NEWSLETTER42
EUROPEAN MECHANICS SOCIETY

President's Address

I am very happy to announce that GertJan Van Heijst of Eindhoven University of Science and Technology has been elected President of EUROMECH as of January 2013. We warmly welcome him as our new leader. GertJan Van Heijst, a EUROMECH Fellow, is recognised for his very distinguished contributions to fluid dynamics. He is a member of Council and, as organizer of several EUROMECH colloquia and past chair of the European Fluid Mechanics Conference Committee, he is a highly experienced and active member of our society. According to the statutes, I will become Vice-President and remain on the Council ex-officio.

Hans Fernholz, the present Vice-President, will leave the Council after more than forty five years of distinguished service to the society. Hans Fernholz has been deeply involved with EUROMECH since it was founded in 1964. He participated in the organisation of Colloquium 1 held in Berlin in 1965 and was Secretary of the EUROMECH Committee in succession of Dietrich Küchemann from 1975 to 1989, during the "early period", when the sponsorship of colloquia was the main business of EUROMECH. He was chair of the European Fluid Mechanics Conference Committee, organiser of the 2nd European Turbulence Conference and chairman of six EUROMECH colloquia. He has been a long-standing member of the Council and was President of the Society from 1998 to 2002. It is in large measure thanks to his vision and his highly effective, yet gentle and considerate leadership, that EUROMECH has grown into a mature, well-established scientific society. On behalf of all of us, I extend our sincere thanks to him. The Council hopes to continue to benefit from his always thoughtful advice.

This newsletter contains essential information regarding the elections to the EUROMECH Council for 2013. The Advisory Board has prepared a list of eight candidates to fill four vacant seats on the EUROMECH Council. All these seats are for a six-year term starting on 1 January 2013. Short biographical statements by the candidates are included in this newsletter. The candidates have been selected so as to maintain subject and geographical balance on the Council. It is always gratifying to see that such a distinguished scientists are prepared to devote some of their time to serve our community.

The EUROMECH voting procedure is now electronic! In order to vote, please log on our website www.euromech.org and access the member area in the lower left-hand corner of the

Home page by entering the username and password which have been e-mailed to you by our management advisor Dr. Sara Guttilla. Short biographical statements by the candidates are available for consultation in electronic form. You will then be able to express your vote in a straightforward manner. The voting deadline is January 15, 2013. For those of you not yet accessible by e-mail, please urgently send your email address to S.Guttilla@cism.it. If any problem arises, please feel free to let her know.

EUROMECH is pleased to announce that the 4th EUROMECH Solid Mechanics Prize has been awarded to John Willis (University of Cambridge) *"For his seminal contributions to the mathematical aspects of a very wide range of phenomena in solid mechanics, including the effective properties of nonlinear composites, bounding methods, elasto-dynamic fracture, dislocation theory, size effects in plasticity and homogenisation theory, and for his unique ability to work on practical problems by generating new mathematical foundations"*. The 5th EUROMECH Fluid Mechanics Prize has been awarded to Yves Couder (Université Paris Diderot) *"For experiments in fluid mechanics which are novel, elegant, deep and provocative"*. Six Fellows have been elected for their seminal contributions to Solid Mechanics and Fluid Mechanics: Marc Geers (Eindhoven University of Science and Technology), Jean-Baptiste Leblond (Université Pierre & Marie Curie), Javier Llorca (Universidad Politecnica de Madrid), Olivier Pouliquen (IUSTI, Marseille), Frederico Toschi (Eindhoven University of Science and Technology) and Roberto Verzicco (University of Rome Tor Vergata). These awards were conferred officially on the occasion of the 8th European Solid Mechanics Conference last July in Graz and of the 9th European Fluid Mechanics Conference last September in Rome.

It has been an enjoyable experience serving EUROMECH as President for the past ten years. I have always found our discussions in Council to be conducted in a spirit of mutual friendship and respect, with issues of nationality only playing a minor role, in the best European spirit. For all of this, many heartfelt thanks.

Patrick Huerre
President, EUROMECH

EUROPEAN MECHANICS SOCIETY

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EUROMECH Council Elections

Voting instructions

At the end of 2012, four seats on the EUROMECH Council will become vacant. In accordance with the statutes, the Advisory Board has drawn up a list of eight candidates. All these seats are for a six-year term starting on 1 January 2013.

The EUROMECH voting procedure is now electronic! In order to vote, please log on our website www.euromech.org and access the member area in the lower left-hand corner of the Home page by entering the username and password which have been e-mailed to you by our management advisor Dr. Sara Guttilla. Short biographical statements by the candidates are available for consultation in electronic form. You will then be able to express your vote in a straightforward manner. The voting deadline is January 15, 2013. For those of you not yet accessible by e-mail, please urgently send your email address to S.Guttilla@cism.it. If any problem arises, please feel free to let her know.

The deadline for the vote is January 15, 2013.

Anne Juel

Anne Juel is a Reader in Applied Mathematics at the University of Manchester, where she took up a position in 2001. As an experimentalist within a School of Mathematics, her approach is to conduct careful experimentation within a strong theoretical framework.
She studied Physics in Paris followed by a D.Phil at Oxford University and post-doctoral research at the University of Texas at Austin. She is a Fellow of the IMA and a member of the American Physical Society.
Her interest is in the intricate behaviour of complex systems from the dynamics of fluid flows to the deformation of elastic materials, encompassing both curiosity-driven and industrially-relevant phenomena. Her research focuses principally on fluid-elastic interactions and two-phase fluid dynamics, with a particular interest in instabilities and bifurcations. She is also involved in industrial research with BP, Cambridge Display Technology and Kraft Foods.
Anne Juel is a regular participant in EFMC meetings. She was involved in organising EFMC7 in Manchester in 2008, and participated in the EUROMECH Colloquium 497 'Recent developments and new directions in thin-film flow' (2009). Her external activities include grant reviewing for a wide range of funding agencies, workshop organisation and outreach activity (e.g. Royal Institution Lecture and Meet the Mathematician 2012). She looks forward to helping to promote EUROMECH, with a focus on the relevance of mechanics to applications in technology, materials and biological sciences.

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Paul Linden

Paul Linden is the GI Taylor Professor of Fluid Mechanics in DAMTP where he obtained his PhD in 1972 and was the Director of the Fluid Dynamics (now G. K Batchelor) Laboratory from 1976-1997. He was the inaugural Blasker Professor of Environmental Science and Engineering in the Department of Mechanical and Aerospace Engineering at UC San Diego from 1998 to 2010. During his time at UCSD he was Department Chair (2004 -2009), Director of the Environment and Sustainability Initiative (2007-2009), and the founding Director of the Sustainability Solutions Institute (2009-2010). He returned to DAMTP in 2010.
Paul's research is concerned with fluid flow in the environment. In particular, he is interested in flow, turbulence and mixing in the oceans and atmosphere, the fluid dynamics of green buildings and in general issues of climate change and sustainability. He specialises in laboratory experiments that examine the physical processes relevant to these natural flows and develops mathematical models to predict their properties.
Paul is a Fellow of the Royal Society, the Royal Meteorological Society and the American Physical Society. He is Deputy Editor of the Journal of Fluid Mechanics and Associate Editor of the Proceedings of the Royal Society A. He has co-organised two EUROMECH colloquia and a number of other conferences.

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José Manuel Gordillo Arias de Saavedra

José Manuel Gordillo Arias de Saavedra obtained his PhD degree at Sevilla University in December 2001. After a postdoctoral stay in Harvard during 2002, he worked for one year as an assistant professor at University Carlos III, Madrid. In 2004 he got a permanent position at Sevilla University, where he currently teaches Fluid Dynamics and Aerodynamics.
Gordillo's research interests cover different fields of Fluid Mechanics: dynamics and breakup of drops and bubbles, generation of monodisperse microemulsions and microbubbles using microfluidic devices, propagation and growth of unstable waves in open shear flows and the impact of solids against free interfaces at high Reynolds numbers. His research papers are a combination of theoretical analysis, numerical computation and experiments. From the point of view of applications, he has coauthored two licensed patents related to the generation of monodisperse microbubbles for ultrasound imaging and ultrasound cleaning purposes, has contributed to the design of a type of microfluidic devices widely used in many laboratories to generate foams or emulsions and is responsible of the wind tunnel at Sevilla University, which is used to measure aerodynamic loads in civil and aeronautical structures. He is the author of a book on Aerodynamics (Introducción a la Aerodinámica Potencial, 270 pp), has received two teaching prizes, is the director of the Fluid Mechanics group at Sevilla University (GIMFus) and has organized the international conference "First Fermat-Impact-GIMFus Meeting" in Sevilla during October 2010.
If he was elected to the Council of Euromech, he would promote active involvement of the increasingly growing Spanish Fluid Mechanics community in the organization of Euromech meetings. He would also try to promote its participation in all types of future Euromech events and would favor the promotion and the exchange of talented European young scientists between different European institutions.

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Antonio Sánchez obtained his PhD from the Department of Mechanical and Aerospace Engineering at UCSD in 1995. After a postdoctoral stay at IRPHE (Marseille), he joined the faculty of the Universidad Carlos III (Madrid), where he is currently Professor and Head of the Fluid Mechanics Group.
His primary research interests lie in the field of reactive flows, including the use of asymptotic methods for the analysis of ignition processes, structure and dynamics of deflagrations and detonations, nonpremixed combustion, and reaction chemical kinetics. He is coauthor of over 40 papers in fluid mechanics and combustion journals. He is member of the Organizing Committees of the European Fluid Mechanics Conference and of the International Conference on Numerical Combustion.

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Alexander Belyaev is Research Director of the Institute for Problems in Mechanical Engineering of the Russian Academy of Sciences and Professor at St. Petersburg Polytechnic University (St.P.PU). He obtained his PhD (1976) and D.Sc (2000) from St.P.PU and Habilitation degree from Vienna TU (1997). He is d.h.c. of Johannes Kepler University of Linz, Austria. He was awarded the Thomas A. Jaeger Prize (main prize) of the International Association for Structural Mechanics in Reactor Technology (1993).
His primary research interests are in the areas of high frequency dynamics of solids, dynamics and stability of structures and machines, non-linear piezoelasticity, mechatronics, hydrogen embrittlement, stochastic waves in solids.
He is author of more than 170 papers and translated 7 classical monographs of the leading Russian scientists into English for Springer-Verlag. He is coordinator of the CISM course "Dynamics of mechanical systems with variable mass".
He was Chairman of the IUTAM Symposium on Vibration Analysis of Structures with Uncertainties (St. Petersburg 2009), the 4th (St. Petersburg, 2008) and 5th (Genoa, 2012) European Conferences on Structural Control, two International conferences on Advanced Dynamics and Model-Based Control of Structures and Machines (Linz, 2010 and St. Petersburg 2012) and the INTAS-Symposium "Advanced Dynamical Modeling" (Vienna, 2004).
He is member of the Editorial Boards of ZAMM and Acta Mechanica.

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Tomasz Kapitaniak

Tomasz Kapitaniak is a professor at the Technical University of Lodz and chair of the Division of Dynamics (since 1992). He has developed scientific activities in the field of machine dynamics and oscillations theory. His work has focused on questions of the theory of bifurcations and deterministic chaos and the control problems of irregular movements.
The most important of his achievements include the development of methods for control and synchronization of chaotic systems, enabling the practical application of chaotic motion in technical applications and development of theoretical models of multi-dimensional attractors. He has presented the results of his work in over 200 publications, which arewidely cited (over 2000 citations). His H-index and G-index are respectively 28 and 44. He is a member of the Council of the National Centre for Science (Poland). In 1989-91 Tomasz Kapitaniak carried out research at the University of Leeds, and in 1998 at the University of Maryland.
He has presented a number of invited courses and lectures as Visiting Professor in Germany, France, Japan, Italy, China (totaling 22 months), and as an invited speaker at a number of conferences including EUROMECH Colloquia. He was an associate editor of Chaos, Solitons and Fractals (1992-2009) and currently is a honorary editor of the Int. J. Bifurcation and Chaos.

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Her main research fields are material modelling of innovative materials such as different kinds of metal alloys, fibre-reinforced polymers and biomaterials. Further, she develops innovative finite element technologies as well as new methods of model reduction for non-linear problems in solid mechanics. Other important goals of her research are realistic applications e.g. in the field of production technology, medical technology and biomechanics.
Stefanie Reese has won several prizes for academic achievements from scientific academies and is a member of the senate of the German Science Foundation (DFG), a high-ranking committee in German science. She is a Fellow of the International Association for Computational Mechanics (IACM) and serves also as a member of its general council. She is associate editor of Mechanics Research Communications and a member of three other editorial boards.
In 2011, she was elected as one of the 25 most influential female engineers in Germany.
Since 2010, Stefanie Reese is member of the Euromech Solid Mechanics Conference Committee. She has participated in numerous Euromech colloquia and conferences, giving a plenary lecture at the 2006 ESMC in Budapest (Hungary).

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Paul Steinmann

Paul Steinmann is full professor and head of the Chair of Applied Mechanics at the Department of Mechanical Engineering of the University Erlangen/Nuremberg since 2007. From 1997 to 2007 he held the same position at the University of Kaiserslautern, where he has also served as Vice Dean and Dean from 2001-2006.
He is the author/co-author of more than 150 publications in reviewed international journals in the fields of Continuum Mechanics, Material Mechanics and Computational Mechanics. Moreover he has contributed some 150 publications in conference proceedings. Many of the corresponding talks have been invited.
He is editor of the GAMM-Mitteilungen, of 'Mechanics of Material Forces', Springer, 2005 (jointly with G.A. Maugin) and a number of special volumes in CMAME, IJSS, IJNME, IJES, Phil. Mag. He serves regularly as reviewer for some 20 international journals. He is member of the editorial/advisory board of several scientific journals, among them CMAME, IJNME, IJSS, Comp. Mech., Arch. Appl. Mech., Meccanica and Arch. Mech. He is member of the general council of IACM, the managing board of ECCOMAS, and the EUROMECH Mechanics of Materials Conference Committee. He is also an ordinary member of GACM, GAMM and EUROMECH and has served as president, vice president and secretary of the DEKOMECH (German Committee for Mechanics).
In 2006 he received the IACM Fellow Award and the EUROMECH Fellow Award.
He organized two EUROMECH colloquia in 2003 and 2011, respectively, and an IUTAM symposium in 2008. Moreover he has organized and co-organized a number of specialised conferences, workshops, sessions and minisymposia in the fields of Material Modelling, Failure Mechanics, Material Forces, Computational Mechanics and Computational Dynamics within conferences under the auspices of IACM, ECCOMAS, EUROMECH, etc.. He also regularly serves on the scientific boards of international conferences in the area of Computational Mechanics.

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EUROMECH Young Scientist Prize Paper

"Rapid rotating spherical shells in self-gravitating force field - from the numerical onset of convection to its experimentally observed patterns"

Birgit Futterer won the EUROMECH Young Scientist Prize, awarded at the 8th EUROMECH FLUID Mechanics Conference held in Bad Reichenhall, September 2010

B. Futterer[1], V. Travnikov[2], R. Hollerbach[3], C. Egbers[1]

Abstract

In geo- and astrophysical research the set-up of rapid rotating spherical shell convection is of basic interest, e.g. as part of dynamo flows. Here, we summarize the hydro-dynamic contribution from the spherical Rayleigh-Bénard experiment 'GeoFlow' in rotating reference frame to our recent knowledge. Starting with the onset of convection we then describe the patterns of convection from numerical simulation and experimental observation. Well-known issue of rapid rotation is the alignment of convective cells at the tangent cylinder due to the domination of centrifugal forces against the self-gravitating buoyancy field. The unique feature of our experiment is to include both influences. Hence, the experimental data reach the regimes of high rotation the system shows very clearly patterns in form of columnar cells. In addition, the fully developed supercritical states turn out to have buoyancy driven polar exchange and complex drift behaviour.

1. Introduction

In 2002, F.H. Busse summarizes 'the understanding of convection in rotating spherical shells' [1]. Inside his work, we face the convenient model of a cylindrical annulus, which offers the opportunity to capture the basic physics of fluid flow by means of only two spatial dimensions due to the existence of the Taylor-Proudman theorem, but which also delivers the possibility of realization of non-magnetic, hydrodynamic laboratory experiments. A major advantage of such experimental fluid mechanics is to capture 'non-linear effects and associated instabilities' [2]. The hydro-dynamic experiment 'GeoFlow' (Geophysical Flow Simulation) traces instability and transition of convection in spherical shells under the influence of central-symmetry buoyancy force in the microgravity environment of the European COLUMBUS module if the International Space Station ISS. Within the first experiment series we focus on the rapid rotation case. In the framework of this newsletter, we will discuss shortly the physical basics, review the results of linear stabilities, present the numerical simulation and, finally, classify our experimental observations.

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2. Physical Basics

The experimental setup of a self-gravitating [1], i.e. a central symmetry buoyancy force field in experimental spherical shell models is consisting of an alternating high voltage potential V_{rms} between the thermal boundaries and the use of a dielectric insulating liquid of kinematic viscosity ν. Moreover the technique needs to be performed in microgravity conditions [3, 4]. Therewith we consider an electro-hydrodynamic convection, which is driven by the temperature dependency of the electric permittivity ($\mathbf{f}_e=\gamma T\mathbf{g}_e$ with $\partial\varepsilon/\partial T=-\varepsilon_r\varepsilon_0\gamma$)[4], in analogy to the 'classical' Rayleigh-Bénard convection, which is driven due to temperature dependency of the density ($\mathbf{f}=\alpha T\mathbf{g}$ with $\partial\rho/\partial T=-\rho\alpha$)[5]. Then, the non-dimensional Boussinesq equations for rotating dielectric convection, including the centrifugal force to capture the real situation in the experiment, follow

$$\nabla\cdot U = 0 \tag{1}$$

$$Pr^{-1}\cdot\left[\frac{\partial U}{\partial t} + (U\cdot\nabla)U\right] = -\nabla p_{eff} + \nabla^2 U + Ra_{centr}\, r^{-5}\, T\, e_r - \sqrt{Ta}\, e_z \times U + \overline{Ra}Tr\sin\theta\, e_{eq} \tag{2}$$

$$\left[\frac{\partial T}{\partial t} + U\cdot\nabla T\right] = \nabla^2 T\ . \tag{3}$$

In this modelling, length is scaled by the outer spherical radius r_o and time by the thermal time scale $(r_o-r_i)^2/\kappa$ with the outer (inner) spherical radius r_o (r_i) and the thermal diffusivity κ. In the 'GeoFlow' experiment, we have, for the fixed radius ratio $\eta=r_i/r_o$ and fixed Prandtl number $Pr=\nu/\kappa\approx 65$ with the kinematic viscosity ν, the parameter domain spanned by the Rayleigh number Ra_{centr} and Taylor number Ta with

$$Ra_{centr} = \frac{\gamma\Delta T g_e r_o^3}{\nu\kappa} \text{ with } g_e = \frac{2\varepsilon_r\varepsilon_0}{\rho}\left(\frac{r_i r_o}{r_o - r_i}\right)^2 V_{rms}^2\, r_o^{-5} \tag{4}$$

$$Ta = \left[\frac{2\Omega r_o^2}{\nu}\right]^2 . \tag{5}$$

The factor $\overline{Ra}=\alpha\Delta T/4\cdot Pr\cdot Ta$ balances the centrifugal influence. Boundary conditions are no-slip for the velocity U, and for the temperature, we have the inner sphere heated and the outer sphere

[4] $\mathbf{g}_e$ – acceleration due to 'electrical' gravity, which is related to temperature dependency of the relative dielectric permittivity ε_r and dielectric constant ε_0, described with coefficient of dielectric expansion γ

[5] $\mathbf{g}$ – acceleration due to gravity, which is related to temperature dependency of the density ρ, described with the coefficient of volume expansion α

cooled with $T(r_i=\eta)=1$ and $T(r_o=1)=0$, respectively. With V_{rms}=10kV and a variation of ΔT up to 10K, we reach $Ra_{centr}\leq 1.4\cdot 10^5$. Hence, for the non-rotating spherical shell convection we are 100 times above the critical onset [5, 6]. For the rotating case, we track the stability line and describe the fully developed convective states (with the rotational rate $n=\Omega/(2\Pi)\leq 2$Hz resulting in $Ta\leq 1.3\cdot 10^7$). This is presented here. Refer additionally to [7], where we include an overview on the experiment hardware and its performance on orbit.

3. Linear Stability Analysis

In order to assess the supercritical flow, initially, the linear onset of convection is of interest. Research on that starts early in [8], with the relation for the onset described by a power law for $Ra_{crit}\sim Ta^{2/3}$ (also known for the Ekman number $E=\nu/(2\Omega r^2)$ with $Ra_{crit}\sim E^{-1/3}$). Furthermore, we refer to [9], who deliver an extended review on the asymptotic theory. Their contribution is on the accuracy and, additionally, on the description of the planform of the instability depending on the scales involved in the spherical shell system. We use the linear stability analysis, both to check the validity of the $1/r^5$ dependency for the acceleration due to 'electrical' gravity, which is in contrast to real Earth related work (linear dependency in the Earth liquid outer core), and to design the experiment [5]. We refer to [5] again for the detailed view on the procedure. Here the results are reconsidered in the context of extended numerical simulation and experimental observation. To summarize it, we have 1st, the shape of stability curves to be independent on Pr and η, 2nd, the stability line in exact agreement with the above described power law (as depicted in Figure 1 by the solid black line.), 3rd, the instability occurs due to a Hopf bifurcation, 4th, the basic flow exists due to the centrifugal force, and at least, the drift velocity changes its sign, which corresponds to a slowing down or fastening of the convective patterns. From this, the shape of stability curve and the drift change is resolvable by the numerical simulation, which is presented below.

4. Numerical Simulation

Our numerical simulation for the equations (1)-(3) uses the pseudo-spectral method from [10]. It follows the real experimental procedure, i.e. to set a temperature difference between the inner and outer spherical boundaries ($\sim Ra_{centr}$) and to increase the rotation rate (~Ta). This is in contrast to the (Ra_{centr},Ta) variation during the stability analysis and is also different to the mode of tracking the onset of convection by asymptotic theory. At least, this is related to an on orbit operational constraint of time-efficient performance [7]. If we vary the thermal drive, we wait at least one thermal time scale $(r_o-r_i)^2/\kappa$ to observe an equilibrated flow state. Thereby the thermal time scale is a magnitude higher than the viscous time scale $(r_o-r_i)^2/\nu$. With this, we have the parameter domain spanned with Ta and Ra as depicted in Fig. 1. The flow states from our simulation are marked with black symbols.

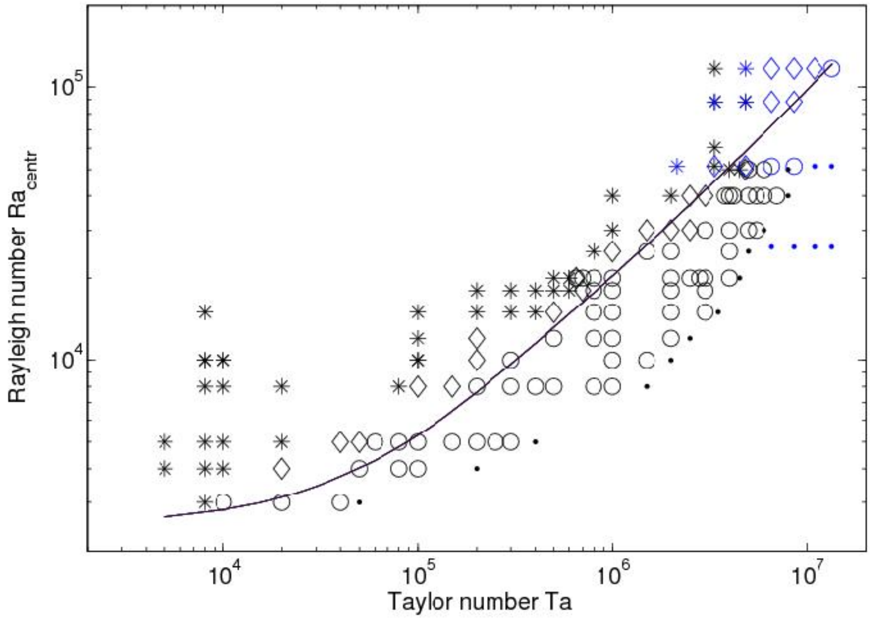

Fig. 1: Rapid rotating spherical shells in self-gravitating force field: onset of convection from stability analysis (solid black line), convective flow states from numerical simulation (black symbols) with transition from subcritical (●), steady (○), periodic (◊) to chaotic (*) flow and experimentally observed flow states (blue markers with specific symbols).

Regarding the onset of convection, it is possible to interpolate between the numerical simulated subcritical flow (black dots) and steady state convection (black circles). This virtual line differs from the regime where it is predicted by the stability analysis (solid line). Both correlate with a power law, but of different exponent. At higher parameters they seem to merge again. It might follow a subcritical bifurcation, which is still under examination. Nevertheless the general functional relation for the onset is regarded as evidence, that the radial gravity does more impact via the direction and not by the magnitude, i.e. either the 'natural' linear or the 'electric' exponential behaviour.

The temporal assessment of the flow states in Fig. 1, i.e. a global amplitude convection is characterized by global variables such as the Nusselt number *Nu* and the kinetic energy E_{kin}. Besides that, we assess the drift and dominating azimuthal mode of the flow by space-time plots as in Fig. 2. Finally the radial velocity component at a selected spherical surface in the research cavity allows the discussion on the planform of convection. The flow modes show the 'typical' alignment of convective cells along the tangent cylinder in the vicinity of the stability line. The supercritical states allocate polar exchange and complex drift behaviour.

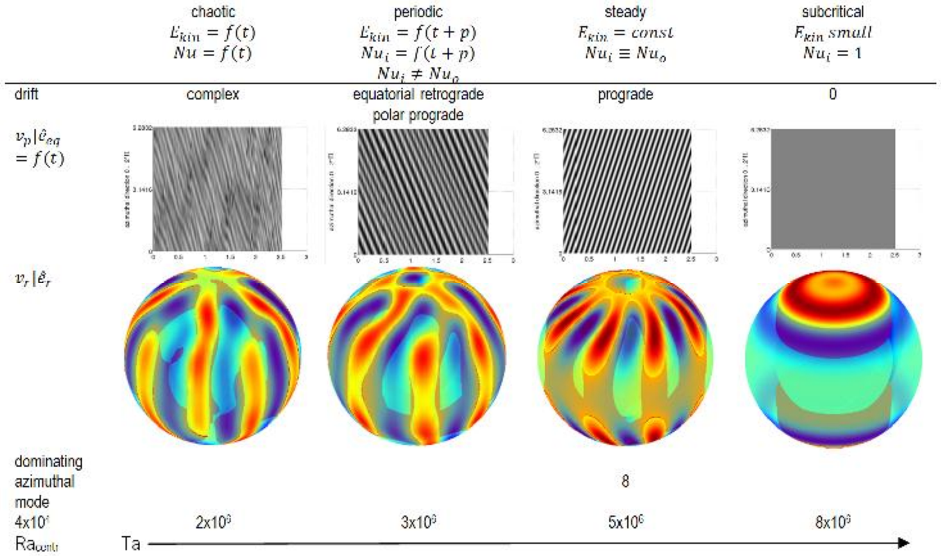

Fig. 2: Rapid rotating spherical shells in self-gravitating force field: Traverse of the stability line from supercritical to subcritical flow analogue the experimental procedure. Globally assessed amplitude convection (Nusselt number and kinetic energy), space-time plots, and patterns of convection deliver a complementary view on the planform of the flow.

5. Results Orbital Experiments

The experimental flow states are observed in space and time by a Wollaston Schlieren interferometry as integrated in the framework of the Fluid Science Laboratory [11, 12]. Thus we have fringe patterns of convection with dense lines corresponding to higher temperature gradients and therewith to thermal upwelling from the inner to the outer sphere. Due to the optical set-up one single image contains the polar part of the spherical shell set-up in the top and the equatorial regions in the bottom. Considering the properties of the flow modes such fringe patterns are depicted in Fig. 3 a)-b) for experimental flow visualization and numerically reconstructed fringe pattern. Finally the experimentally verified onset of convection and the spatio-temporal transition from steady via periodic to chaotic flow agrees with the numerical data sets (again Fig.1, blue markers). Furthermore it allows extrapolating to higher parameters.

6. Outlook

'GeoFlow' is a spherical Rayleigh-Bénard experiment in self-gravitating force field for rotating geometry in the microgravity environment of COLUMBUS on ISS. It delivers hydrodynamic stability with focus on flow patterns, which exist due to specific conditions in dependence of the driving mechanism both the thermal convection (~Rayleigh number) and the rotational influence

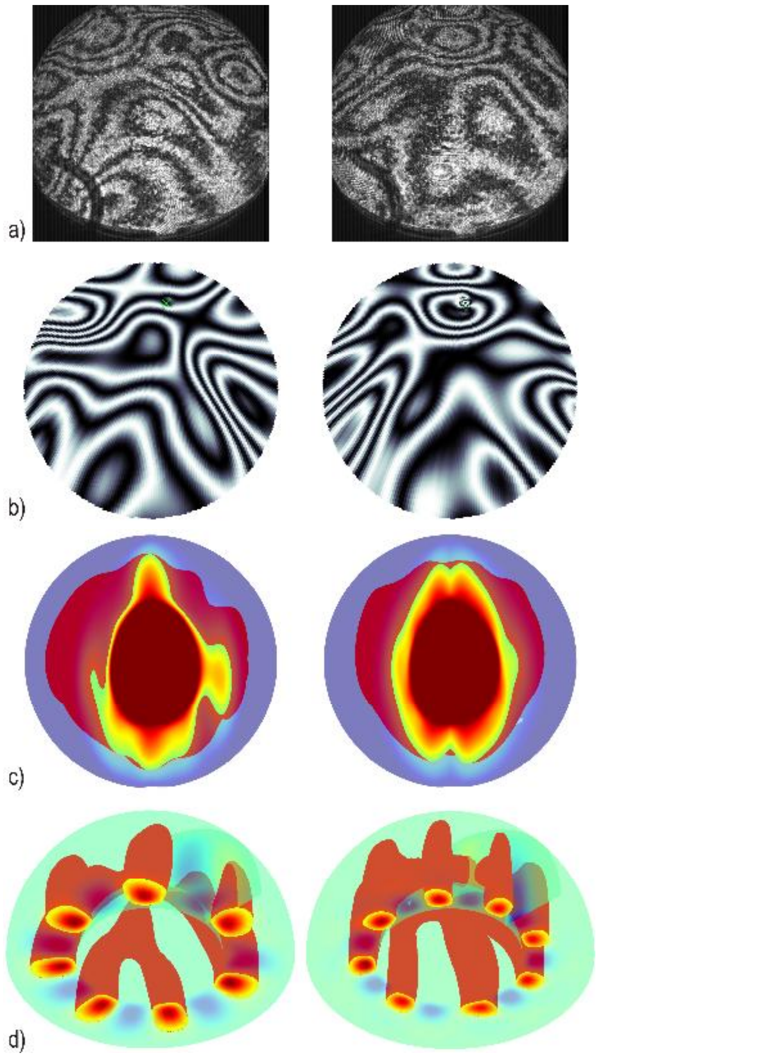

Fig. 1: Fringe patterns of convection in rapid rotating spherical shells: a) experimental interferogram at $Ra_{centr}=5.15x10^5$, $Ta=4.83x10^6$ (left) and $Ra_{centr}=5.15x10^5$, $Ta=6.58x10^6$ (right). From numerical simulation at $Ra_{centr}=2x10^4$, $Ta=6x10^5$ (left) and $Ra_{centr}=5x10^4$, $Ta=4x10^6$ (right) b) numerically reconstructed interferogram, c) isosurface of the temperature field inside the spherical gap and d) radial velocity component on a isosurface in the northern hemisphere with cut at the equator.

(~Taylor number). We describe a numerical verification for the onset of convection with $Ra_{centr, onset} \sim Ta^{2/3}$. The experimental data align with a comparable power law. Details still have to be addressed. Finally, comparison of Rossby wave properties influenced by different Pr and force fields are still under review and the numerical experimental alignment of highly supercritical domain.

7. Acknowledgements

The 'GeoFlow' project is funded by ESA (Grant no. AO-99-049) and by the German Aerospace Center DLR (Grant nos. 50 WM 0122 and 50 WM 0822). The authors would also like to thank ESA for funding the 'GeoFlow' Topical Team. (Grant no. 18950/05/NL/VJ). The scientists also thank the industry involved for support, namely Astrium GmbH, Friedrichshafen, Germany and the User Support and Operations Center MARS Telespazio, Naples, Italy and E-USOC, Madrid, Spain. Recently, the first author is supported by the Brandenburg Ministry of Science, Research and Culture (MWFK) as part of the International Graduate School at Brandenburg University of Technology (BTU) as leader of the junior research group 'Applications of turbulent Rayleigh-Bénard-, Taylor-Couette- and Pipe flow in nature and engineering'.

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2010 EUROMECH Fluid Mechanics Fellow Paper

"Eulerian and Lagrangian statistics in fully developed Turbulence"

Luca Biferale was named Fellow of EUROMECH at the 9th EUROMECH Fluid Mechanics Conference held in Bad Reichenhall, Germany. September 2010

Abstract

I present state-of-the-art numerical results and phenomenological ideas concerning the relations between Eulerian and Lagrangian statistics for locally Homogeneous and Isotropic Turbulence, emphasizing closed and open problems.

1. Introduction

We encounter turbulence in Rayleigh-Bénard or Taylor-Couette systems, in turbulent boundary layers or wakes, jets, channel flows, stratified flows, etc. All these cases differ only in either the external driving mechanism or the geometry of the bounded domain, or both. These flows have large-scale non-universal mean profiles that may be non-homogeneous, anisotropic, non-parity invariant and sometimes non-stationary. Nevertheless, the real 'hard' scientific 'core' of all of them resides in the non-linear processes, coupling all degrees of freedom across all scales. Non-linear terms are rotational and translational invariant. Indeed, there is empirical evidence of a recovery of a certain degree of universality, accompanied by a restoring of statistical translational and rotational invariance, for turbulence fluctuations at small scales and for all flows in nature. **This is why locally Homogeneous and Isotropic Turbulence played, plays and will always play a key role in theory, numerics and experiments.** Unfortunately, in spite of a long and glorious history of attempts [Vo11], Homogeneous and Isotropic turbulence is still **'unsolved'**, concerning both its Eulerian properties (those measured by a fixed probe in the lab) and its Lagrangian ones (those measured flowing with the fluid) [Fr96].

Turbulence is a multiscale phenomenon, strongly non-Gaussian, non-linear, non-perturbative out-of-equilibrium and far from mean field phenomenology. The combination of these obstacles makes the problem "unsolved" theoretically, computationally "extreme" and experimentally "hard". A striking fingerprint of all turbulent flows is the development of anomalous fluctuations becoming more and more non-Gaussian by going to smaller and smaller scales, a phenomenon called **intermittency**, that can easily produce events up to 60 times their rms value [To09]. Such huge small-scale fluctuations are also important for a wide range of applications as, e.g., in turbulent mixing, combustion and particles aggregation/break-up. *As a result, the importance of intermittency cannot be minimised by any scientists working on turbulence*. The mean field approach (Kolmogorov 1941) underestimates the probability of acceleration fluctuations by many orders of magnitude. In this article, I briefly summarize some recent advances in the understanding of small-scale and high-frequency turbulent fluctuations in Eulerian and Lagrangian domains, using both direct numerical simulations and a phenomenological approach based on Multifractal theory.

2. Multifractal Theory: Eulerian vs Lagrangian and vice versa.

Turbulent fluctuations at varying scales and frequencies are typically quantified by Structure Functions [Fr96]. We speak about longitudinal Eulerian properties for moments of velocity increments, $\delta_r \mathbf{u} = \mathbf{u}(\mathbf{x}+\mathbf{r}) - \mathbf{u}(\mathbf{x})$, projected along their separation distance, r (ESF, see eq. 1) or about Lagrangian properties for increments of any velocity component along particle trajectories at changing time lag, $\delta_\tau v$ (LSF, see eq. 2). It is a matter of fact, first observed 30 years ago, that

$$\begin{cases} S_E^{(p)}(r) = \langle(\delta_r u)^p\rangle \sim r^{\zeta_E(p)} & (1)\\ S_L^{(p)}(\tau) = \langle(\delta_\tau v)^p\rangle \sim \tau^{\zeta_L(p)} & (2)\end{cases}$$

ESFs have anomalous scaling properties, i.e. they do not follow Kolmogorov 1941 (K41) mean-field inertial-range scaling, $\delta_r v \sim r^{1/3}$. Indeed, anomalous scaling laws are the counterparts of the increasing non-Gaussianity observed for PDFs by decreasing the scale.

$$\begin{cases} \mathbf{x} \to \lambda \mathbf{x} \\ \mathbf{v} \to \lambda^h \mathbf{v} & \forall h \\ t \to \lambda^{1-h} t \end{cases}$$

Multifractal phenomenology was developed originally to describe these empirical facts. The idea is to postulate that due to the symmetry under rescaling of Navier-Stokes equations in the inertial range there exists a distribution of local scaling exponents statistically interwoven in different fractal spatial sets (see Box on the left). The whole phenomenology is then defined once the set of Eulerian fractal dimensions, $D_E(h)$, characterizing the probability, $P_h(r)$, to observe a scaling property, $\delta_r v \sim r^h$, is given. The formalism embodies the K41 theory as a special case, when, $D_E(h) = 3\,\delta(h-1/3)$. The formalism has been able to predict non-trivial properties of small-scaled Eulerian turbulence, including Reynolds number dependencies of Flatness and Skewness gradients [Ne90, Be91], multi-scale correlation functions [Be98], fluctuations in the viscous Kolmogorov scales [Bi08] and many others. In recent years, some attention moved to Lagrangian turbulence, thanks to the blooming of new experimental and numerical techniques that address the problem [To09]. Eulerian and Lagrangian statistics are obviously correlated, but in a way that is still a matter for discussion. Multifractal phenomenology can be naturally translated to the Lagrangian domain, either in a fully uncorrelated way (i.e. assuming, somehow unnaturally, a new Lagrangian distribution for $D_L(h)$, fully disconnected from its Eulerian counterpart), or by using a **'bridge relation'** [Bo93, Bi04] that allows $D_L(h)$ to be explicitly calculate once known is $D_E(h)$, and *vice versa*. In this sense, a bridge relation **is a prediction for Lagrangian fluctuations once the Eulerian is given**.

2.1 Bridge relation and prediction for acceleration PDF.

The idea at the basis of the Multifractal bridge relation between Eulerian and Lagrangian statistics is based on a simple generalisation of dimensional arguments. The problem is to control the statistical properties of velocity increments along a particle tracer, **X**(t), i.e. a particle moving with a velocity **v**(t) corresponding to the local underlying turbulent fluid, **u**(**x**,t):

$$\dot{\mathbf{X}}(t) = \mathbf{v}(t) = \mathbf{u}(\mathbf{X}(t), t)$$

In order to estimate the typical Lagrangian velocity difference $\delta_\tau v$ along the particle trajectory at time lag τ we use the Eulerian velocity increment $\delta_r u$ at a given spatial distance r. The spatial increment is chosen such that the typical eddy-turn-over time of turbulent fluctuations at that scale corresponds to the time lag over which the Lagrangian statistics is evaluated. The rationale is simple: during the particle trajectories from t to t+τ, the Lagrangian velocity will have experienced Eulerian fluctuations coming from eddies with different sizes.

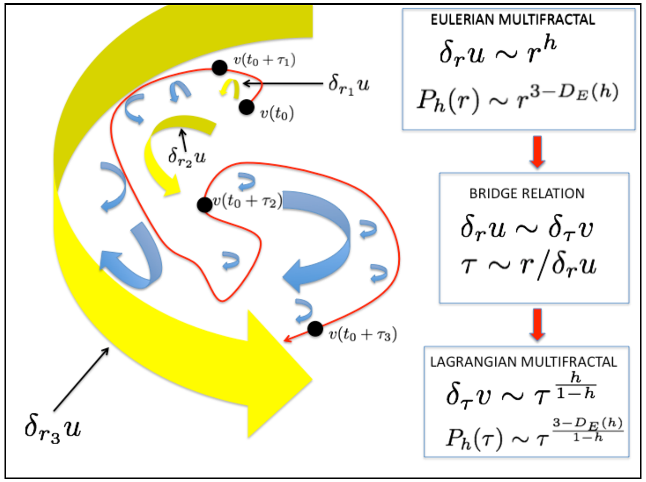

Fig. 1

The simple bridge relation here discussed, assumes that eddies with a scale much larger than the traveled distance do not contribute because they are frozen on a time scale of the order of τ, while eddies with a size much smaller have fast fluctuations and a vanishing (sub-leading) contribution. Hence, the leading contribution is carried out by eddies with a typical decorrelation time of the order of τ. The whole scenario is depicted in the figure above, where we show how Eulerian eddies of size r_1 contribute to Lagrangian velocity increments over a time lag τ_1, while eddies of size r_2 are connected to Lagrangian increments over a time lag τ_2, etc...

It is then easy to get a Lagrangian multifractals prediction starting from the Eulerian one, as detailed in the three boxes on the figure in the previous page. Such a relation has been validated against different numerical and experimental data sets, leading to a very accurate prediction for both inertial and viscous time lags [Bi04, Ar08, Be10]. Here we want to present the results concerning turbulent acceleration.

Numerical simulations and experimental data have clearly detected a high intermittent trend in the acceleration PDF with strong non-Gaussian tails and a high probability of observing very intense fluctuations (state-of-the-art numerical simulations are capable of measuring fluctuations up to 70 times a_{rms} [Be06, Be10a]). It is possible to generalize the bridge relation described previously to reconstruct the whole PDF shape of any Lagrangian observable, with the only additional empirical observation that large scale quantities have a Gaussian distribution [Fr96]. So, assuming that the large scale velocity field has an amplitude distributed as $P(u_0)du \sim u_0^2 \exp(-u_0^2/2\sigma)du_0$, one may derive, following the calculation in [Bi04], a MF bridge relation for the acceleration amplitude, a = |**a**|, defined in terms of the Lagrangian increment on the Kolmogorov time scale τ_η :

$$\begin{cases} y(h) = (3h - D_E(h) - 3)/3 \\ z(h) = (2D_E(h) + 6h - 9)/3 \\ q(h) = (2 + 2h)/3 \\ p(h) = (4h - 2)/3 \end{cases} \qquad \begin{cases} a = \frac{\delta_{\tau_\eta} v}{\tau_\eta}; \qquad a \sim u_0^{\frac{3}{1+h}} \nu^{\frac{2h-1}{1+h}} \\ P(a)da \propto \int dh\, P_h(\tau_\eta) \int du_0\, P(u_0) \delta(a - u^{\frac{3}{1+h}} \nu^{\frac{2h-1}{1+h}}) \\ P(\tilde{a}) \propto \int dh\, \tilde{a}^{y(h)} Re^{z(h)} exp[-\tilde{a}^{q(h)} Re^{p(h)}] \end{cases}$$

where with ã we have denoted the acceleration normalized with its a_{rms} value and we have normalized the integral scale to be of the order of unity. Moreover, the acceleration root mean square is given by the expression:

$$\langle a^2 \rangle^{1/2} \sim Re^{\chi} \qquad \chi = \min_h [(D_E(h) - 4h - 1)/(1+h)] \sim 0.57$$

which is in good agreement with the empirically derived asymptotic expression that fits the data [Sh94]. In order to get the given value in the previous expression we have used the expression for $D_E(h)$ that fits the longitudinal Eulerian velocity increments statistics. A slightly different value would have been obtained by using the $D_E(h)$ that fits the transverse increments [Be10]. In the figure, we show the capability of the formalism to fit the whole shape of the acceleration PDF **without any adjusting parameters,** i.e. using the $D_E(h)$ that is optimised to reproduce the Eulerian statistics. The data are obtained from a Direct Numerical Simulation (DNS) at $Re_\lambda \sim 400$ [Be06]. The quality of the fit is very high: the Multifractal model is able to reproduce the whole distribution of fluctuations without introducing any new fitting parameters. Similar results are obtained concerning the scaling properties of the Lagrangian Flatness and hyper-Flatness at different time lags [Ar08, Be10].

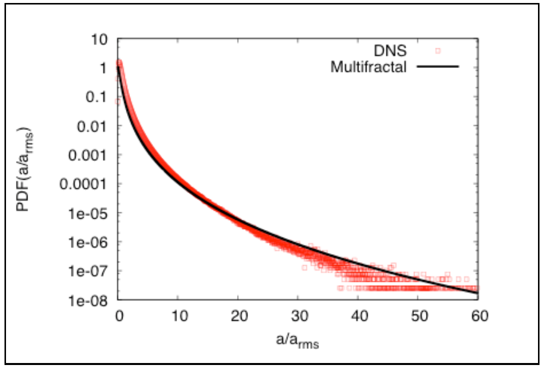

Fig. 2

In spite of this evident success, several problems are still open. First, it is not known if the bridge relation here discussed is valid also for very intense, inertial-range fluctuations, i.e. events that dominate high-order moments in Eulerian and Lagrangian structure functions. Second, we do not know how to connect in a more stringent way the Multifractal conjecture to the analytical structure of the Navier-Stokes equations. Third, we lack a way to extend the Multifractal bridge relation to the case of inertial particles, even in the limit of small inertia [Be06]. This is due to the difficulty in incorporating preferential concentration in the Eulerian-Lagrangian relation, i.e. to the lack of any topological information in the statistical Multifractal approach.

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EUROMECH Fellows: Nomination Procedure

The EUROMECH Council was pleased to announce the introduction of the category of **EUROMECH Fellow**, starting in 2005. The status of Fellow is awarded to members who have contributed significantly to the advancement of mechanics and related fields. This may be through their original research and publications, or their innovative contributions in the application of mechanics and technological developments, or through distinguished contribution to the discipline in other ways.

Election to the status of Fellow of EUROMECH will take place in the year of the appropriate EUROMECH Conference, EFMC or ESMC respectively. The number of fellows is limited in total (fluids and solids together) to no more than one-half of one percent of the then current membership of the Society.

Nomination conditions:

- The nomination is made by **two sponsors** who must be members of the Society;
- Successful nominees must be members of the Society;
- Each nomination packet must contain a completed Nomination Form, signed by the two sponsors, and no more than four supporting letters (including the two from the sponsors).

Nomination Process:

- The nomination packet (nomination form and supporting letters) must be submitted **before 15 January** in the year of election to Fellow (the year of the respective EFMC or ESMC);
- Nominations will be reviewed before the end of February by the EUROMECH Fellow Committee;
- Final approval will be given by the EUROMECH Council during its meeting in the year of election to Fellow;
- Notification of newly elected Fellows will be made in May following the Council meeting;
- The Fellow award ceremony will take place during the EFMC or ESMC as appropriate.

Required documents and how to submit nominations:

Nomination packets need to be sent before the deadline of 15 January in the year of the respective EFMC or ESMC to the President of the Society. Information can be obtained from the EUROMECH web page www.euromech.org and the Newsletter. Nomination Forms can also be obtained from the web page or can be requested from the Secretary-General.

EUROMECH - European Mechanics Society

NOMINATION FORM FOR FELLOW

NAME OF NOMINEE: ....

OFFICE ADDRESS: ....

....

EMAIL ADDRESS: ....

FIELD OF RESEARCH: ....

Fluids: ☐ Solids: ☐

NAME OF SPONSOR 1: ....

OFFICE ADDRESS: ....

....

....

EMAIL ADDRESS: ....

SIGNATURE & DATE: ....

NAME OF SPONSOR 2: ....

OFFICE ADDRESS: ....

....

....

EMAIL ADDRESS: ....

SIGNATURE & DATE: ....

SUPPORTING DATA

- Suggested Citation to appear on the Fellowship Certificate (30 words maximum);
- Supporting Paragraph enlarging on the Citation, indicating the Originality and Significance of the Contributions cited (limit 250 words);
- Nominee's most Significant Principal Publications (list at most 8);
- NOMINEE'S OTHER CONTRIBUTIONS (invited talks, patents, professional service, teaching etc. List at most 10);
- NOMINEE'S ACADEMIC BACKGROUND (University Degrees, year awarded, major field);
- NOMINEE'S EMPLOYMENT BACKGROUND (position held, employed by, duties, dates).

SPONSORS' DATA

Each sponsor (there are two sponsors) should sign the nomination form, attach a letter of recommendation and provide the following information:

- Sponsor's name;
- Professional address;
- Email address;
- Sponsor's signature/date.

ADDITIONAL INFORMATION

Supporting letters (no more than four including the two of the sponsors).

TRANSMISSION

Send the whole nomination packet to:

Professor Patrick Huerre
President EUROMECH
Laboratoire d'Hydrodynamique, École Polytechnique
91128 Palaiseau Cedex, France
E-mail: huerre@ladhyx.polytechnique.fr

EUROPEAN MECHANICS SOCIETY

EUROMECH Prizes: Nomination Procedure

Fluid Mechanics Prize
Solid Mechanics Prize

Regulations and Call for Nominations

The Fluid Mechanics Prize and the Solid Mechanics Prize of EUROMECH, the European Mechanics Society, shall be awarded on the occasions of Fluid and Solid conferences for outstanding and fundamental research accomplishments in Mechanics.
Each prize consists of 5000 Euros. The recipient is invited to give a Prize Lecture at one of the European Fluid or Solid Mechanics Conferences.

Nomination Guidelines

A nomination may be submitted by any member of the Mechanics community.
Eligible candidates should have undertaken a significant proportion of their scientific career in Europe. Self-nominations cannot be accepted.
The nomination documents should include the following items:

- A presentation letter summarizing the contributions and achievements of the nominee in support of his/her nomination for the Prize;
- A curriculum vitae of the nominee;
- A list of the nominee's publications;
- At least two letters of recommendation.

Five copies of the complete nomination package should be sent to the Chair of the appropriate Prize Committee, as announced in the EUROMECH Newsletter and on the Society's Web site www.euromech.org Nominations will remain active for two selection campaigns.

Prize committees

For each prize, a Prize Committee, with a Chair and four additional members shall be appointed by the EUROMECH Council for a period of three years. The Chair and the four additional members may be re-appointed once. The committee shall select a recipient from the nominations. The final decision is made by the EUROMECH Council.

Fluid Mechanics Prize

The nomination deadline for the Fluid Mechanics prize is **15 January in the year of the Solid Mechanics Conference**. The members of the *Fluid Mechanics Prize and Fellowship Committee* are:

- A. Kluwick (Chair)
- O. E. Jensen
- D. Lohse
- P. Monkewitz
- W. Schröder

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Solid Mechanics Prize

The nomination deadline for the Solid Mechanics prize is **15 January in the year of the Solid Mechanics Conference**. The members of the *Solid Mechanics Prize and Fellowship Committee* are:

- W. Schiehlen (Chair)
- H. Myhre Jensen
- N.F. Morozov
- M. Raous
- B. A. Schrefler

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EUROMECH Conferences in 2013

The general purpose of EUROMECH conferences is to provide opportunities for scientists and engineers from all over Europe to meet and to discuss current research. Europe is a very compact region, well provided with conference facilities, and this makes it feasible to hold inexpensive meetings.

The fact that the EUROMECH Conferences are organized by Europeans primarily for the benefit of Europeans should be kept in mind. Qualified scientists from any country are of course welcome as participants, but the need to improve communications within Europe is relevant to the scientific programme and to the choice of leading speakers.

A EUROMECH Conference on a broad subject, such as the ESMC or the EFMC, is not a gathering of specialists all having the same research interests. Much of the communication which takes place is necessarily more in the nature of imparting information than exchange of the latest ideas. A participant should leave a Conference knowing more and understanding more than on arrival, and much of that gain may not be directly related to the scientist's current research. It is very important therefore that the speakers at a Conference should have the ability to explain ideas in a clear and interesting manner, and should select and prepare their material with this expository purpose in mind.

2013

ETC14
14th European Solid Mechanics Conference
DATE: 2-4 September 2013
LOCATION: Lyon, France
CONTACT: Prof. J. F. Pinton
E-MAIL: jean-francois.pinton@ens-lyon.fr

EMMC13
13th European Mechanics of Materials Conference - ICMM3
DATE: 8-11 September 2013
LOCATION: Warsaw, Poland
CONTACT: Prof. P. Dhuzewski
E-MAIL: icmm3@ippt.gov.pl

EUROPEAN MECHANICS SOCIETY

EUROMECH Conferences Reports

6th EuropeanPostgraduate Fluid Dynamics Conference 2012

The sixth European Postgraduate Fluid Dynamics Conference took place from 10th to 12th of July at Imperial College London, UK. There were 75 participants (40% currently studying in the UK), 3 plenary speakers and 10 organising committee members.
The participants represented 41 European and 3 Asian institutions and 21% were female. The conference programme comprised 3 guest lectures from invited speakers, 11 oral presentation sessions, 3 poster presentation sessions and regular refreshment breaks to enable introductions, discussions and debates. During the application process, 134 abstracts were submitted and from these, 68 were selected. 38 postgraduate students were invited to give an oral presentation and 30 to present their work with a poster.

The sessions and posters were on the following topics:

1. Turbulent Flows – 6 talks, 4 posters (28 submitted);
2. Temperature and Buoyancy Driven Flows – 4 talks, 5 posters (11 submitted);
3. Applied Aerodynamics – 4 talks, 1 poster (12 submitted);
4. Boundary Layers – 3 talks, 2 posters (5 submitted);
5. Flow Control – 3 talks, 3 posters (7 submitted);
6. Geophysical Flows – 4 talks, 3 posters (10 submitted);
7. Environmental and Engineering Applications – 4 talks, 5 posters (20 submitted);
8. Physiological Flow – 3 talks, 3 posters (6 submitted);
9. Hydrodynamic stability – 3 talks, 2 posters (10 submitted);
10. Waves and stability – 4 talks, 0 posters (14 submitted).

Additional events included demonstrations and tours of the aerodynamics and fluid dynamics laboratory facilities at the Department of Aeronautics and the Department of Civil & Environmental Engineering. The Welcome Barbeque on the first evening was a great success, providing evening entertainment in a relaxed environment overlooking the Royal Albert Hall. The Conference dinner, hosted in the official residence of the Rector, gave some feeling of the history of Imperial College London and provided yet more opportunities for the participants to socialise and make hopefully lasting acquaintances. To encourage and stimulate intellectual conversation, the refreshment breaks were held in the same room as the posters were displayed. Posters were displayed throughout the day of their session allowing two refreshment breaks for participants to get familiar with the posters before the extended poster session in the afternoon.

The participants were accommodated in en-suite single or twin rooms in Eastside student hall, just across the road from the main campus, with the breakfast served in the senior common room of the university.

EUROMECH Colloquia in 2013

EUROMECH Colloquia are informal meetings on specialized research topics. Participation is restricted to a small number of research workers actively engaged in the field of each Colloquium. The organization of each Colloquium, including the selection of participants for invitation, is entrusted to a Chairman. Proceedings are not normally published. Those who are interested in taking part in a Colloquium should write to the appropriate Chairman. Number, Title, Chairperson or Co-chairperson, Dates and Location for each Colloquium in 2010, and preliminary information for some Colloquia in 2011 and 2012, are given below.

2013

533. **Biomechanics of the Eye**
Chairperson: Dr. Rodolfo Repetto
Department of Civil, Environmental and Architectural Engineering
University of Genoa
Via Montallegro 1,
16145, Genoa, Italy
Email: raous@lma.cnrs-mrs.fr
Co-chairpersons: Dr. Jennifer Siggers; Dr. Alessandro Stocchino
Dates and location: 22-24 July 2013, Genova, Italy
http://www.dicca.unige.it/euromech-533/index.html

541. **New Advances in the Nonlinear Dynamics and Control of Composites for Smart Engineering Design**
Chairperson: Prof. Stefano Lenci
Department of Architecture, Buildings and Structures
Polytechnic University of Marche
via Brecce Bianche
I-60131 Ancona, Italy
Email : lenci@univpm.it
Co-chairpersons: Prof. Jerzy Warminski
Dates and location: 3 -6 June 2013, Senigallia, Italy
http://www.dipmat.univpm.it/euromech541/

542. **Progress in statistical theory and pseudo-spectral DNS**
Chairperson: Dr. Claude Cambon
LMFA
Ecole Centrale de Lyon
36 rue de Collongue
69134 Ecully cedex, France
Email: claude.cambon@ec-lyon.fr
Co-chairpersons: Prof. Ananias Tomboulides
Dates and location: 15-18 January 2013, Lyon, France
http://lmfa.ec-lyon.fr/index.php?p_id=lmfa.003.005.000

543. **Quantification of uncertainties in modelling and predictive simulations of fluids**
Chairperson: Prof. Nikolaus. Adams
Technische Universität München
Lehrstuhl für Aerodynamik und
Strömungsmechanik
Boltzmannstrasse 15
D-85747 München, Germany
Email: Nikolaus.Adams@tum.de
Dates and location: October 2013, München, Germany

544. **Dense flows of soft objects: bringing together the cases of bubbles, droplets and cells**
Chairperson: Dr Gwennou Coupier
Laboratoire Interdisciplinaire de Physique (LIPhy)
CNRS et Université J. Fourier-Grenoble I,
BP 87, 38402 Saint-Martin d'Hères, France
Email: gwennou.coupier@ujf-grenoble.fr
Co-Chairpersons: Prof. Dr. Ralf Seemann, Dr. Philippe Marmottant
Dates and location: 13-15 May 2013, Grenoble, France
http://www-liphy.ujf-grenoble.fr/Euromech544

545. **Frontiers in Finite Deformation Electromechanics**
Chairperson: Prof. Andreas Menzel
Institute of Mechanics
Technische Universitaat Dortmund
Leonard Euler Str. 5
Dortmund, Germany
Email: christina.mcdonagh@tu-dortmund.de
Co-Chairpersons: Prof. Ellen Kuhl; Prof. Serdar Goktepe
Dates and location: 21-24 May 2013, Dortmund, Germany
http://www.euromech545.de/

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546. Combustion Dynamics and Combustion Noise
Chairperson: Prof. Christian Oliver Paschereit
Chair of Fluid Dynamics, TU Berlin
Müller-Breslau-Str. 8
D- 10623 Berlin, Germany
Email: oliver.paschereit@tu-berlin.de
Co-Chairperson: Dr. Jonas P. Moeck
Dates and location: 13-17 May 2013, Loveno di Menaggio, Italy

547. Trends in Open Shear Flow Instability
Chairperson: Prof. Lutz Lesshafft
Laboratoire d'Hydrodynamique
CNRS - Ecole Polytechnique, France
Email: lutz@ladhyx.polytechnique.fr
Co-Chairpersons: Prof. François Gallaire
Dates and location: 1-3 July 2013, Ecole Polytechnique, Palaiseau, France

548. Direct and Variational Methods for non smooth problems in Mechanics
Chairperson: Prof. Géry de Saxcé
Laboratoire de Mécanique de Lille
Villeneuve d'Ascq, France
email: gery.desaxce@univ-lille.fr
Co-Chairpersons: Prof. Gianpietro Del Piero
Dates and location: 1-3 June 2013, Amboise, Indre-et-Loire, France

549. Current status and future research directions in the development and application of Immersed Boundary Methods
Chairperson: Dr. W.P. Breugem
University of Technology Delft
Laboratory for Aero and Hydrodynamics
Leeghwaterstraat 21
2628CA Delft, Netherlands
Email: w.p.breugem@tudelft.nl
Co-Chairperson: Prof. Roberto Verzicco
Dates and location: 17-19 June 2013, Leiden, the Netherlands
http://www.pe.tudelft.nl/~wim/euromech549/

550. Multi-physical couplings in solid polymers: experiments and modeling
Chairperson: Dr. S. Castagnet
Institut Prime
Department of Physics and Mechanics of Materials
ENSMA, 1 Avenue Clement Ader, BP 40109
86961 Futuroscope cedex, France
Email : sylvie.castagnet@ensma.fr
Co-Chairperson: Prof. Alexander Lion
Dates and location: June 2013, Poitiers, France

551. Mechanics Fibre reinforced Materials: Theory and Applications
Chairperson: Prof. R. Ogden
School of Mathematics and Statistics
University of Glasgow,
Glasgow, UK
Email: Raymond.Ogden@glasgow.ac.uk
Co-Chairpersons: Prof. Kostas P. Soldatos; Prof. José Merodio
Dates and location: 2-5 September 2013, Nottingham, UK
http://fibre-reinforced-materials.co.uk/

552. Modelling Atmospheric and Oceanic flows: insights from laboratory experiments and numerical simulations
Chairperson: Dr. Thomas von Larcher
Freie Universitaet Berlin
Dept. of Mathematics & Computer Sciences
Institute for Mathematics
Arnimallee 6,
D-14195 Berlin-Dahlem, Germany
Email: larcher@math.fu-berlin.de
Co-Chairpersons: Dr. Paul D. Williams, Dr Wolf-Gerrit Fruh
Dates and location: 24-27 September 2013, Berlin, Germany

555. Small-scale numerical methods for multi-phase flows
Chairperson: Prof. Stéphane Vincent
I2M-TREFLE
16, avenue Pey-Berland
33607 Pessac Cedex, France
Email: vincent@enscbp.fr
Co-Chairpersons: Prof. Ruben Scardovelli
Dates and location: 28-30 August 2013, Pessac, France

EUROMECH Colloquia Reports

EUROMECH Colloquium 512

Following EUROMECH Colloquium 512 on Small Scale Turbulence http://www.euromech512.polito.it/, a special issue of PhysicaD: Nonlinear Phenomena was published on 1st February 2012.
It is now available online at http://dx.doi.org/10.1016/j.physd.2011.11.013

EUROMECH Colloquium 524
"Multibody System Modelling, Control and Simulation for Engineering Design"
27-29 February, 2012, Enschede, The Netherlands
Chairperson: . Prof. J.B. Jonker
Co-Chairperson: Prof. W. Schiehlen

EUROMECH Colloquium 524 was devoted to multibody system dynamics with regard to engineering design principles and modelling for design and simulation. A broad variety of engineering applications were presented. These ranged from nanomotion systems to robotics and biomechanics, and from vehicle dynamics to historic masonry construction in civil engineering. Detailed analyses using large-scale industrial models as well as high-level analyses based on simple (prototype) models with a small number of degrees of freedom were presented.

Colloquium 524 took place at the University of Twente, The Netherlands. There were 41 participants from 9 European countries and one country outside Europe.

There were 30 presentations, grouped into the following topics:

- Numerically efficient multibody system dynamics techniques;
- Modelling for design and simulation;
- Design principles and contact problems;
- Underconstraint and overconstraint mechanical systems;
- Flexible multibody dynamics and reduced order modelling;
- Mechatronic design and compliant mechanisms;
- Parameter optimization and manufacturing tolerances;
- Simulation for engineering design;
- Applications to engineering systems.

The application oriented sessions clearly demonstrated that multibody system modelling techniques can effectively support the different phases of the design and optimisation processes, mainly because of their computational efficiency and their ability to allow models to be easily updated and extended during design. Key aspects in this context appear to be the development of efficient formulations and numerical integration techniques. In the case of flexible multibody systems, model reduction techniques are of particular importance.
Presentations in various sessions demonstrated the importance of the development of contact algorithms.

Very much appreciated was the visit to the laboratory of the Department of Mechanical Automation and Mechatronics. This included the presentation of a broad range of compliant mechanisms featuring frictionless motion.

A book of abstracts has been published and distributed to the participants. More detailed information on the programme and others aspects of Colloquium 524 can be found at the website http://www.utwente.nl/ctw/euromech524. Selected authors have been invited to submit their contributions for publication as peer-reviewed papers in an issue of the journal "Multibody System Dynamics".

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EUROMECH Colloquium 534
"Advanced experimental approaches and inverse problems in tissue biomechanics"
29-31 May 2012, Saint-Etienne, France
Chairperson: Prof. Stéphane Avril
Co-Chairperson: Prof. Sam Evans

The objectives of EUROMECH Colloquium 534 were to foster the interaction and networking between research workers in universities, industries, and government laboratories in the general area of mechanics as applied to biological tissues, materials and applications, and to provide an opportunity for the exchange of ideas in an interdisciplinary forum.

EUROMECH 534 served as a forum for presentation of recent advances in testing approaches, imaging techniques and inverse problems for applications in tissue mechanics and biomechanics. Participants included the leading European developers of advanced tools for characterising the mechanical behaviour of biotissues, and principal users in actual clinical situations.

It has become common practice to combine video based full-field measurements of the displacements experienced by tissue samples in vitro with an inverse method to infer the best-fit material parameters using nonlinear regression. Similar approaches also exist for characterising tissues in vivo where advanced medical imaging can provide precise measurements of tissue deformation under different modes of action and inverse methodologies are used to derive material properties from those data.

Two main applications of imaging techniques exist in the tissue mechanics community:

- **Predictive models for computer aided surgery** The classical approach is to construct a 3D patient-specific geometry and to mesh it for computation using finite elements. This generates several types of inverse problems to be solved, as neither the boundary conditions nor the material properties are known for these simulations.
- **Fundamental mechanobiology** The aim is to achieve better insight into the characteristics of biological tissues, which appear to develop, grow, remodel and adapt in order to maintain particular mechanical metrics (e.g. stress) near target values. To accomplish this, tissues often develop regionally varying stiffness, strength and anisotropy. Important challenges in tissue mechanics are now to develop and implement hybrid experimental-computational methods to quantify regional variations in properties in situ.

The colloquium was interdisciplinary. There were 42 presentations in 6 sessions:

- **Soft tissues (9 presentations)** The keynote speech by Karol Miller focused on brain tissue. The challenge in this field is to set up predictive models for computer aided surgery. Other presentations concerned cervix tissue, skin and fat tissue.
The use of imaging techniques is crucial for defining the geometry and boundary conditions in finite element models. Inverse problems arise in determining parameters that make the models patient-specific.
- **Cornea (4 presentations)** Combinations of mechanical and optical systems are being developed to predict the mechanical response of the cornea to surgical operations. The semi-transparency of the corneal tissue has allowed pioneering research using Digital Volume Correlation within the stroma.
- **Osteoarticular elastic tissues (6 presentations)** The mechanical properties of tendons, ligaments and muscles were discussed. Muscle tissue has very complex behaviour, being anisotropic and nonlinear. Strains can be several hundred percent.
The prediction of mechanical response in vivo requires precise characterization of the mechanical properties. Further development of Elastography is needed to identify anisotropic and nonlinear properties.
- **Identification techniques (9 presentations)** New techniques based on imaging and numerical analysis for characterising living tissues were presented. The keynote speech by Katia Genovese described the characterisation of aneurisms using the Digital Image Correlation technique. Novel image interpretation techniques are being developed to determine tissue response to treatments or surgical operations.
- **Cardiovascular tissues (6 presentations)** The session addressed the determination of stresses in the wall of arteries. The keynote speech by Jia Lu concerned determination of the stress distribution in membrane-like structures. Rupture of soft tissues still needs to be better understood. A principal aim is to predict the risk of rupture in case of lesions such as aneurisms or arteriosclerosis.
- **Bone tissue (8 presentations)** The session covered ongoing intensive research into the mechanical properties of bone tissues. Understanding of the link between the microstructure and the macroscopic response is likely to be essential for treatment of diseases such as osteoporosis.

A special issue of the Journal of the Mechanical Behaviour of Biomedical Materials will include the best presentations at the Colloquium. It is envisaged that special sessions on this topic might form part of future major conferences such as CMBBE, ICEM, ESB and ISB. Another Euromech colloquium should be organized in 2014 to address the most recent developments in the field, with greater involvement by the elastography community (MRI and ultrasounds).

EUROMECH Colloquium 535
"Similarity and Symmetry Methods in Solid Mechanics"
6-9 June 2012, Varna, Bulgaria
Chairperson: Prof. Jean-François Ganghoffer
Co-Chairperson: Dr. Ivailo Mladenov

EUROMECH Colloquium 535 was followed by the fourteenth international Conference on Geometry, Integrability and Quantization (June 08-13 in Varna) at the same venue. The EUROMECH Colloquium was focused on symmetry methods in mechanics, and was intended to attract additional participants who are active in the field of symmetries in solid and fluid mechanics. The informal and pleasant atmosphere of the meeting fostered many exchanges amongst the participants. The Colloquium showed overall the great potential of applications of symmetry methods in engineering.

Despite a rather limited number of participants, a wide number of topics were presented and discussed. Peter Olver (invited speaker from the University of Minnesota, U.S.) gave a survey of symmetry methods from a mathematical point of view, including the moving frame method due to E. Cartan. Talks related to the following topics were presented:

- **Hamiltonian mechanics** A few talks from the Polish group (Institute of Fundamental Technological Research, Polish Academy of Sciences, Warsaw) were devoted to extension of Hamiltonian mechanics to non conservative systems.
- **Symmetry analysis** of wave propagation in non-uniform media.
- **Symmetry methods in mechanics of materials** Lie symmetries are involved to build a constitutive law for given materials provided experimental data for various set of parameters are available, and assuming those data obey the structure of a Lie group.
- **Geometric mechanics** for rigid body motion.
- **Symmetries of the membrane shape equations** The Helfrich model is chosen as the prototype model to describe the shape of biological membranes; the Euler-Lagrange equation is a fourth-order PDE involving the surface Laplacian.
  For cylindrical membranes, it reduces to an ordinary differential equation for the curvature of a planar curve, similar to the modified KdV equation.
- **Lie groups and differential equations** The more mathematical aspects of Lie symmetries have been exposed, allowing to solve the differential equations (ordinary or partial differential equations) arising in mathematical physics and to find associated conservation laws.

EUROMECH Colloquium 536
"Nanobubbles and micropancakes"
13-17 February 2012, Les Houches, France
Chairperson: Dr. James Seddon
Co-Chairpersons: Prof. Detlef Lohse, Dr. Elisabeth Charlaix

Surface nanobubbles and micropancakes are two recently discovered stable gaseous domains found at the solid/liquid interface. They form a relatively new field that is rapidly expanding. An intriguing feature is that the bubbles should be unstable from a simple classical viewpoint. The surface tension should squeeze the bubbles to annihilation on a time scale of microseconds, but the experimental life time is greater than 5 days and is still to be measured.

The goals of EUROMECH Colloquium 536 and Workshop at Les Houches were to clarify the field to date and to allow exchange of new ideas on recent advances. There were 50 participants and 38 presentations, including those by 10 key-note speakers: Anne-Laure Biance (Lyon), Frederic Caupin (Lyon), Derek Chan (Melbourne), Vince Craig (ANU), William Ducker (Virginia Tech.), Karin Jacobs (Saarbruecken), Seiichiro Nakabayashi (Saitama), Patrick Tabeling (ESPCI), Harold Zandvliet (Twente), and Xuehua Zhang (Melbourne).
The presentations were concentrated in intensive morning sessions. Lighter evening sessions followed afternoon reflection and discussion periods, during which participants could exchange ideas freely. There was also a 90-minute focus session on nanobubble stability, the key issue in the field to date.

The major themes addressed in the talks and discussion sessions were:

- **Nanobubble stability** Although ideas concerning stability have converged in recent years, specific issues were raised, including: (i) If nanobubbles are inherently dependent on micropancakes, why are micropancakes only ever found on hydrophobic surfaces while nanobubbles are found on all surfaces; (ii) why do nanobubbles not Ostwald ripen if they exist on an underlying micropancake; (iii) what is the role of substrate pinning on nanobubble stability?
- **Nanobubble nucleation** Several recipes exist for nanobubble nucleation, but only a few are reproducible and these tend to give low numbers of nucleation sites. Presentations of new techniques for nucleation, included saline/pure water exchange, low temperature to high temperature water exchange, and electrolytic switching between nucleation and annihilation. These methods offer more than previous techniques, giving an easier entry point for newcomers, as well as more robust results for those experienced in the field.
- **Slippage** One key application highlighted was the control of slip in microfluidic devices. By coating the walls of a microfluidic channel with a stable gas layer,

the boundary condition is changed from one of no-slip to one of slip. Presentations showing the recent advances in numerical simulations on this topic suggest that slip control is indeed possible, but the available channel width is reduced by the impinging bubble profiles. Experiments are now needed to test these concepts in a controlled way.

- **New techniques** Novel applications of techniques to investigate nanobubbles include attenuated total reflection infrared spectroscopy, allowing nucleation and annihilation dynamics to be measured in a controlled statistical way. Interference-enhanced reflection microscopy allows optical visualisation of nanobubbles. Previously, nanobubbles could only be imaged individually through the very intrusive technique of atomic force microscopy. Ellipsometry offers dynamic measurements of micropancake growth and annihilation. Interpretation of data from a quartz crystal microbalance has helped disentangle the range of competing results in the literature. The range of numerical methods for investigatation of nanobubbles has also been increased, including Kinetic Monte Carlo to show both 2D and 3D stable bubbles in a high Knudsen regime.
- **Bulk nanobubbles** As well as surface nanobubbles, bulk nanobubbles have also recently been discovered and are unusual for the same reasons as their surface counterparts, i.e. peculiar stability and long life times. Advances in bulk nanobubble research were also presented at the colloquium and it is now important to address the true relationship between the two types of nanoscopic bubble.
- **Related topics** It was our intention to invite speakers from disciplines outside the immediate topic in order to both increase the field and draw in from those external knowledge bases. Several interesting and related talks were given on wetting, surface tension driven flows, microfluidic slip, nanofluidic film flow, nucleation, and nanoscopic variations to macroscopic material properties. Each of these topics feeds directly into the nanobubble and micropancake community.

The field has advanced greatly in terms of a common consensus and a clear focus, thanks to Colloquium 536. The community has tentatively agreed to have a follow-on meeting in 2014-15 in Australia. The decision to invite people working in related, but different, fields allowed a particularly fruitful exchange of ideas. Several new collaborations were initiated at the Colloquium, including personnel exchanges and new experiments. Some of the new work has already been published, with acknowledgement to Colloquium 536 for providing the essential framework. We thank Euromech for making the colloquium possible, and for the organisational support.

EUROMECH Colloquium 537

"Multi-scale Computational Homogenization of heterogeneous structures and materials"

26-28 March, 2012, Marne-la-Vallée, France
Chairperson: Prof. Julien Yvonnet
Co-Chairpersons: Prof. Marc Geers, Dr. Frederic Feyel

In recent years considerable progress has been made in linking the mechanics of materials to other disciplines, e.g. downscaling to the field of materials science or upscaling to the field of structural engineering. The steady progress essentially results from the research efforts invested in multi-scale modelling in general, so there is a natural focus on multi-disciplinary aspects. EUROMECH Colloquium 537 addressed the state-of-the-art in computational homogenization, which is probably one of the most accurate techniques for upscaling the complex behaviour of a well-characterized microstructure. This method is essentially based on the construction of a micro-scale boundary value problem, which is used to determine the local governing behaviour at the macro scale.

Colloquium 537 involved 55 participants, represented by ten nationalities including European Countries, Japan and USA. 54% of the speakers and 45% percent of the participants were from outside of France. There were 27 presentations, including 4 keynote lectures. These were by: Kenjiro Terada (Tohoku University, Japan), Pierre Suquet (LMA, Marseille, France), Paul Steinmann (University of Erlangen-Nuremberg, Germany) and Christian Miehe (University of Stuttgart, Germany). In addition to the presentations, two round table/discussion sessions were organized.

The following points were raised during the various presentations and discussions:

- Computational homogenization methods involving fully coupled scales (concurrent multiscale methods) are limited by computational costs and are therefore mainly to be used for reference solutions. Fully concurrent two-scale simulations for structural problems are not yet within reach. Presentations and discussions showed the potential of other methods like NTFA or model reduction-based methods for extracting only the relevant information from the microscopic scale in order to construct computationally cheaper macroscopic constitutive relationships.
- The important role of uncertainties in the multiscale modelling of complex, heterogeneous materials was emphasized, especially when dealing with models arising from experimental images.
- The emergence of interface modelling is a clear trend, either through multiscale schemes to determine interface properties or by introducing surface energy.
- Issues related to transition from microscopic localization to global instability were discussed.

- Several discussions and debates about microscopic solvers like FFT, XFEM and isogeometric elements took place.
- There was interest in strain gradient approaches for upscaling discrete phenomena to the continuum scale.

The following issues were also debated during discussion sessions, emphasising some open problems and unresolved questions:

- The coupling between space and time effects in homogenization processes requires further exploration.
- When spatial resolution increases, the complexity, level of uncertainties and missing data for a complete model are further exposed. One open question is to define an optimal model to capture the relevant information needed at the coarse scale, while still providing an in-depth understanding of the local phenomena.

EUROMECH Colloquium 540
"Advanced Modelling of Wave Propagation in Solids"
1-3 October, 2012, Prague, Czech Republic
Chairperson: Dr. Radek Kolman
Co-Chairpersons: Dr. Arkadi Berezovski

EUROMECH Colloquium 540 took place at the Institute of Thermomechanics in Prague. It aimed at bringing together engineers and scientists interested in modelling of wave propagation in solids. Wave phenomena play an important role in various scientific fields such as continuum mechanics, material science, and physics. The reliable modelling of wave propagation in solids is of utmost importance in industry, seismology, security and defence.

There were 67 participants from 18 countries, with 42 oral and 11 poster presentations. Colloquium 540 focused on topics related to linear and non-linear wave propagation in solids, such as solitary waves, strongly dispersive waves in inhomogeneous solids and waves in materials with microstructure. Attention was also paid to up-to-date formulations of nonlinear constitutive equations in thermomechanical coupling, finite strains, strain rate effects, shock waves, visco-plasticity, damage and phase transformation.

Recent advances in numerical approaches and strategies were discussed. To guarantee the accuracy and stability of numerical approaches, proper understanding of techniques to suppress artifacts and parasitic effects is essential. Among these are size effects, dispersion attenuation and appearance of spurious modes and evanescent waves. The main purpose of Colloquium 540 was to discuss novel methods of wave propagation modelling and to assess the credibility of results in cases when experiment validation was not available.

Issues addressed throughout the talks and discussion included:

- **Surface Waves** These have probably been studied more thoroughly than any other kind of wave motion in solid materials. Various analytical methods for surface wave propagation have been discussed with respect to geometrical and material dispersion effects. Among them, a new approach was proposed to the formulation and interpretation of dynamical solutions of the surface acoustic wave type of which Rayleigh waves are the most celebrated case.
- **Nonlinear Waves** The balance between nonlinearity and dispersion results in the formation of stationary nonlinear waves. Several approaches to the modelling of the influence of nonlinearity were presented and compared. In particular, a Mindlin-type mathematical model of microstructured solids with nonlinearities in the macro- and microscale is used to study propagation of 1D solitary waves in such media.

- **Wave Modelling** The dispersive wave equations are based on the material modelling, even if this is not stated explicitly. Replacement of a microscopic material model by an enriched continuum model can be used to capture micro-structural effects. The evolution equations of generalised continuum mechanics (e.g. microdeformation or Cosserat continua) are obtained by analogy of elasticity and continuum mechanics, while those of internal variables are routinely generated by the Second Law of thermodynamics. A novel asymptotic procedure was proposed for homogenization of periodic structures. Self-similarity in material properties and stability of models were discussed.
- **Numerical Methods** Many numerical strategies for modelling of wave propagation were presented. These included: the finite element method (FEM) in connection with classical time integration methods, the finite volume method (FVM), the discontinuity Galerkin (DG) and discontinuity Galerkin-Petrov (DPG) methods, spline based finite elements (isogeometric analysis), non-spurious oscillation schemes, Hermite methods and variation time integration methods. The numerical errors and the cost of wave computation were considered. It was concluded that future attention should be paid to further development of suitable methods for wave propagation treatment in solids, including with error analysis.
- **Impact Problems** Experimental and computational methods for the response of materials to impact loading in various applications were presented, including numerical modelling of dynamic materials testing using the Split Hopkinson Pressure Bar device. Experiments with plane shock waves in condensed matter allow study of the properties of materials at extremely high strain rates with controlled loading conditions.

The diversity of proposed approaches demonstrates that analytical and numerical modelling of wave propagation in solids is not yet mature. Further development is needed for nonlinear wave propagation in inhomogeneous solids with thermal effects, in both 2D and 3D simulations.

Selected papers will appear in a special issue of Wave Motion. Other participants may send their papers for publication in regular issues of three journals: Proceedings of the Estonian Academy of Sciences, Engineering Mechanics and Applied and Computational Mechanics.

Objectives of EUROMECH, the European Mechanics Society

The Society is an international, non-governmental, non-profit, scientific organisation, founded in 1993. The objective of the Society is to engage in all activities intended to promote in Europe the development of mechanics as a branch of science and engineering. Mechanics deals with motion, flow and deformation of matter, be it fluid or solid, under the action of applied forces, and with any associated phenomena. The Society is governed by a Council composed of elected and co-opted members.

Activities within the field of mechanics range from fundamental research on the behaviour of fluids and solids to applied research in engineering. The approaches used comprise theoretical, analytical, computational and experimental methods.
The Society shall be guided by the tradition of free international scientific cooperation developed in EUROMECH Colloquia.
In particular, the Society will pursue this objective through:

- The organisation of European meetings on subjects within the entire field of mechanics;
- The establishment of links between persons and organisations including industry engaged in scientific work in mechanics and in related sciences;
- The gathering and dissemination of information on all matters related to mechanics;
- The development of standards for education in mechanics and in related sciences throughout Europe.

These activities, which transcend national boundaries, are to complement national activities.

The Society welcomes to membership all those who are interested in the advancement and diffusion of mechanics. It also bestows honorary membership, prizes and awards to recognise scientists who have made exceptionally important and distinguished contributions. Members may take advantage of benefits such as reduced registration fees to our meetings, reduced subscription to the European Journal of Mechanics, information on meetings, job vacancies and other matters in mechanics. Less tangibly but perhaps even more importantly, membership provides an opportunity for professional identification; it also helps to shape the future of our science in Europe and to make mechanics attractive to young people.

European Journal of Mechanics - A/Solids

ISSN: 0997-7538

The *European Journal of Mechanics A/Solids* continues to publish articles in English in all areas of Solid Mechanics from the physical and mathematical basis to materials engineering, technological applications and methods of modern computational mechanics, both pure and applied research.
The following topics are covered: Mechanics of materials; thermodynamics; elasticity; plasticity; creep damage; fracture; composites and multiphase materials; micromechanics; structural mechanics; stability vibrations; wave propagation; robotics; contact; friction and wear; optimization, identification; the mechanics of rigid bodies; biomechanics.

European Journal of Mechanics - B/Fluids

ISSN: 0997-7546

The *European Journal of Mechanics B/Fluids* publishes papers in all fields of fluid mechanics. Although investigations in well established areas are within the scope of the journal, recent developments and innovative ideas are particularly welcome. Theoretical, computational and experimental papers are equally welcome. Mathematical methods, be they deterministic or stochastic, analytical or numerical, will be accepted provided they serve to clarify some identifiable problems in fluid mechanics, and provided the significance of results is explained. Similarly, experimental papers must add physical insight in to the understanding of fluid mechanics. Published every two months, EJM B/Fluids contains:

- Original papers from countries world-wide
- Book reviews
- A calendar of scientific meetings