UNIVERSITY OF MARYLAND

The Burgers Program for Fluid Dynamics Twentieth Anniversary Symposium

Friday, October 6th, 2023, 1:00 to 6:00 pm
AJC Forum (Room 1101)
A. James Clark Hall (Building 429)

Institute for Physical Science and Technology
College of Computer, Mathematical and Natural Science and the
A. James Clark School of Engineering
University of Maryland, College Park

Program:

1:00 – 1:05 **Welcoming Remarks,** James Duncan**,**
Director of the Burgers Program for Fluid Dynamics, Department of Mechanical Engineering and the Institute for Physical Science and Technology, University of Maryland.

1:05 – 1:50 ***Multiphase Flow in Pipelines,*** R.A.W.M. (Ruud) Henkes,
Department of Mechanical Engineering, Delft University of Technology, Scientific Director of the J.M. Burgerscentrum for Fluid Mechanics, The Netherlands. https://www.tudelft.nl/staff/r.a.w.m.henkes/

1:50 – 2:00 **Break, informal discussions**

2:00 – 2:45 ***The Art of the Possible in Hypersonic Modeling and Simulation***, Graham Candler,
Department of Mechanical Engineering, University of Minnesota.
https://cse.umn.edu/aem/computational-hypersonics-research-lab

2:45 – 3:30 **Graduate student and post-doctoral poster session. Refreshments served.**

3:30 – 4:15 ***Fluid Dynamics of Phytoplankton Blooms***, Amala Mahadevan,
Woods Hole Oceanographic Institution. https://mahadevan.whoi.edu/

4:15 – 5:00 ***Planet Formation: Building Rocks from Turbulent Fluids***, Phil Armitage, Department of Physics and Astronomy, Stony Brook University, https://www.astro.sunysb.edu/parmitage/

5:00 – 6:00 ***Reception and Announcement of Best Posters***

ABSTRACTS and BIOGRAPHIES

Ruud Henkes

Abstract: Although a pipeline is a simple geometry, the multiphase flow through it can be rather complex. Key parameters of gas-liquid or liquid-liquid transport are flow regimes, pressure drop, and fluid accumulation. Both because of its variety of industrial applications (such as cooling systems of nuclear reactors, oil and gas transport, CO2 transport) and of its challenging fluid mechanics (such as interaction of waves and turbulence), much research was devoted to it over the past decades. The presentation will give an overview of what has been obtained, and where the knowledge gaps are, e.g. with respect to two-phase CO2 transport. This will include the model description with the transient one-dimensional conservation equations, and the required numerical solution methods.

Biography: Prof. Henkes obtained a Master's Degree Aerospace Engineering (with honors) in 1985 at Delft University of Technology, and a PhD degree (with honors) in Fluid Flow and Heat Transfer in 1990 at the same university. Associate Professor Aerodynamics in Delft until 1997, when he joined the multiphase flow team of the Shell Technology Centre in Amsterdam. Since then, various roles as team lead and Principal Technical Expert Fluid Flow at Shell. Combined with part-time full professorship multiphase flow at Delft since 2008, with the role of Scientific Director of the Dutch J.M. Burgerscentrum for Fluid Mechanics since 2021. Has numerous scientific publications on boundary layer flow, turbulence, heat transfer, and multiphase flow.

Graham Candler

Abstract: Hypersonic flows involve complex interactions between high-temperature gas dynamics and material response. For example, the aerodynamics and heating of a planetary entry capsule are affected by finite-rate gas-phase and gas-surface reactions, transition to turbulence, radiative transport, and thermal protection system response. It is not possible to replicate the entire hypersonic flight environment in wind tunnels, and flight tests are extremely expensive. Thus, modeling and simulation is required for the design and analysis of future hypersonic flight systems. It is now possible to predict many of these effects using physics-based models, advanced numerical methods and large-scale computing. In this seminar, I will use several examples to illustrate recent advances in the prediction of hypersonic flows, as well as to motivate the need for further improvements to models and numerical methods.

Biography: Graham Candler is the McKnight Presidential Chair of Aerospace Engineering and Mechanics at the University of Minnesota. He uses computational methods to study high-speed flight with application to future hypersonic flight systems and the entry of spacecraft into planetary atmospheres. Recently, his work has focused on the development of high accuracy simulation methods for the exploration of hypersonic design space. He has published extensively in the areas computational methods, high-temperature gas dynamics, boundary layer laminar to turbulent transition, and validation of computational simulations with hypersonic wind tunnel data. Candler has been at the University of Minnesota since 1992, and leads a research group in hypersonic aerodynamics and computational fluid dynamics. He received the American Institute of Aeronautics and Astronautics Thermophysics Award and Fluid Dynamics Award. He is a Fellow of the AIAA and was elected to the National Academy of Engineering in 2020.

Amala Mahadevan

Abstract: Microscopic plants proliferate the world's oceans, producing food and oxygen for other life forms, while sequestering carbon at depth. Reliant on sunlight and nutrients, freely drifting phytoplankton depend on the oceanic flow field for their sustenance. This talk will describe some of the fluid dynamical instabilities that create a conducive environment for phytoplankton growth in three contrasting oceanic regimes. In the subpolar oceans, where light is limiting during the winter, oceanic mixed layer instabilities initiate the spring phytoplankton bloom by enabling access to sunlight. In the subtropical oceans, phytoplankton rely on eddies and fronts to deliver nutrients from the subsurface to sunlit layers where photosynthesis can occur. In coastal margins, wind-driven upwelling and frontal instabilities uplift nutrients and transport them offshore. A wide range of fluid dynamical processes is crucial for supporting the production of phytoplankton and the health of our planet — a challenge is to understand how such processes will evolve in a changing climate.

Biography: Amala Mahadevan is a Senior Scientist at the Woods Hole Oceanographic Institution (WHOI) and teaches in the MIT/WHOI Joint Program in Oceanography. After graduating in Civil Engineering from India, she joined the Environmental Fluid Mechanics laboratory at Stanford University where she earned her master's and Ph.D. before moving to the University of Chicago as a Postdoctoral Associate. Her interests lie in exploring fluid dynamical processes that affect the oceanic carbon cycle and climate. As an oceanographer, she develops and uses computational models along with measurements from research expeditions to study fluid instabilities, transport, mixing and bio-physical interactions. Amala serves as the Faculty Dean of Mather House, one of twelve undergraduate houses at Harvard University that is home to 450 upperclassmen. She is a recipient of the Radcliffe fellowship in 2015, MIT's Frank E. Perkins award for excellence in graduate advising in the School of Science in 2019, and the Arnold Arons award at WHOI for excellence in teaching, advising, and mentoring in 2020.

Philip Armitage

Abstract: An important step toward building planetary systems is the formation of planetesimals, solid bodies with sizes of at least hundreds of meters that can be thought of as primordial versions of asteroids and comets. Planetesimals grow from dust that is embedded within disks of gas that orbit young stars for the first few millions of years of their lives, but exactly how this growth occurs remains unclear. The leading hypothesis is that planetesimals form due to the gravitational collapse of dense clouds of pebbles, whose clustering is the highly non-linear outcome of instability in aerodynamically coupled mixtures of gas and dust. If this hypothesis is correct, the origin of the Earth and other planets could be traced back to a relatively simple linear fluid instability. I will discuss the computational progress and ongoing challenges in simulating planetesimal formation and describe the prospects for observational tests of the proposed mechanism.

B**iography:** Phil Armitage is a Professor in the Department of Physics and Astronomy at Stony Brook University, and the group leader for planet formation at the Flatiron Institute's Center for Computational Astrophysics in Manhattan. After a Ph.D. at the University of Cambridge in 1996, he did postdoctoral work at the University of Toronto and held a faculty position at the University of Colorado, Boulder, prior to moving to New York in 2018. His research interests include computational and theoretical studies of the formation and early evolution of planetary systems, and aspects of the astrophysics of black holes.