the disturbance phase speed relative to the boundary-layer edge velocity: 1) subsonic, 2) sonic and 3) supersonic. One of the most significant developments in compressible theory consists in detection of new unstable waves. At moderate Mach numbers most unstable are the three-dimensional (3-D, inclined) waves of the first mode. The lowest-frequency the so-called second mode is found to be the dominant instability for Mach number greater than about 4; it is more unstable than either the 3-D first mode.

When the amplitudes of instability waves reach considerable values the flow enters a phase of nonlinear breakdown, randomization, and a final transition into a turbulent state. In the case of a weak non- linearity it is watched the development of non-symmetrical triads, because of the primary unstable mode is three-dimensional in the supersonic boundary layer. If the amplitudes are large enough the three-dimensional disturbances could be degenerate into two- dimensional.

All this problem will be considered in the report.

Brief Biography of the Speaker:

Field of research: Fluid dynamics, laminar- turbulent transition in wall-bounded shear layers.

Surname: Gaponov First name: Sergey Date of birth: August 20, 1940

Affiliation: Laboratory wave processes in supersonic viscous flows, Institute of Theoretical and Applied Mechanics of Siberian Branch of Russian Academy of Science (ITAM SB RAS); Professor at the Department of Theoretical Mechanics, Novosibirsk State University of Architecture and Civil Engineering (NSUACE).

Address: Institutskaya Street, 4/1, 630090 Novosibirsk, Russia

Phone: +7(383)3301228 Fax: +7(383)3307268 E-mail: gaponov@itam.nsc.ru

Education: Graduated from Physics Department of Novosibirsk State University (NSU), 1964.

Brief description of professional career (including the title of the dissertation work, the year and the Institution where it has been defended):

1. Junior and Senior Scientific Researcher, Head of Laboratory of the Institute of Theoretical and Applied Mechanics SB RAS, January 1965 – till now.

2. Professor at the Department of Theoretical Mechanics, Novosibirsk State University of Architecture and Civil Engineering (NSUACE), 1992-till now.

Ph.D. Thesis: "Stability of the Incompressible Boundary Layer on a Permeable Surface", 1971, Institute of Theoretical and Applied Mechanics of Siberian Branch of Russian Academy of Science (ITAM SB RAS).

Degree of Doctor (Physics and Mathematics): «Development of disturbances in a supersonic boundary layer», 1987, Moscow Physical-Technical Institute.

Other fields: Member of Council on Defence of doctoral Thesis's at Institute of Theoretical and Applied Mechanics, Member of Russian National Committee on Theoretical and Applied Mechanics, Prize-Winner of Professor Joukovski

List of recent grants for fundamental research: Grant of International Science and Technology Center: ISTC-128-96 (1996-1999, investigator). Grants of Russian Foundation for Basic Research (1994-95, 1996-98, 1999-01, 2002-04, 2005-07, team leader.)

Publications: Number of communications to scientific meetings exceed hundred. Number of papers in refereed journals: 130. Two books are published.

Plenary Lecture XI

Analysis of separated flows in hydro machines

Professor Arpad A. Fay
Mechanical engineer, PhD, retired from GANZ Co.
(the only Hungarian hydro turbine manufacturer),
and from the Department of Fluid and Heat Machinery,
University of Miskolc,
Hungary
E-mail: arpad.fay@t-online.hu

Abstract: Starting point of the discussion is a paper by the author ″Analysis of separated 2D flows″ shown in the WSEAS Conference FMA’07 (Vouliagmeni Beach, Athens, August 25-27, 2007, Paper 565-373). From this paper, statements about the flows around circular cylinders, the Coanda effect, the Knapp’s cycle, and the alternate jet theory of Karman vortices are recalled to mind. These are then applied to flows around single airfoils, cascades of airfoils, Francis and Kaplan turbine runners, and axial-flow pump impellers.

For single airfoils experiences obtained with circular cylinders are generalized. Adherence or reattachment of the boundary layer is discussed. Stall is defined as flow separation without reattachment. For non-stalled flows around profiles the Kutta-Joukowskij condition (equal velocities on suction and pressure sides near exit) is explained by the von Karman vortex row.

For cascades of vanes the onset of stall is moving from vane to vane as learned from the theory of rotating stall. The nature and effects of rotating stall are well known from the blower and compressor practice. However, they are more general, valid also for incompressible flows. For axial-flow pumps the shape of the pump characteristics is explained by single and multiple rotating stall on the suction sides of the blades. The merits and limitations of using 3D Euler solvers in the computations of hydro turbine or pump characteristics are discussed from practical point of view. For Francis turbine runners part-load instabilities (limiting the allowed operating range), which are generally associated with spiraling cavitation ropes in the draft tubes, are explained by rotating stall on the suction sides of the runner vanes. Full-load instabilities obtained in a few Francis turbines (60 MW surges for 315 MW turbines) are also understandable based on rotating stall at the pressure sides of the vanes and the model turbine tests by the author. The vain of such instabilities in Kaplan turbines is also explained. At the end a summary is attempted and open questions are listed.

Brief Biography of the Speaker: Arpad A. Fay, M. Math & Mech. Eng. PhD, retired from Fluid and Heat Machinery Department of Miskolc University, Hungary. He has been engaged in experimental and theoretical research on hydroturbines and pumps, field work, guarantee tests on models and prototypes, calculation of forces on large parts of hydromachines, computing, consultancy and teaching for the past 50 years at GANZ Company the largest hydroturbine and pump manufacturer in Hungary. He worked in Egypt, South Africa, Universities of Budapest, Southampton and Miskolc, UNESCO & UNDP projects at NIT Bhopal and CWPRS Pune India etc., He was a member of IEC Working Group on Scale effects of Technical Committee on Hydraulic Turbines and IAHR Section on Hydraulic Machinery, Equipment and Cavitation, Working Group on Scale effects. He has over 50 papers published. As a member of the Society of the Hungarian Mechanical Engineers, he organized several international Conferences on Fluid Machinery in Budapest.

Plenary Lecture XII

The Fluid Mechanics of the Response of Confined Explosives to Hypervelocity Impact

Dr. John Curtis
UCL Honorary Senior Research Fellow
Royal Society Industry Fellow
QinetiQ Fellow
Room 21, Building Q27
Fort Halstead
Sevenoaks
Kent TN14 7BP
UK
E-mail: jpcurtis@qinetiq.com

Abstract: When an explosive is struck by a particle travelling at very high speeds of the order of several km / s a powerful shock is transmitted into the explosive. As the violence of the impact increases the reaction of the explosive also becomes more violent. Reactions can range from inert, to minor burning, to deflagration, to the so-called deflagration to detonation transition, and finally to outright detonation. The last two of these can, of course, have catastrophic consequences if there is further volatile material in proximity. Many efforts to model the relationship between the impact parameters and the resulting reaction have therefore been attempted. A brief review of these is provided and then the methods in current use at QinetiQ are reviewed. The fluid mechanics of these methods is discussed and it is shown how a new method based upon shock physics has been applied to create a simple but effective empirical model for the impact of cylinders. Some remaining unsolved problems are reviewed.

Brief Biography of the Speaker: Following his first degree in mathematics at Corpus Christi College, Cambridge, Dr Curtis took an MSc in Theoretical Mechanics at the University Of East Anglia, Norwich, and continued there to complete his PhD on Optimisation in Continuum Mechanics. He had a spell as a spacecraft engineer at British Aerospace, working on the Ulysses and Hubble Space Telescope missions, before joining Scicon to undertake mathematical modelling research on shaped charges. In 1996 he joined QinetiQ, where he has continued his work in this field, publishing papers on all aspects of shaped charge jet mechanics. He was appointed a QinetiQ Fellow in 1996 and is also a Fellow of both the UK Institute of Mathematics and its Applications and of the Institute of Physics. Recently he has been awarded a Royal Society Industry Fellowship and has been appointed Honorary Senior Research Fellow in the Mathematics Department at UCL, working in collaboration with Professor Frank Smith FRS.

Special Session I

Engine-Structure Interactions during the Powered Flight of Atmospheric Vehicles

Organizer:

Professor Radu D. Rugescu
Chair of Aerospace Sciences “Elie Carafoli”
University “Politehnica” of Bucharest
Spl. Independentei 313 sector 6, 060042 Bucuresti,
ROMANIA

Brief Biography of the Organizer:

Dr. Radu D. Rugescu, Romania, is affiliated with University “Politehnica” of Bucharest, Chair of Aerospace Sciences “Elie Carafoli”, Space Sciences Division since 1969, successively as Assist. Prof. and Professor. With interests and expertise in Astronautics, Propulsion Systems, Robotics, Optimization and Statistics, he teaches courses in Romanian, English and German on “Numerical methods”, “Manufacturing technology of aerospace systems”, “Astrodynamics”, “Turbomaschinen”. His research firsts include a Genuine Rocket Solid Propellant in 1959, The first Romanian liquid propellant rocket engine in 1969, the first Capture of freezing temperature of water-gas reaction in 1982, the first Romanian air-breathing rocket engine in 1987, a New variational method for discontinuous integrands in 1997, a new technology for Air captured imaging and TV live transmission from high altitude airplanes of solar eclipse in 1999, non-Keplerian gravity coupling of very large space structures in 2004.

Participates in EU funded research projects in space technology as Romanian Director. Conducts a five-year collaborative research with Texas A&M University, USA, where had performed a Fulbright research grant under sponsorship of the State Department in Space Ecology. He is known for 175 publications, including nine books. He is active member of the Astronautics Commission of the Romanian Academy since 1975, member of the International Institute for Acoustics and Vibrations since 2002 and in other societies.

Author Index

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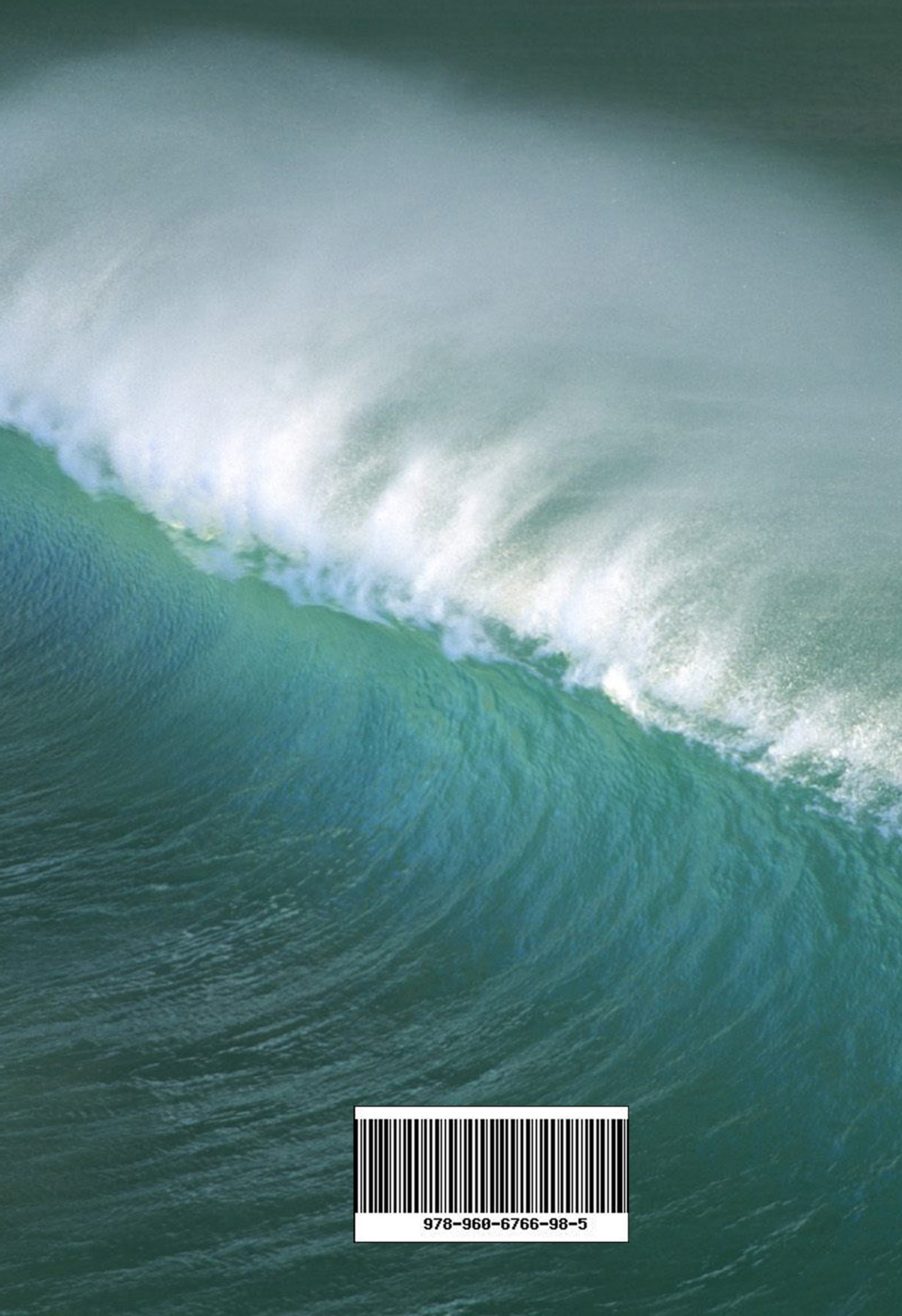

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