UNIVERSITY OF MARYLAND

The Burgers Program for Fluid Dynamics

Fifteenth Annual Symposium

Wednesday, November 14, 2018
1:00 to 6:00 p.m.
Jeong H. Kim Engineering Building
Rooms 1107 & 1111

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

Program

1:00 - 1:15

Welcoming Remarks

Jim Wallace
Director, The Burgers Program for Fluid Dynamics
Emeritus Professor, Department of Mechanical Engineering &
Insitute for Physical Science and Technology
University of Maryland

1:15 - 2:15

Burgers Lecture

Adopting Lattice-Boltzmann for simulating turbulence and emulsification

Harry Van den Akker
School of Engineering
University of Limerick and Technical University, Delft

2:15 - 2:50

Prediction of frictional drag for rough surfaces

Karen Flack
Department of Mechanical Engineering
Naval Academy

2:50 - 3:50

Graduate student and post-doctoral poster session. Refreshments served

3:50 - 4:25

Mathematical perspectives on coherent structure vs chaos in fluid mechanics

Jacob Bedrossian
Department of Mathematics and Center for Scientific Computation and Mathematical Modeling
University of Maryland

4:25 - 5:00

Water flows at nanoscopic interface

Siddhartha Das
Department of Mechanical Engineering
University of Maryland

5:00 - 6:00

Reception and announcement of best poster awards

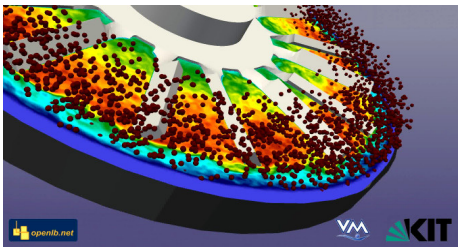
Adopting Lattice-Boltzmann for simulating turbulence and emulsification

Harry Van den Akker

The Lattice-Boltzmann (LB) model is a mesoscopic physics approach that conceives fluids as consisting of interacting fictitious parcels of molecules. The parcels are bound to move at a constant velocity from node to node of a lattice (or grid). The number of molecules in each parcel, i.e. its density, may change, at a node only, due to interactions and external forces. The LB model develops into an equation rather different from the Navier-Stokes (NS) equation, turning simulations fast due to the spatio-temporal locality of the computations. The resulting flow fields do obey NS, albeit subject to certain restrictions. An important driver for using LB techniques is that generally simulations are faster by an order of magnitude compared to the finite volume techniques used in most computational fluid dynamics software.

The LB model can be applied for both Large Eddy Simulations (LESs) and Direct Numerical Simulations (DNSs). Such dynamic simulations can be carried out on the macro-scale, e.g. for a stirred vessel, as well as on the meso-scale in a so-called periodic box to investigate local flow characteristics. Typical results with respect to turbulence will be presented.

The powerful LB techniques can also be used for simulating and investigating multi-phase flows in a periodic box at an unprecedented level of detail. The focus in this Burgers lecture will be on droplets and emulsions as simulated by the multi-component pseudopotential LB approach. The technique will be illustrated by means of simulations for two immiscible components and for emulsification due to both shear and turbulence. Finally, novel results will be presented with respect to the effects of a surfactant on surface tension, on droplet formation and on droplet breakup.



Dynamic Cross-Flow Filtration – Simulations in Process Engineering. Simulation with OpenLB by Robin Trunk, Visualisation by Marie-Luise Maier.

Prediction of frictional drag for rough surfaces

Karen Flack

The goal of this research is to develop engineering correlations for the prediction of frictional drag for a generic rough surface in all roughness regimes. Predictions of surface roughness is generally characterized by k_S, the equivalent sandgrain roughness height, the size of uniformly packed sandgrains tested by Nikuradse that produces the same frictional drag in the fully-rough regime. k_S is a hydraulic scale, not a physical scale and this is what is listed on the Moody diagram as ε, the equivalent roughness height. Ideally, robust engineering correlations should be based on information that can be obtained solely from the surface topography, thus excluding any information that requires hydrodynamic testing. While a significant number of studies have tackled this problem, correlations that are valid for a wide range of roughness types are still not available. The present work focuses on random roughness that contain a range of roughness scales. This is an active area of research with numerous research groups contributing numerical and experimental results to make headway towards providing engineering correlations with more fidelity than the Moody diagram.

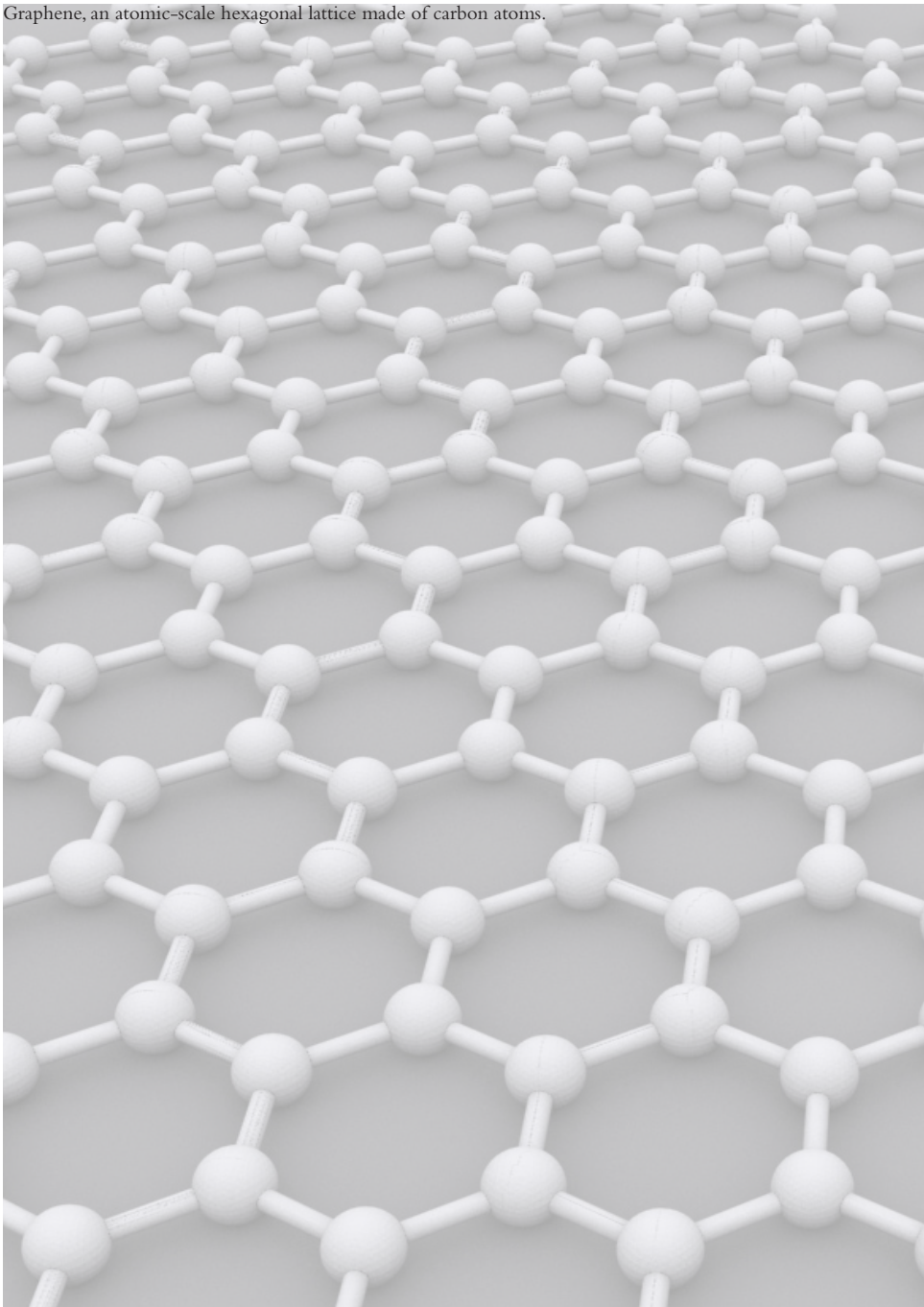
Mathematical perspectives on coherent structure vs chaos in fluid mechanics

Jacob Bedrossian

In this talk I will discuss some recent mathematically rigorous progress towards understanding two regimes of fluid mechanics: the stability of coherent laminar structures vs chaotic dynamics and turbulence. We will discuss the mechanisms which can stabilize vortices and shear flows in 2D fluids and go on to discuss how these mechanisms still play a role in 3D, allowing us to shed some additional light on the subcritical transition of 3D shear flows and vortex filaments. Nevertheless, at high Reynolds number, the generic behavior of fluid mechanics is turbulent and chaotic, and building a rigorous theory of such dynamics remains one of the most important challenges in mathematical physics. We will discuss some of the recent progress made in this direction via stochastic fluid mechanics, espe-

cially, our recent results on using the ergodic theory of random dynamical systems to study the chaotic dynamics of the Lagrangian flow and to the subsequent complete proof of Yaglom's law of passive scalar turbulence in a variety of settings.

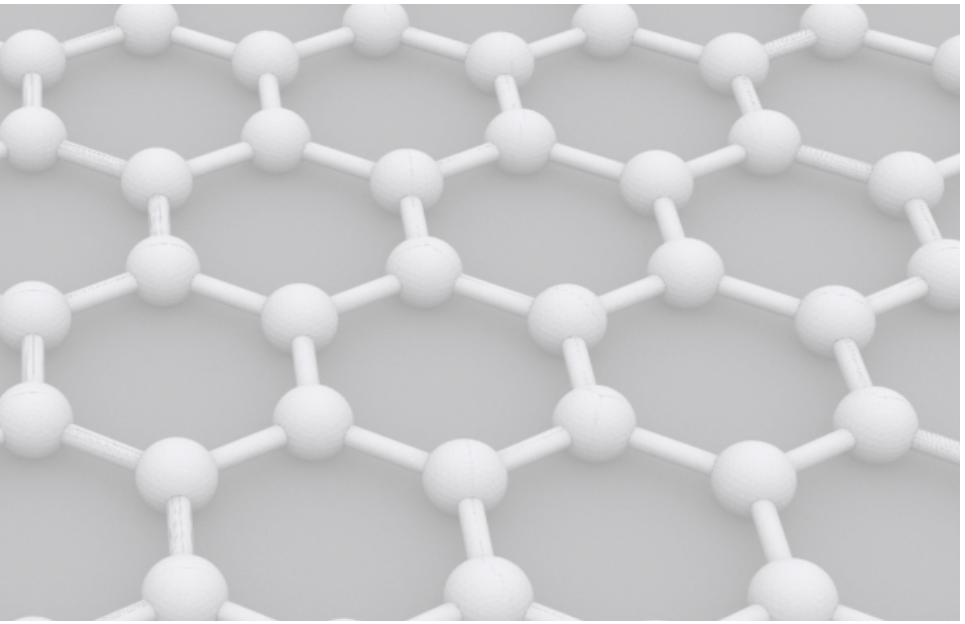
Graphene, an atomic-scale hexagonal lattice made of carbon atoms.



Water flows at nanoscopic interface

Siddhartha Das

Liquid flows at nanoscopic interfaces regulate a myriad of events ranging from the use of nanoporous graphene for water filtration and functionalized nanochannels for ion and biomolecular sensing to controlling the transport of nanoscale vesicles (e.g., biological cellderived exosomes) for cancer detection. This talk will focus on the water and ion transport at a nanostructured 2-D, van der Waals solid (e.g., graphene). First, the talk will discuss how the presence of nanopillars attributes superhydrophobicity to graphene. Secondly, the transport in defective, holey graphene, unraveling the breakdown of Darcy's Law and the generation of highly augmented water-accessible graphene surface area, will be discussed. Thirdly, the talk will discuss the transport of ion-rich water drops through holey graphene and the possible corrections needed in the very basic framework to analyze the ion-capillary-wave interactions, which in turn would help to better explain ion-water-graphene interactions. Finally, the talk will end with some recent findings demonstrating the manner in which water and graphene-phonons interact to trigger a most remarkable enhancement in water flows in graphene nanochannels with strained walls.



Burgers Board

James M. Wallace, Chair
James H. Duncan
Kayo Ide
Christopher Jarzynski
Kenneth Kiger
Jan V. Sengers
Konstantina Trivisa

THE BURGERS PROGRAM FOR
FLUID DYNAMICS

INSTITUTE FOR
PHYSICAL SCIENCE
& TECHNOLOGY

4211 Atlantic Building
University of Maryland
College Park, MD 20742-2431
Phone: +1 (301) 405 4889
http://ipst.umd.edu