UNIVERSITY OF MARYLAND

The Burgers Program for Fluid Dynamics

Twenty Second Annual Symposium

Friday, October 3rd, 2025, 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
A. James Clark School of Engineering
University of Maryland, College Park

Program:

1:00 – 1:05

Welcoming Remarks

Jim Duncan
The Burgers Program for Fluid Dynamics, University of Maryland
Department of Mechanical Engineering and the Institute for Physical Science and Technology

1:05 – 1:50

The Physics of Spray Formation

D. (Daniel) Bonn
Faculty of Science
University of Amsterdam

1:50 – 2:00

Break, informal discussions

2:00 – 2:45

Particles Motions in Turbulence

Ellen Longmire
Department of Aerospace Engineering and Mechanics
University of Minnesota

2:45 – 3:30

Graduate student and post-doctoral poster session. Refreshments served

3:30 – 4:15

Instability of Internal Waves in Non-uniform Stratification

Bruce R. Sutherland
Departments of Physics and Earth & Atmospheric Sciences
University of Alberta

4:15 – 5:00

Fluid-Structure Interactions Up in the Sky and Deep inside the Earth

Jun Zhang
Department of Physics and Courant Institute
New York University

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

ABSTRACTS and BIOGRAPHIES

The Physics of Spray Formation

D. (Daniel) Bonn

Abstract: Sprays are of paramount importance for many applications ranging from medicine to agriculture. In most practical situations, sprays are formed from the breakup of liquid jets or sheets. We investigate the different parameters that determine the characteristic drop size in the breakup of sheets and jets. We vary both the spraying parameters, such as the pressure and geometry of the nozzle, and the fluid parameters, such as viscosity and surface tension. The combined results show that the drop size is determined by a competition between fluid inertia and surface tension, which allows for the prediction of the drop size from the Weber number and geometry/size of the nozzle.

Biography: Daniel Bonn is group leader of the Soft Matter Group, which studies the flow behavior of complex fluids and solids, and totals about 60 people. He published more than 400 papers on wetting, complex fluids and hydrodynamics and was invited more than 40 times as a speaker at international conferences in the past five years. Daniel Bonn has a large amount of industrial collaborations such as with Michelin, SKF and Unilever, Shell, DSM, Akzo Nobel, Medspray ASML, and many others. Bonn is also co-founder of the scale-up company GreenA that received a Round A investment from a venture capital firm and now employs several people. He is the recipient of the Marie Curie and Physica Prizes, a Fellow of the American Physical Society, a member of the Royal Dutch Academy of Sciences, and in 2024 received the Ig Nobel Prize.

Particles Motions in Turbulence

Ellen Longmire

Abstract: Our work is motivated by the need to understand and predict turbulent particle-laden flows across a range of environmental and industrial applications. In this talk, we consider a relatively canonical yet challenging experimental flow designed to be accessible to direct numerical simulation. A spherical particle in a turbulent boundary layer undergoes complicated particle-wall and particle-turbulence interactions. Particles with significant diameter are subject to variations in shear and normal forces around their circumference. Wall friction will affect the particle rolling and sliding motions while coherent flow structures can lift the particle away from the wall. To resolve the sphere dynamics in such a flow, 3D tracking experiments were conducted in a water channel facility. The translation and rotation of individual spheres released from rest were tracked over distances of 6δ for multiple flow Reynolds numbers and particle-to-fluid density ratios. Simultaneous stereoscopic PIV measurements were acquired in the logarithmic region surrounding the moving spheres. While neutrally buoyant particles typically lift off from the wall upon release, denser particles travel mostly along the wall. The relative contributions of turbulence, wall friction, and mean shear to the resulting particle motions will be discussed for the different cases considered.

Biography: Ellen Longmire is a Professor of Aerospace Engineering & Mechanics at the University of Minnesota. She received an A.B. in physics from Princeton University and M.S. and Ph.D. degrees in mechanical engineering from Stanford

University. She is a Fellow of the American Physical Society and received the UM Distinguished Women Scholars Award, the McKnight Land-Grant Professorship, and the NSF National Young Investigator Award. She is currently an Editor-in-Chief for *Experiments in Fluids* and a member of the US National Committee on Theoretical and Applied Mechanics. She previously served as Associate Dean of Academic Affairs for Science & Engineering at University of Minnesota, Chair of the APS Division of Fluid Dynamics, and Associate Editor for *Physics of Fluids*.

Instability of Internal Waves in Non-uniform Stratification

Bruce R. Sutherland

Abstract: One proposed mechanism for the transfer of energy from large-scale internal tides to small dissipative scales is through triadic resonant instability, whereby a pair of sibling waves interact with a parent internal tide so that they grow in amplitude, extracting energy from the parent. In uniform stratification, the sibling waves can grow in pure resonance such that their frequencies and both horizontal and vertical wavenumbers add or subtract to those of the parent. However, in realistic ocean stratification, a low vertical mode internal tide does not have sinusoidal vertical structure. Pure resonance requires only requires matching of the frequencies and horizontal wavenumbers. However, assessing whether this resonance leads to instability requires consideration of the vertical structure of the parent and sibling waves. In this work we develop a theory for the growth of sibling waves in near resonance due to a frequency mismatch between the forced frequency and natural frequency of the parent waves, and from this determine when pure resonant growth occurs. The predictions are tested against fully nonlinear numerical simulations and laboratory experiments in which the background buoyancy frequency decreases linearly with depth. Theory, simulations and experiments show that near-resonance can occur if the parent wave has frequency close to the maximum buoyancy frequency. However, the maximum growth rate is negligibly small if the parent wave has frequency less than approximately have the maximum buoyancy frequency.

Biography: Bruce Sutherland received his PhD in atmospheric science in the Department of Physics at the University of Toronto in 1994 then pursued postdoctoral training in the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge before taking up a position in 1997 as Assistant Professor in the Department of Mathematics at the University of Alberta. He is now a Professor jointly appointed in the Departments of Physics and of Earth & Atmospheric Sciences at the University of Alberta. His research combines theory, numerical simulations and laboratory experiments to examine phenomena occurring in stratified fluids. Main topics include interfacial and vertically propagating internal waves, the evolution of gravity currents and plumes in stratified fluids, and the transport and deposition of sediments in geophysical flows. He is a Fellow of the American Physical Society and currently serves as Associate Editor of Physical Review Fluids, as well as serving on the Executive Committee of the Woods Hole Oceanographic Institution Geophysical Fluid Dynamics Summer Program.

Fluid-Structure Interactions Up in the Sky and Deep inside the Earth

Jun Zhang

Abstract: In this talk, I will introduce two recent experiments on fluid-structure interactions. In both cases, solid boundaries are set to interact freely with their surrounding flows. The experiments and the emergent dynamics are inspired by and related to natural phenomena. In the first experiment, the free fall of snowflakes (in the air) is investigated using mica flakes falling in water, and their intriguing optical effects are discussed. The second experiment is inspired by the recent discovery of the 'super-rotation' of the solid core of the earth, as

this core spins slowly deep inside the earth. In our table-top experiment, a free-rotating body takes the central axis of a symmetric thermal convection cell, a persistent co-rotation of the free body and the large-scale convective flow is observed. The mechanism that powers the co-rotation and its stochastic reversals are explained in some detail.

Biography: Prof. Jun Zhang is a jointly appointed Professor of Physics and Mathematics, between New York University and NYU Shanghai. He has obtained a PhD in physics from the Niels Bohr Institute of the University of Copenhagen and is a member and Fellow of the American Physical Society (APS/DFD), and a foreign member of the Academia Europaea (MAE). His research activities focus on many fluid phenomena arising from the biological and geophysical world. In particular, he is interested in how animals move in air and water, and he has been trying to understand the rich dynamics of the planet Earth from a fluid point of view.