University of Maryland

The Burgers Program for Fluid Dynamics

Burgers Symposium 2020
Seventeenth Annual Symposium

[Photo of J. M. Burgers]

November 6, 13 and 20, 2020
11 am to 12 pm
Online

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

Program

November 6th, 11:00 am EDT

Welcoming Remarks

Jim Duncan
Department of Mechanical Engineering, Institute for Physical Sciences and Technology, and Applied Mathematics & Statistics and Scientific Computation Program, University of Maryland

Burgers Lecture

Combustion Dynamics in Turbulent Flames and the Path to Instability

J. B. W. (Jim) Kok
Faculty of Engineering Technology
University of Twente

November 13th, 11:00 am EDT

That Sinking Feeling: Gravity and Its Role in How Life Navigates the Oceans

Manu Prakash
Department of Bioengineering
Stanford University

November 20th, 11:00 am EDT

The Deep Ocean, Menagerie of Instabilities?

Jacob O. Wenegrat
Department of Oceanic and Atmospheric Sciences
University of Maryland

Followed by University of Maryland Student/Postdoc Poster Session at 1:00 pm

ABSTRACTS AND BIOGRAPHIES ON THE FOLLOWING PAGES

Abstracts and Speaker Biographies

Combustion Dynamics in Turbulent Flames and the Path to Instability

J. B. W. (Jim) Kok

Abstract: For the design and operation of Gas Turbine engines a key element is the reduction of polluting emission of nitric oxides that are produced in the combustion process of the fuel. This reduction of emission of nitric oxides can be achieved by the use of lean premixed combustion. This kind of combustion design is vulnerable to high amplitude pressure pulsations that may develop because of the coupling between the pressure field and the heat release fluctuations, known as thermoacoustic instabilities, and can result in structural damage. Lean combustion is employed successfully already for stationary GT engines fired on natural gas. The next challenge is to apply lean combustion to aero GT engines that are fired on jet fuel. For aero engines the need to predict and avoid these instabilities is even more important than for stationary engines.

In order to predict the transition point from stable to unstable operation and acquire information that can lead us to the prevention of thermo acoustic instabilities, the combustion processes are explored in two configurations. They are both developed in EC funded Marie Curie ITN projects that were coordinated by the University of Twente. These are a natural gas fired turbulent atmospheric combustor (LIMOUSINE project) and the jet fuel fired pressurized turbulent combustor developed in the currently running MAGISTER project. Discussed will be the behavior of gas and liquid fuel flames and the analysis of the acquired data with the help of the familiar chaos theory and more recent machine learning methods.

Bio: Jim Kok (Alkmaar/NL, 1960) received his MSc degree in Mechanical Engineering in 1985 at the University of Twente (Enschede, NL). Subsequently he obtained his PhD degree at this university in 1989 under supervision of Professor Leen van Wijngaarden on the subject of dynamics of gas bubbles moving through liquid. Subsequently he became a member of faculty. In 1996-1997 he spent a year as a visiting associate Professor at the Sibley School of Engineering at Cornell University in Ithaca, NY. Since 1989, he performed research on turbulent combustion with application on gas turbine engines. Before 2000 the focus was on reduction of nitric oxide emission, but since then the interest focused on the interaction of combustion dynamics and acoustics and engine design and operation. The work involves both CFD modeling and experiments. On this topic he coordinated the EC/ITN project LIMOUSINE (2008-2012, 15 PhD students) and currently the EC/ITN project MAGISTER (2017-2021, 15 PhD students). The latter project aims on the application of Machine Learning on the analysis and characterization of combustion dynamics and related acoustics.

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That Sinking Feeling: Gravity and Its Role in How Life Navigates the Oceans

Manu Prakash

Abstract: Marine plankton exhibit a Diel Vertical Migration with vertical displacement scales from several tens to hundreds of meters. Even at the scale of small phytoplankton and zooplankton (100 µm to a few mm) the interaction of this vertical swimming behavior with hydrodynamics affects large scale distribution of populations in the ocean and is thus an important component of understanding ocean ecology. However, concurrently observing organismal physiology and behavior is challenging due to the vast separation of scales involved. Resolving physiological processes involves sub-cellular (micron) resolution while tracking freely swimming organisms implies vertical displacements of several meters. We present a simple solution to this problem in the form of a "hydrodynamic treadmill" incorporated into a table-top scale-free vertical tracking microscope [1]. We use this method to study the behavior of freely swimming marine plankton, both in lab and on-board a research vessel, revealing a rich space of dynamic behavioral states in marine micro-organism. Time permitting, I will also share our efforts in bringing oceanography to "seatizens" around the world by democratizing tools for science accessible to sailors across the world [2]

https://gravitymachine.org
https://www.planktonscope.org

1. Krishnamurthy, D., Li, H., Benoit du Rey, F. et al. Scale-free vertical tracking microscopy. Nat Methods (2020). https://doi.org/10.1038/s41592-020-0924-7

2. PlanktonScope: Affordable modular imaging platform for citizen oceanography
Thibaut Pollina, Adam G. Larson, Fabien Lombard, Hongquan Li, Sebastien Colin, Colomban de Vargas, Manu Prakash
bioRxiv 2020.04.23.056978; doi: https://doi.org/10.1101/2020.04.23.056978

Bio: Manu Prakash is a physical biologist applying his expertise in soft-matter physics to illuminate often easy to observe but hard to explain phenomena in biological and physical contexts and to invent solutions to difficult problems in global health, science education, and ecological surveillance. His many lines of research are driven by curiosity about the diversity of life forms on our planet and how they work, empathy for problems in resource-poor settings, and a deep interest in democratizing the experience and joy of science globally.

Prakash received a B.Tech. (2002) from the Indian Institute of Technology Kanpur and a Ph.D. (2008) from the Massachusetts Institute of Technology. He was a junior fellow of the Harvard Society of Fellows (2008–2011) prior to joining the faculty of Stanford University, where he is currently an Associate Professor in the Department of Bioengineering, a member of the Biophysics Program in the School of Medicine and the Center for Innovation in Global Health, Faculty Fellow of Stanford ChEM-H, and a senior fellow of the Woods Institute for the Environment. Prakash was recipient of 2016 MacArthur fellowship.

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The Deep Ocean, Menagerie of Instabilities?

Jacob O. Wenegrat

Abstract: The ocean is rich with small-scale fronts, eddies, and filaments with horizontal length scales of approximately 0.1 - 10 km—where both planetary rotation and nonlinearity influence the dynamics—in what is termed the ocean submesoscale. It is now widely recognized that processes at these scales play a fundamental role in both the dynamics and biogeochemistry of the upper-ocean, however it has only recently become evident that the bottom boundary layer can also support active submesoscale turbulence, with largely unknown con- sequences. In this talk I will discuss recent work on submesoscale instabilities of the ocean bottom boundary layer, with a focus on how they may alter current conceptual models of flow-topography interaction in both coastal and deep oceans. Modifications to turbu- lent mixing along topography suggest pathways for these instabilities to affect the general ocean circulation, both through the dissipation of kinetic energy, and by affecting how dense waters are made lighter and brought back to the surface, a central uncertainty in our understanding of the closure of the ocean abyssal overturning circulation. Notably, our best projections suggest that we will not have sufficient computational power to directly resolve submesoscale processes in coupled climate models until near the end of the century, and I will therefore conclude with a brief discussion of the challenges and opportunities that the submesoscale poses for numerical modelers and theoreticians.

Bio: Jacob Wenegrat received his PhD in Oceanography, and MS in Applied Mathematics, from the University of Washington in 2015, followed by postdoctoral work at Stanford University with Dr. Leif Thomas. His research focuses on ocean and atmosphere dynamics, with a particular interest in the use of theory and high-resolution numerical modeling to explore processes at the ocean submesoscale (horizontal scales of 0.1-10 km). He joined the University of Maryland, College Park's Department of Atmospheric and Oceanic Science as an Assistant Professor in 2020, and is affiliate faculty in the Applied Mathematics & Statistics, and Scientific Computing program and the Burgers Program for Fluid Dynamics.