UNIVERSITY OF MARYLAND

The Burgers Program for Fluid Dynamics

Eighth Annual Symposium

Wednesday, November 16, 2011
1:00 to 6:30 p.m.
Jeong H. Kim Engineering Building
Rooms 1107 & 1111

Institute for Physical Science and Technology,
Department of Physics,
College of Computer, Mathematical, and Natural Sciences

Program

1:00 – 1:15 **Welcome.**
James M. Wallace, Burgers Program for Fluid Dynamics, University of Maryland, USA.

1:15 – 2:15 **Burgers Lecture: Is the resistance of fluid flow still an open problem in the fully developed turbulent flow regime?**
Marie Farge, Directrice de Recherche, CNRS; École Normale Supérieure Paris, France.

2:15 – 2:50 **Numerical study of eccentric core annular flow.**
Gijs Ooms, Scientific Director, J. M. Burgerscentrum, The Netherlands.

2:50 – 3:50 **Student Poster Session with refreshments.**

3:50 – 4:25 **Elongated chain molecules.**
Jutta Luettmer-Stathmann, Department of Physics, The University of Akron, USA.

4:25 – 5:00 **G. I. Taylor: The inspiration behind the Cambridge School of fluid mechanics.**
Katepalli Sreenivasan, Dept. of Physics, Senior Vice Provost, New York University, USA.

5:00 – 6:30 **Best Poster Awards and Gala Reception in honor of Jan V. Sengers.**

Burgers Lecture: Is the resistance of fluid flow still an open problem in the fully developed turbulent flow regime?

Marie Farge
Directrice de Recherche, CNRS
École Normale Supérieure Paris, France.

When fluid flows reach the fully-developed turbulent regime, one observes that the dissipation rate becomes independent of the fluid viscosity. We conjecture that, when the Reynolds number *Re* tends to infinity, viscous dissipation becomes negligible and turbulent dissipation, triggered by the nonlinear flow dynamics, takes over. To study this we consider the generic case of a jet hitting a wall. We perform direct numerical simulations of the two-dimensional Navier-Stokes equations in the vanishing viscosity limit, using a volume penalization method to take into account the wall. We show that the energy dissipation first sets up within a very thin vorticity sheet and then detaches from the wall and rolls up into a spiral where dissipation is maximal. We thus propose a new explanation of the d'Alembert's paradox (1752), which is based on turbulent dissipation rather than on viscous dissipation. Our observations are compatible with Kato's theorem (1984) which proved that for dissipation to occur, anywhere in the flow and at any time, at least some dissipation had to occur in the vanishing viscosity limit within a very thin boundary layer whose thickness is proportional to $1/Re$.

This work is done in collaboration with Romain Nguyen van yen (Freie Universität Berlin, Germany) and Kai Schneider (Université d'Aix-Marseille, France). It was published in Physical Review Letters, ***106****, 184502, 6 May 2011.*

Numerical study of eccentric core-annular flow.

Gijs Ooms
Scientific Director, J. M. Burgerscentrum, The Netherlands

To transport a high-viscosity liquid (oil) through a pipeline a low-viscosity liquid (water) can be used as a lubricant film between the pipe wall and the oil core. Usually the density of oil is lower than that of water, which causes an eccentric position of the core in the pipeline. A numerical study has been made of eccentric core-annular flow, special attention being paid to the vertical force on the core. The viscosity of the core is assumed to be so large that it behaves as a rigid solid. A wave is present at its surface. The vertical force changes from an upward vertical direction to a downward vertical direction with increasing value of the Reynolds number. This is due to a rather subtle change in the pressure distribution around the top of the wave with changing Reynolds number.

In collaboration with M.J.B.M. Pourquie and P. Poesio.

Elongated chain molecules.

Jutta Luettmer-Strathmann
Department of Physics, The University of Akron, USA

Polymer solutions under shear flow, grafted chains in dense polymer brushes, and adsorbed biomolecules have elongated chain conformations in common. Thermodynamic properties, such as solvent quality and temperature, as well as interactions between chain segments or with a substrate affect the structure and the elastic response of the chains. To identify common factors in the elastic behavior and to separate the effects of particular interactions from thermodynamic conditions it is important to study chain molecules under controlled tension. Experimental work on single molecules has been carried out both under equilibrium conditions, for example with magnetic tweezers, and away from equilibrium, for example with atomic force microscopes and laser tweezers. For equilibrium systems, three thermodynamic fields corresponding to the temperature, the solvent quality, and the surface interactions determine the equilibrium configurations of the chains. We have performed density-of-states simulations of lattice models for tethered chain molecules under tension over the state space conjugate to these three thermodynamic fields. To validate the work, we calculate force-extension curves for a range of conditions and compare our results with recent data obtained in magnetic-tweezers experiments. We investigate the effect of tension on conformational transitions, such as chain collapse and adsorption in good and poor solvent, and show how tension may alter the character of these transitions.

G.I. Taylor: The inspiration behind the Cambridge School of Fluid Mechanics.

K.R. Sreenivasan
Dept. of Physics, Senior Vice Provost, New York University, USA

The speaker co-edited a book published by the Cambridge University Press on a dozen historical figures of turbulence. The articles were in the style of short scientific biographies. The speaker also wrote an article on Sir Geoffrey Ingram Taylor, a great doyen of fluid mechanics. The talk will be based on that article, and will examine Taylor's contributions to turbulence.

Celebrating Jan V. Sengers at 80

Jan V. Sengers

Born in 1931 in Heiloo, a village close to the city of Alkmaar, The Netherlands, Jan Sengers was the first of 11 children in his family.

Jan attended the University of Amsterdam, where he earned a B.S. in Physics and Mathematics (1952), an M.S. in Physics (1955), and a Ph.D. in Physics (1962), all three *cum laude*.

Jan worked as a Research Associate from 1955 to 1963 at the Van der Waals Laboratory where he met the woman who would become his wife, Johanna M.H. Levelt Sengers, aka Anneke. Anneke left to do a postdoc at the University of Wisconsin, Madison from 1958 to 1959. After she returned from the U.S. and Jan completed his Ph.D., he asked her to marry him. The couple got married on February 24, 1963, and decided to go to America so that Jan could also gain research experience abroad. They were hired in 1963 by the National Bureau of Standards (later renamed National Institute of Standards and Technology). "We decided to stay in the U.S., since at that time it was very difficult for a married woman to have a scientific career in The Netherlands, thus solving the two-career marriage problem," Jan says.

In 1968 Jan became an Associate Professor in the Institute for Molecular Physics, the predecessor to the Institute for Physical Science and Technology (IPST), at the University of Maryland, College Park. Jan built his professional career at the University of Maryland, going on to become the Director of the Chemical Physics Program (1978-1985); Professor and Chair of the Dept. of Chemical Engineering (1994-1999); Distinguished University Research Professor, IPST; Distinguished University Professor Emeritus, Dept. of Chemical and Biomolecular Engineering; Affiliate Professor, Dept. of Mechanical Engineering; and recipient of the Outstanding Commitment Award of the A. James Clark School of Engineering in 2011.

In 1980, Jan was elected a correspondent of the Royal Netherlands Academy of Sciences; and in 1992, he and his wife each received an honorary doctorate degree from Delft University of Technology, which was a first for a married couple to receive such honor at Delft. In 2004, Jan was instrumental in the creation of the Burgers Program for Fluid Dynamics and served as its first director. For these, and many other international collaborations, Jan was honored with the Distinguished International Service Award by President Mote at the Office of International Programs annual UM International Awards Ceremony in 2008.

Jan and Anneke have four children and four grandchildren. He drives a Prius.

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