JFM Symposia:

From Fundamentals to Applied Fluid Mechanics

SPEAKER BIOGRAPHIES
AND ABSTRACTS

13-14 DECEMBER
IISc, BANGALORE

Day 1 - JFM Symposium
Day 2 - Publishing Workshop

CAMBRIDGE
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ABOUT THE SYMPOSIA

We are delighted that you have chosen to attend the first series of mini-symposia organised jointly by the Editorial Board members of the *Journal of Fluid Mechanics* and world-class researchers based in India, notably Mumbai, Bangalore and Chennai.

The aim of these symposia is to bring together leading researchers from across the breadth of fluid mechanics – from fundamentals to applied interdisciplinary research including aeronautics, astrophysics, biology, chemical and mechanical engineering, hydraulics, materials, meteorology, oceanography, geology, acoustics and combustion.

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Manish Choudhary, *Cambridge University Press, Delhi, India*

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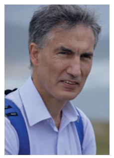
Dear Colleagues,

Cambridge University Press is delighted to be co-organising this JFM Symposium: From Fundamentals to Applied Fluid Mechanics, together with the Indian Institute of Science Bangalore. We would like to give special thanks to our hosts, Gaurav Tomar and Binod Sreenivasan, from IISc Bangalore, for their generous help and support of the meeting and for agreeing to co-host this symposium.

The *Journal of Fluid Mechanics* was founded in Cambridge by George Batchelor in 1956 and has become the leading journal in the field. The Journal has grown very significantly in capacity and in breadth, as indeed the subject of fluid mechanics itself has grown from traditional areas of engineering science to engage with almost every area of science and technology.

We are pleased to be joining colleagues from India to share our exciting ideas in research. And we are delighted to have this opportunity to share our experiences of scientific publication, whether as authors or editors, so that we can understand more clearly how the *Journal of Fluid Mechanics* can best serve the global scientific community.

We would like to thank all of speakers, organisers, editors and committee members especially our new JFM Associate Editor, Professor Prabhu Nott. We hope that all presentations will stimulate exchange of ideas, experiences and potentially foster future research collaborations. Welcome to what promises to be an exciting meeting!



GRAE WORSTER
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MANDY HILL
Managing Director
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Cambridge University Press, UK

KATHLEEN TOO
Publisher, Physical Sciences STM Journals
Cambridge University Press, UK

Dear Colleagues,

Welcome to the Bangalore chapter of the JFM Symposia: From Fundamentals to Applied Fluid Mechanics. We are delighted to host the first of such efforts by the Cambridge University Press and the *Journal of Fluid Mechanics*, aiming to bring together researchers from Bangalore for a day full of scintillating discussions on the concepts and applications of fluid mechanics. On behalf of the organizing committee, I would like to thank the participants who have enthusiastically responded to the invitation to attend and participate in this event.

Bengaluru has always been a major contributor to science and technology at the international stage. In addition to its recent fame as Silicon Valley of India, the city has also emerged as the Research and Development hub of the country. Bengaluru is also the home of some of the leading scientific research institutions in India, such as the Indian Institute of Science, Jawaharlal Nehru Center for Advanced Scientific Research, International Center for Theoretical Sciences, Indian Institute of Astrophysics, Tata Institute of Fundamental Research Centre for Applicable Mathematics, and Raman Research Institute. This JFM Symposium provides a unique platform to bring together researchers from all these and other institutions under one roof to discuss the past, present and future of fluid mechanics in general, and in the context of developments in India in particular.

We would like to thank the JFM Editors, Professors Grae Worster, Moshe Matalon and Ivan Marusic, to have generously agreed to give talks during the symposium. We here at the Department of Mechanical Engineering in the Indian Institute of Science wish you all a pleasant experience and vibrant discussions at the Symposium.

PRADIP DUTTA
Chairman, Department of Mechanical Engineering
Indian Institute of Science
Bangalore, India

13 December 2017

Time	Lecture	Chair
09.00-09.30	Opening speech from Cambridge University Press **Kathleen Too, *Cambridge University Press*** Opening speech from IISc Bangalore **Gaurav Tomar, *IISc Bangalore*** **Binod Sreenivasan, *IISc Bangalore***	**Grae Worster**
09.30-10.00	Turbulent premixed flames in the context of hydrodynamic theory **Moshe Matalon, *University of Illinois at Urbana-Champaign***	
10.00-10.30	Convective mass transport from drops in shearing flows **Ganesh Subramanian, *Jawaharlal Nehru Centre for Advanced Scientific Research***	
10.30-11.00	Coffee/Tea break	
11.00-11.30	High Reynolds number wall turbulence: Universality, structure and interactions **Ivan Marusic, *University of Melbourne***	**Rama Govindarajan**
11.30-12.00	Transient growth in swirling jets with vortex breakdown **Arnab Samanta, *IISc Bangalore***	
12.00-12.10	Introduction to Books @ Cambridge University Press **Manish Choudhary, *Cambridge University Press***	
12.10-13.00	Lunch	
13.00-13.30	Decimated Navier-Stokes turbulence **Samriddhi Sankar Ray, *International Centre for Theoretical Sciences***	**Jaywanth H Arakeri**
13.30-14.00	Marine ice sheets **Grae Worster, *University of Cambridge***	
14.00-14.30	Small-scale turbulence in the Earth's core **Binod Sreenivasan, *IISc Bangalore***	
14.30-15.00	Slip in lid driven cavity flows **Gaurav Tomar, *IISc Bangalore***	
15.00-15.30	Coffee/Tea break	
15.30-16.00	15:30 – 15:37 Flash talk 1 TBC 15:37 – 15:44 Flash talk 2 TBC 15:44 – 15:51 Flash talk 3 TBC 15:51 – 15:58 Flash talk 4 TBC (5 mins talk and 2 mins Q+A each).	**Saptarshi Basu**
16.00-16.15	What does a JFM Editor look for when assessing a paper? **Grae Worster, *University of Cambridge***	**Kathleen Too**
16.15-17.15	JFM panel discussions **Grae Worster, *University of Cambridge*** **Moshe Matalon, *University of Illinois at Urbana-Champaign*** **Ivan Marusic, *University of Melbourne*** **Prabhu Nott, *Indian Institute of Science***	
17.15-17.30	Closing remarks **Grae Worster, *University of Cambridge*** **Gaurav Tomar, *IISc Bangalore*** **Binod Sreenivasan, *IISc Bangalore***	

Workshop with librarians and students

14 December 2017

Time	Lecture
09.00-10.00	Publishing workshop **Kathleen Too, *Cambridge University Press***
10.00-10.45	Awareness workshop on Cambridge Core **Gunjan Hajela, *Cambridge University Press***
10.45-11:15	Discussions and coffee break

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Grae Worster completed his PhD at the University of Cambridge, UK in 1983, has been an Instructor in Applied Mathematics at MIT and an Assistant Professor in Applied Mathematics and Chemical Engineering at Northwestern University. He is currently Professor of Fluid Dynamics in the Department of Applied Mathematics and Theoretical Physics, University of Cambridge. His research focuses on buoyancy-driven flows and phase change, particularly in situations where these two phenomena interact. In the context of climate change, he has combined mathematical modelling and laboratory experiments to understand and quantify the mechanisms affecting brine drainage from sea ice, the flow and stability of marine ice sheets and fundamentals of frost heave. Grae also teaches at the African Institute for Mathematical Sciences, from which he has written the book "Understanding Fluid Flow". He co-edited the book "Perspectives in Fluid Dynamics" with George Batchelor and Keith Moffatt.

Grae Worster has been an Associate Editor of the *Journal of Fluid Mechanics* since 1994 and is currently its Editor in Chief.

ABSTRACT

Title: Marine ice sheets

The equivalent of about 75 metres of sea-level are currently locked up in Antarctica as a continental ice sheet. Much of the West Antarctic Ice Sheet sits on bedrock that is a kilometre or two below current sea level, forming what is known as a marine ice sheet. As it flows outwards towards the continental margin, the ice sheet thins, eventually becoming sufficiently thin to float on the ocean as an ice shelf. Ice shelves calve icebergs from time to time, as we have witnessed recently when a giant iceberg calved from the Larsen C ice shelf. While this does not give rise to an immediate rise in sea level, ice shelves can buttress the ice streams that feed them, so collapse of an ice shelf can allow the ice streams to accelerate and thin, which does cause sea level to rise. The overall mass balance of a marine ice sheet is dominated by fluid-dynamical controls across the grounding line – the locus of where the grounded ice sheet first begins to float to form an ice shelf. I will describe some analogue laboratory experiments and associated fluid-mechanical models that help to elucidate the dynamics of marine ice sheets and their stability.

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Moshe Matalon received his undergraduate and Master's education at Tel Aviv University, followed by a Ph.D. in Mechanical and Aerospace Engineering from Cornell University in 1977. He has worked at Cornell University, the Polytechnic Institute of New York, Northwestern University, and since 2007 has been at the University of Illinois at Urbana-Champaign, where he is the College of Engineering Caterpillar Distinguished Professor. Matalon's research interests are in combustion theory, theoretical fluid mechanics and applied mathematics. He made significant and long lasting contributions to numerous areas of combustion science including the derivation and formulation of a hydrodynamic theory of premixed flames, a general description of the reaction zone structure of diffusion flames, studies of flame instabilities (linear and nonlinear) in various configurations, contributions to liquid droplet and solid particle combustion, understanding combustion at the microscale, and theories of turbulent flames in the flamelet regime of turbulent combustion.

Matalon was named Associate of the UIUC Center of Advanced Study in 2008, was elected Fellow of the American Physical Society in 1995, Fellow of the Institute of Physics in 1999 and Fellow of the American Institute of Aeronautics and Astronautics (AIAA) in 2012, and was recipient of several awards, including the AIAA Pendray Aerospace Literature Award in 2010, the AIAA Fluid Dynamics award in 2016 and the Numa Manson medal of the Institute for the Dynamics of Explosions and Reacting Systems (IDERS) in 2017.

Matalon has been an Associate Editor of the *Journal of Fluid Mechanics* since 2008.

ABSTRACT

Title: Turbulent premixed flames in the context of hydrodynamic theory

The notion of *laminar flamelet* has been a fundamental and constructive one in understanding the complex flame-turbulence interactions occurring during the propagation of premixed flames. The turbulent flame in this approach is viewed as an ensemble of stretched laminar flamelets, defined as thin reactive-layers embedded within the turbulent flow field. The basis for the flamelet concept lies in an asymptotic model - the hydrodynamic theory, that exploits the disparity between the distinct scales associated with the flow field, the diffusion processes, and the highly temperature-sensitive reaction rates. The idea led to a qualitative classification of possible flame-turbulence interactions, widely known as the "regime diagram of premixed turbulent combustion", and to the development of flamelet models based on a level-set approach in conjunction with a function that serves as a progress variable and allows tracking the evolution of the flame surface.

The present work is based on the hydrodynamic theory. The flame of thickness, assumed much smaller than the characteristic hydrodynamic length, is approximated by a surface that separates burned from unburned gases and propagates relative to the fresh combustible mixture at a speed that depends on the local mixture and flow conditions. The turbulent flow field is modified, in turn, by the gas expansion resulting from the heat released in the thin flame zone. Effects due to the flame thickness, such as differential diffusion or variations in the overall system pressure, can be studied by appropriately varying the Markstein length. The results, devoid of turbulence-modelling assumptions and ad-hoc coefficients, provide fundamental understanding of the influence of the system parameters, individually and collectively, on the turbulent propagation which is difficult to achieve in experiments. Evidently, the approach neglects possible modifications of the internal flame structure resulting from the turbulence and, therefore, strictly speaking falls within the "flamelet regime" of turbulent premixed flames.

A parametric study has been carried for mixtures with positive Markstein length (i.e., absence of thermo-diffusive instabilities), examining different factors that affect the propagation. The computations have been carried out for flame propagation in "two-dimensional turbulent flows" which, despite the idealization leads to results that correlate well with experimental data. Aspects that will be discussed in this presentation include (i) flame topology, (ii) scaling laws for the turbulent flame speed, (iii) the influence of the Darrieus-Landau instability on the turbulent flame, (iv) relation of the predictions to experimental observations.

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Ivan Marusic is a Redmond Barry Distinguished Professor and the Deputy Dean Research in the Melbourne School of Engineering at the University of Melbourne. He received his PhD in 1992 and BE (Hons) Mech in 1987 from the University of Melbourne. From 1998-2006 he was a faculty member at the University of Minnesota in the Department of Aerospace Engineering and Mechanics, and returned to Australia at the end of 2006. His research is primarily in experimental and theoretical studies of turbulence at high Reynolds numbers. This includes studies in atmospheric surface layer flows and aquatic ecosystems. Over his career he has held a number of prestigious fellowships, including an Australian Research Council (ARC) Laureate Fellowship (2012-2017), ARC Federation Fellowship (2006-2011), and a Packard Fellowship in Science and Engineering (2001-2006).

He is a recipient of a number of awards including an NSF Career Award, Woodward Medal at the University of Melbourne, the Stanley Corrsin Award from the American Physical Society, and he is a Fellow of the American Physical Society and the Australasian Fluid Mechanics Society. In 2014 he was elected as a Fellow of the Australian Academy of Science.

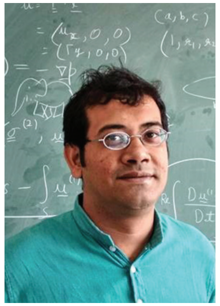
Professor Marusic has been an Associate Editor of the *Journal of Fluid Mechanics* since 2008, and generally covers topics related to turbulence, boundary layers, free-shear flows, vortex dynamics and experimental methods.

ABSTRACT

Title: High Reynolds number wall turbulence: Universality, structure and interactions

A key consideration in the characterization of the mechanics of turbulent flows is to understand the generation, evolution and interactions of the large-scale structures and the range of eddying motions that make up the turbulent flow. The non-linearity of these processes makes the problem very challenging, both computationally and experimentally. This is particularly true in wall-bounded flows where an increasing hierarchy of energy-containing eddy scales exists with increasing Reynolds number.

In this talk we will review recent studies by our group in high Reynolds number flow facilities and from the atmospheric surface layer documenting unique high Reynolds number phenomena in wall turbulence. The focus will be the logarithmic region, looking at issues regarding its universality, coherent structures and how they interact across the boundary layer. These findings lead to a new consideration of so-called “inner-outer” interactions and form the basis of a predictive model for the near-wall inner region and the wall-shear stress. The implications of this model will be discussed.



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Samriddhi Sankar Ray is a Reader (Assistant Professor) at the International Center for Theoretical Sciences of the Tata Institute of Fundamental Research (ICTS-TIFR), in Bangalore. As a statistical physicist, his areas of interest include different aspects of turbulent flows and turbulent transport.

After finishing his undergraduate studies from Presidency College, Calcultta, Samriddhi obtained a PhD in Physics from the Indian Institute of Science, Bangalore in 2010. Subsequently, he went to the Observatoire de la Cote d'Azur in Nice, France as a post-doctoral fellow before returning to India to join the ICTS-TIFR in the beginning of 2013 as a Junior Faculty, and in 2015 as a Reader.

Samriddhi's work spans areas of Eulerian and Lagrangian turbulence in a variety of settings overlapping statistical physics and applied mathematics. He has contributed to the understanding of the various time-scales which characterise fully developed turbulence. He has also worked extensively on the interplay of equilibrium statistical mechanics and out-of-equilibrium turbulence which led to the discovery of the "tyger" phenomenon as the mechanism through which finite-dimensional inviscid equations of hydrodynamics thermalize. Later, work at this interface of statistical physics and turbulence led to the so-called decimated Navier-Stokes turbulence where, along with his co-workers, Samriddhi showed that, starting from two dimensions, there exists a critical dimension where the solutions obtained from the Gibbsian equilibrium distributions agree with the Kolmogorov scaling theory. This trick of fractal Fourier decimation is now being used to understand fresh questions related to intermittency in turbulence.

ABSTRACT

Title: Decimated Navier-Stokes turbulence

We give an overview of recent advances in the study of small-scale and high-frequency turbulent fluctuations in turbulent flows under Fourier-mode reduction. The Navier–Stokes equations are evolved on a restricted set of modes, obtained as a projection on a fractal or homogeneous Fourier set. In the first part of the talk, we will describe how such a system allows us to obtain a non-integer critical dimension where the Kolmogorov spectrum coincides with the equilibrium distribution. We then show a strong sensitivity (reduction) of the high-frequency variability of the Lagrangian velocity fluctuations on the degree of mode decimation. This is quantified by a tendency towards a quasi-Gaussian statistics, i.e., to a reduction of intermittency, at all scales and frequencies. This can be attributed to a strong depletion of vortex filaments and of the vortex stretching mechanism. Nevertheless, we found that Eulerian and Lagrangian ensembles are still connected by a dimensional bridge-relation which is independent of the degree of Fourier-mode decimation. Finally we discuss the implications of such an approach for intermittency, chaos and irreversibility in turbulence.

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Arnab Samanta has been an Assistant Professor at the Department of Aerospace Engineering, Indian Institute of Science since 2011. Before, he was a Postdoctoral Scholar at the California Institute of Technology (Caltech) where he was involved in projects that included the use of non-linear stability analysis to predict and reduce the aeroacoustic sound from turbulent jets and performing computational heat transfer calculations to model and simulate a hot-air balloon aerobot to be used for interplanetary explorations. He obtained his Ph.D in Theoretical and Applied Mechanics from the University of Illinois at Urbana-Champaign in 2009, where his thesis included theoretical modelling of aeroacoustic wave scattering involving vortical and acoustic waves at a diffuser exit. He was also involved in a novel study to investigate the robustness of acoustic analogies, widely used to compute the aerodynamic sound.

His current research interests include theoretical and computational aeroacoustics and analysing the hydrodynamic stability of flows. In aeroacoustics, Dr. Samanta has recently focussed on the modal structure of heated, supersonic jets and their scattering while advanced stability methods have been used to model the aerodynamic sound from supersonic reacting mixing layers. Also, jet noise from interacting twin jets are being studied, while fan noise modelling from open rotor-type devices are being initiated. In stability, the major focus has been on all kinds of rotating flows including pipe flows, swirling jets and vortex rings.

ABSTRACT

Title: Transient growth in swirling jets with vortex breakdown

We investigate the role of continuous spectrum in the stability of high-Reynolds number (*Re*), rapidly-swirling jets with a vortex breakdown bubble located slightly down-stream of the nozzle exit. The presence of this bubble, also referred to as the recirculation zone and terminated via stagnation points on its either sides, physically alters the stability character of such flows, which are characterized by a transition from an initial ring-jet-like profile to a wake-like profile further downstream post the collapse of bubble. Here, any detailed analysis of stability states can be quite complex due to the inherent multi-dimensional nature of such flows involving the recirculation zone and twin shear layers, with associated shear forces in different directions.

The nature of inlet velocity profile and the degree of swirl are important parameters for stability, especially at the higher swirl numbers when helical modes outside the bubble are known to dominate and a major focus in the past has been to isolate a pocket of absolute instability in the flow which could be linked to the instability via higher-order spiral breakdown states. In this context, two such locations have been identified: one inside (or around) the recirculation bubble, while a second one downstream of the collapsed bubble, i.e. inside the wake region. A few local and global normal-mode-based stability analyses, including those carried out with experimental data, have shown the presence of a wavemaker region at the upstream location. On the other hand, at other parametric configurations, e.g. at higher *Re* and swirl numbers, the wake region has been proposed to select the frequency of this absolute mode, in spite of the fact that this region in general has much weaker modal growths.

In this work, we perform a pseudospectrum analysis of a high-*Re*, high-swirl flow to first identify the spectrum of continuous modes, consisting of potential and freestream modes, which is shown to get wider as the swirling jet develops down-stream. These potential modes are non-modal solutions of the eigen system, which however has potential for strong transient growths. Here, we show such transient gains to be much stronger inside the wake region for higher azimuthal-order modes that easily exceed modal growths from unstable modes at shorter times. We propose such transient gains from the potential modes to be the key initiator that eventually feed into and augment the classical normal growth, thus deciding the overall stability of such flows.

In this work, we perform a pseudospectrum analysis of a high-Re, high-swirl flow to first identify the spectrum of continuous modes, consisting of potential and freestream modes, which is shown to get wider as the swirling jet develops downstream. These potential modes are non-modal solutions of the eigen system, which however has potential for strong transient growths. Here, we show such transient gains to be much stronger inside the wake region for higher azimuthal-order modes that easily exceed modal growths from unstable modes at shorter times. We propose such transient gains from the potential modes to be the key initiator that eventually feed into and augment the classical normal growth, thus deciding the overall stability of such flows.

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Binod Sreenivasan earned his B Tech (Honours) in Mechanical Engineering from the National Institute of Technology, Calicut (India) and MS from the Indian Institute of Technology, Madras. After a stint as Scientist at the Indian Space Research Organization (ISRO), he went on to do a PhD at the University of Cambridge, specializing in magnetohydrodynamics (MHD). As part of his PhD, Binod did the first liquid metal experiments that showed two distinct phases of decay of MHD turbulence. Following this, he held a one-year CNRS postdoctoral fellowship at the Laboratoire EPM in Grenoble, researching on the dynamics of surface gravity waves subject to magnetic fields. Binod entered the field of planetary dynamos through a postdoctoral position at the Department of Mathematical Sciences, University of Exeter. This was followed by a named Leverhulme Research Fellowship held at the School of Earth and Environment, University of Leeds. Back in India, Binod served on the faculty at the Indian Institute of Technology (IIT) Kanpur for nearly 3 years before moving to the Indian Institute of Science (IISc), Bangalore, where he is a faculty member in the Centre for Earth Sciences since 2012.

Binod's research interests span the areas of MHD, vortex dynamics, dynamo theory, stability theory and planetary magnetism. The focus of his recent research has been on the fluid dynamical processes in the Earth's core that give rise to a dipole-dominated magnetic field, convection within the Earth's tangent cylinder, thermal core–mantle interaction and small-scale motions in planetary cores.

ABSTRACT

Title: Damping of MHD waves in a rotating fluid and implications for the Earth's core

Turbulence in the Earth's liquid outer core is thought to be driven by blobs of light elements released from the inner core boundary. The long-time evolution of an isolated flow structure subject to background rotation and a magnetic field provides some insight into the character of small-scale turbulence in the core. In this study, two regimes are analysed in the inviscid limit, that of strong rotation where the inertial wave frequency is much higher than the Alfvén wave frequency, and that of weak rotation where the Alfvén wave frequency is dominant. In either regime, the evolution consists of a damped wave-dominated phase followed by a diffusion-dominated phase. For strong rotation, the laws of energy decay in the damped wave phase are obtained by considering the decay of the fast and slow Magneto-Coriolis (MC) waves individually. The diffusion-dominated phase obeys the decay laws in the well-known quasi-static approximation. The wave–diffusion transition time scale indicates that the wave phase of decay is very long, so that small-scale turbulence in the core is characterised by perpetual damped wave motions. Interestingly, the induced magnetic field is far more efficient than the velocity in supporting slow MC waves. In the regime of weak rotation, the fast and slow MC wave solutions merge and tend to the classical damped Alfvén wave solution. Here the decay laws in non-rotating MHD turbulence are recovered. Computations of the long-time decay of an isolated vortex confirm the theoretical energy scalings as well as the wave–diffusion transition time scale of the kinetic energy. It is also shown that a magnetically damped system that initially generates Alfvén waves because of relatively weak rotation can subsequently give rise to MC waves.

The present study suggests that a mean intensity of order 10 mT or even higher is plausible for the toroidal magnetic field within the Earth's core.

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Ganesh Subramanian completed his PhD in chemical engineering from Caltech in 2002. After a three-year post-doctoral stint at the department of chemical and bio-molecular engineering in Cornell University in 2005, Ganesh joined the Engineering Mechanics Unit (EMU) at the Jawaharlal Nehru centre for advanced scientific research (JNCASR) in November 2005. He is currently a professor in the same department. His research interests include the dynamics and rheology of complex fluids, active matter, stability of non-Newtonian and multi-phase flows, vortex dynamics, and the role of radiative processes in the nocturnal boundary layer.

ABSTRACT

Title: Convective mass transport from drops in shearing flows

We analyze mass transfer from a neutrally buoyant spherical drop embedded in a linear shearing flow of an ambient Newtonian medium, a problem relevant to transport processes in disperse multiphase systems.

We begin with hyperbolic planar linear flows (which constitute a one parameter family, the parameter being α, with $0 \leq \alpha \leq 1$, the extremal members being simple shear ($\alpha = 0$) and planar extension ($\alpha = 1$)). An analysis of the streamline equations shows that there exist two distinct exterior streamline topologies separated by a critical viscosity ratio $l_c = 2\alpha/(1- \alpha)$. For $\lambda < l_c$ all streamlines are open, while near-field streamlines are closed for $\lambda > l_c$. These two regimes lead to qualitatively different mechanisms of transport for $Pe >> 1$. Transport in the open streamline regime is enhanced via a thermal boundary layer, while the closed streamline regime exhibits diffusion-limited transport at $Re = 0$. The analysis for the rate of transport relies on the identification of the drop surface streamlines as generalized Jeffery orbits with an (α,λ)-dependent aspect ratio; this effective aspect ratio is purely imaginary in the open streamline regime, while being real valued in the closed streamline regime. A Jeffery-orbit-based non-orthogonal coordinate system serves as a natural candidate for the large-*Pe* boundary layer analysis, and allows one to derive a closed-form expression for the Nusselt number, for $\lambda < l_c$, of the form $Nu = F_1(\alpha,\lambda)Pe^{1/2}$ with $F_1(\alpha,\lambda)$ given in terms of a one-dimensional integral. For $\lambda > l_c$, weak inertia crucially circumvents the diffusion limitation by breaking open the closed streamline region; spiralling near-field streamlines ensure convective enhancement of the transport for small but finite *Re*. A three-dimensional generalization of the Jeffery-orbit-based coordinate system allows one to analyze the inertial convection in the limit $Re << 1$, $RePe >> 1$, and one obtains $Nu = F_2(\alpha,\lambda)(RePe)^{1/2}$, with $F_2(\alpha,\lambda)$ given in closed form. Scaling arguments highlight the manner in which the *Nu*-surfaces on the open and closed streamline sides connect smoothly across the curve $\lambda = l_c(\alpha)$.

Symmetry arguments point to a Jeffery-orbit-based coordinate system for any linear shearing flow. Thus, the methodology developed above is quite general, allowing for solutions of convective transport problems where the near-field streamlines lack symmetry about an axis or a plane. We also revisit the mass transport from a rigid particle, originally analyzed by Batchelor (1979) using the classical von Mises coordinates, and obtain the same result via the alternate Jeffery-orbit-based methodology.

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Gaurav Tomar completed his bachelors in technology in Mechanical engineering from the Indian Institute of Technology Kanpur (IITK) in 2003. He completed his PhD in Mechanical engineering from IITK in 2008. His PhD work focused on the interfacial instabilities in adhesion, dewetting and boiling. He spent the year 2008-2009 as a post-doctoral researcher in the Institute Jean Le Rond D'Alembert (University Pierre et Marie Curie, Paris) working on the multiscale methodologies for simulations of atomization. Dr. Tomar joined the department of Mechanical Engineering at the Indian Institute of Science as an Assistant Professor from April 2010 till April 2016. He is currently an Associate Professor in the same department since April 2016. He received the Young Engineer award from the Indian National Academy of Engineering in 2012. Prof. Tomar's research interests are in the instabilities of thin fluid films, boiling, electrohydrodynamics, atomization and multiscale simulations.

ABSTRACT

Title: Slip in lid driven cavity flows

No slip condition at the rigid wall boundaries in fluid mechanics is an assumption that holds well in most of the fluid flow scenarios. However, in certain flow situations such as flow past a wedge and flow in a corner, partial slip is observed. Although a few continuum models of slip, such as Navier slip boundary condition, have been proposed, these models require parameters that a continuum model cannot be expected to yield, given the nature of the flow in these regions of slip. Therefore, several recent studies have employed molecular dynamics (MD) to investigate the role of microscopic effects in the macroscale physics. In this talk, we will discuss some of our recent results on the physics of the origin of slip in corner flows using molecular dynamics. Using Argon as a typical Newtonian liquid at a temperature of around 157.5K, we perform simulations of lid driven cavity flow with varying cavity sizes and corner angles. The Reynolds number of the flow can be altered by either changing the size of the cavity or by varying the velocity of the lid. A large set of MD simulations is performed, and each case is run for a long duration to provide sufficient data to generate reliable averaged continuum fields. Slip regions are observed in both the left and the right corners of the cavity. Interestingly, the extent of the slip region near the corners is independent of the Reynolds number. We show that based on the direction of the motion of the driving plate relative to the corner, that is, focusing or defocusing flow in the corner, the Newtonian constitutive model itself may not remain valid in the corner region. Indeed, we observe that the residence time of the argon atoms is higher in the corner regions, where focusing of the flow occurs, and it is inversely proportional to the corner angle. Therefore, structural changes in the fluid are observed that suggest a change in the constitutive model locally near the corner. Finally, since the molecular dynamics simulations can be performed only for small cavity sizes and short time scales, we propose a multiscale coupling methodology, using appropriate non-periodic boundary conditions, for the corner flows that allows us to simulate larger cavity sizes while resolving the corners up to molecular scale.

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Gunjan Hajela is the Marketing Lead for Academic Business in India/South Asia with more than 10 years of experience in Marketing, Customer Engagement, Sales and Business Development. He joined the Press in November 2016. Previously he spent more than six years working with Elsevier. He is post graduate in Marketing and Human Resources and has also done an executive management development program from Indian Institute of Management, Calcutta.

ABSTRACT
Title: Cambridge Core review
Gunjan will be talking about the new academic platform for Cambridge University Press – Cambridge Core – and will showcase the content on offer. He will give a background of Core's development. He will also demonstrate its features and functionalities both from the perspective of librarians and researchers.

KATHLEEN TOO
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Kathleen Too is currently the Publisher for Mathematical and Physical Sciences Journals at Cambridge University Press. She is currently responsible for over 50 journals at CUP covering Mathematics, Computer Science, Earth Sciences, Physics, Engineering and Astronomy. She has 10 years' experience in managing existing journals and launching new journals. She worked as an Assistant Editor and then a Deputy Editor at the Royal Society of Chemistry. In 2013, she became the International Development Manager for Asia, helping the Royal Society of Chemistry to reach out to emerging markets in Asia. She graduated from the University of Leeds where she did her BSc and PhD and she did a postdoc at the Medical Research Council, Lab of Molecular Biology in Cambridge UK.

ABSTRACT
Title: Publishing workshop
In this workshop, aimed at early career researchers, we'll discuss the nuts and bolts of publishing your research. How should you choose which journal to submit to? How do you approach a publisher if you have an idea for a book? What do editors consider when assessing your work for publication? How does peer review work behind the scenes, and how should you respond to peer reviewers? Come along to find out the answers to these questions and many more, followed by an interactive discussion.

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