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HUMMINGBIRD TONGUES, BUTTERFLY SIPS, SWIMMING BACTERIA, AND ROBOTIC CLAMS
Animal Highlights of the Fluid Dynamics Conference
Minneapolis, Nov. 22-24, 2009
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FOR IMMEDIATE RELEASE

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WASHINGTON, D.C., November 24, 2009 -- Take a new look at nature through the eyes of physicists and engineers at this month's 62nd Annual Meeting of the American Physical Society's (APS) Division of Fluid Dynamics, which takes place from November 22-24 at the Minneapolis Convention Center. This is the largest scientific meeting of the year devoted to the dynamics of fluid flows, and it brings together researchers from around the globe to present work with applications in engineering, energy, physics, astronomy, medicine, and mathematics.

Many of nature's most fascinating phenomena involve the flow of liquids and gases, and a number of talks at this year's meeting focus on how fluid dynamics is revealing the secrets of animal motion and physiology -- from bacteria swimming to butterflies and mosquitoes drinking, to hummingbirds licking nectar and engineered materials based on nature. Highlights of a few of these talks are described below.

Reporters are invited to attend the conference free of charge. More information may be found at the end of this news release.

ANIMAL SCIENCE FROM THE SCIENTIFIC PROGRAM
The following is a sampling of animal-related science from among the 1,611 abstracts to be presented at the meeting.

1) The Mechanism of Mosquito Sucking
2) Hummingbirds' Tongues
3) Butterfly Proboscis to Sip Cells
4) Robotic Clam Digs in Mudflats
5) Bacteria Swimming in Rough Waters

1) THE MECHANISM OF MOSQUITO SUCKING
When you get bitten by a mosquito, it's only females that are doing the damage. They take the blood to obtain protein for egg production, and they typically extract more than three times their body weight. Large mosquitoes can drink 6 micro-liters at one go. Sang Joon Lee of the Pohang University of Science & Technology in Korea, will report on the mechanics of mosquito blood sucking.

The feeding takes place in four stages. First, the mosquito lands and inserts her bayonet-shaped stylets into the victim. Then she determines the optimum penetration depth and begins to extract. Finally, the mosquito straightens her forelegs and retracts the stylets.

A few theoretical studies of this sequence have been made before, but detailed flow information was lacking. Lee gets inside the mosquito's head to measure the flow details, which proceeds by the reciprocal action of two sets of pumps, sort of like the systolic rhythm of the mammalian heart. The expansion of the cibarial pump stroke is longer than that of the complementary pharyngeal pump. Lee will be the first to summarize this coordinated action, which maximizes the sucking force and regulates the movement of the blood to the mosquito's digestive organs.

The presentation, " Experiments on blood-sucking mechanism of a female mosquito" by Sang Joon Lee, Bo Heum Kim, and Jung Yeop Lee of POSTECH is at 10:30 a.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/110807*

2) HUMMINGBIRDS' TONGUES

The hummingbird's hovering and darting movements impose a huge metabolic burden. MIT scientist John Bush will talk about one crucial element of the bird's nectar-collection system -- its tongue. The tongue is about 2 cm long, twice as long as the beak. When dipped into nectar it spontaneously wraps into a cylindrical straw shape, which then acts as a siphon. The capillary rise of nectar up the column is quick, allowing the bird to fill its tongue up to 20 times per second. After each dip the nectar is scraped free and swallowed.

Bush and coworkers are the first to study the mechanics of this process in detail. They model the wrapping-up of the tongue as a sort of "capillary origami": the tongue folds courtesy of surface-tension forces, and so this represents a self-assembling siphon.

"Most drinking strategies in nature have -- or eventually will have -- industrial analogues," says Bush. "The scale of the hummingbird tongue suggests that it may inform and inspire biomimetic designs for microfluid transport."

The presentation, "The hummingbird's tongue: a self-assembling syphon" by John Bush, Francois Peaudecerf, and David Quere of MIT is at 9:31 a.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/110595*

3) BUTTERFLY PROBOSCIS TO SIP CELLS

A butterfly's proboscis looks like a straw -- long, slender, and used for sipping -- but it works more like a paper towel, according to Konstantin Kornev of Clemson University. He hopes to borrow the tricks of this piece of insect anatomy to make small probes that can sample the fluid inside of cells.

At the scales at which a butterfly or moth lives, liquid is so thick that it is able to form fibers.. The insects' liquid food -- drops of water, animal tears, and the juice inside decomposed fruit -- spans nearly three orders of magnitude in viscosity. Pumping liquid through its feeding tube would require an enormous amount of pressure.

"No pump would support that kind of pressure," says Kornev. "The liquid would boil spontaneously."

Instead of pumping, Kornev's findings suggest that butterflies draw liquid upwards using capillary action -- the same force that pulls liquid across a paper towel. The proboscis resembles a rolled-up paper towel, with tiny grooves that pull the liquid upwards along the edges, carrying along the bead of liquid in the middle of the tube. This process is not nearly as affected by viscosity as pumping.

Kornev has been recently awarded an NSF grant to develop artificial probes made of nanofibers that use a similar principal to draw out the viscous liquid inside of cells and examine their contents.

The presentation, "Butterfly proboscis as a biomicrofluidic system" by Konstantin Kornev et al of Clemson University is at 12:01 p.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/110814*

4) ROBOTIC CLAM DIGS IN MUDFLATS
To design a lightweight anchor that can dig itself in to hold small underwater submersibles, Anette (Peko) Hosoi of MIT borrowed techniques from one of nature's best diggers -- the razor clam.

"The best anchoring technology out there is an order or magnitude worse than the clam - most are two or three orders worse," says Hosoi.

Using relatively simple anatomy, the bivalve burrows into the bottom of its native mudflats at a rate of a centimeter per second. Hosoi's studies of the physics behind this remarkable ability have revealed that the digging is accomplished in two motions - a push upwards with its foot, which mixes the grains of solid into the liquid above, and a synchronized push down.

By borrowing this principle, Hosoi and graduate student Amos Winter have created a simple robot that is now being tested out in the salt water mudflats off of Cape Cod. It digs just as fast as the living clam and is "small, lightweight, and does not use a lot of energy," says Hosoi.

The robot is operated electronically via a tether and is made to open and close via pressured air from a scuba tank.

The presentation, "The design, testing, and performance of RoboClam, a robot inspired by the burrowing mechanisms of Atlantic razor clam (Ensis directus)" by Amos Winter et al of MIT is at 11:35 a.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/110965*

5) BACTERIA SWIMMING IN ROUGH WATERS
For bacteria living in an aquatic environment, one of the most important things to do is to find food. For that purpose, many bacteria have evolved the ability to swim.

Scientists have known for decades that bacteria follow chemical gradients coming from potential food sources in order to find their way. Proteins on their surfaces sense these chemicals, detecting which direction they are coming from, and the bacteria spin their corkscrew-shaped propeller-like "flagella" to swim in that direction.

What has been less appreciated is that the aquatic habitats of bacteria are often in motion, and the fluid movement creates velocity gradients ("shear"), which affects bacterial motility. In order to study this process, MIT professor Roman Stocker and his student Marcos, in collaboration with Prof. Thomas Powers and Dr. Henry Fu at Brown University, model how E. coli and marine bacteria swim by putting them in microfluidic chambers with carefully controlled fluid flow. They measure their swimming patterns, and they model the physical forces to which they are exposed.

Recently, the team found that the elongated shape characteristic of many bacteria tends to align them with the direction of the flow, potentially hindering foraging. A further reorientation comes from the helical shape of the flagella, which causes bacteria to orient in a direction angled away from the flow. Both of these effects have profound implications for how bacteria swim and will need to be taken into account to appropriately model bacterial foraging in the environment.

The presentation, "Bacteria Swimming in Shear" by Marcos and Roman Stocker is at 11:22 a.m. on Monday, November 23, 2009.
Abstract: http://meetings.aps.org/Meeting/DFD09/Event/111664

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MORE MEETING INFORMATION

The 62nd Annual DFD Meeting will be held at the Minneapolis Convention Center in downtown Minneapolis. All meeting information, including directions to the Convention Center is at: http://www.dfd2009.umn.edu/

PRESS REGISTRATION

Credentialed full-time journalist and professional freelance journalists working on assignment for major publications or media outlets are invited to attend the conference free of charge. If you are a reporter and would like to attend, please contact Jason Bardi (jbardi@aip.org, 301-209-3091).

USEFUL LINKS

Main meeting Web site: http://meetings.aps.org/Meeting/DFD09/Content/1629
Searchable form: http://meetings.aps.org/Meeting/DFD09/SearchAbstract
Local Conference Meeting Website: http://www.dfd2009.umn.edu/
PDF of Meeting Abstracts: http://flux.aps.org/meetings/YR09/DFD09/all_DFD09.pdf
Division of Fluid Dynamics page: http://www.aps.org/units/dfd/
Virtual Press Room: SEE BELOW

VIRTUAL PRESS ROOM

The APS Division of Fluid Dynamics Virtual Press Room will contain tips on dozens of stories as well as stunning graphics and lay-language papers detailing some of the most interesting results at the meeting. Lay-language papers are roughly 500 word summaries written for a general audience by the authors of individual presentations with accompanying graphics and multimedia files. The Virtual Press Room will serve as starting points for journalists who are interested in covering the meeting but cannot attend in person. See: http://www.aps.org/units/dfd/pressroom/index.cfm

Currently, the Division of Fluid Dynamics Virtual Press Room contains information related to the 2008 meeting. In mid-November, the Virtual Press Room will be updated for this year's meeting, and another news release will be sent out at that time.

ONSITE WORKSPACE FOR REPORTERS

A reserved workspace with wireless internet connections will be available for use by reporters. It will be located in the meeting exhibition hall (Ballroom AB) at the Minneapolis Convention Center on Sunday and Monday from 8:00 a.m. to 5:00 p.m. and on Tuesday from 8:00 a.m. to noon. Press announcements and other news will be available in the Virtual Press Room.

GALLERY OF FLUID MOTION

Every year, the APS Division of Fluid Dynamics hosts posters and videos that show stunning images and graphics from either computational or experimental studies of flow phenomena. The outstanding entries, selected by a panel of referees for artistic content, originality and ability to convey information, will be honored during the meeting, placed on display at the Annual APS Meeting in March of 2010, and will appear in the annual Gallery of Fluid Motion article in the September 2010 issue of the journal Physics of Fluids.

This year, selected entries from the 27th Annual Gallery of Fluid Motion will be hosted as part of the Fluid Dynamics Virtual Press Room. In mid-November, when the Virtual Press Room is launched, another announcement will be sent out.

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ABOUT THE APS DIVISION OF FLUID DYNAMICS
The Division of Fluid Dynamics of the American Physical Society exists for the advancement and diffusion of knowledge of the physics of fluids with special emphasis on the dynamical theories of the liquid, plastic and gaseous states of matter under all conditions of temperature and pressure. See: *http://www.aps.org/units/dfd/*

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