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Fluid Dynamics Conference Highlights
Minneapolis, Nov. 22-24, 2009
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FOR IMMEDIATE RELEASE

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WASHINGTON, D.C. November 24, 2009 -- The 62nd Annual Meeting of the American Physical Society's (APS) Division of Fluid Dynamics will take place from November 22-24 at the Minneapolis Convention Center. The largest scientific meeting of the year devoted to the fluid dynamics, it brings together researchers from around the globe to present work with applications in engineering, energy, physics, climate, astronomy, medicine, and mathematics.

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

HIGHLIGHTS OF SCIENTIFIC PROGRAM
The following is a brief sampling of some of the 1,611 abstracts to be presented at the meeting.
1) ENERGY: Wind Farm Design Borrows Strategy from Schooling Fish
2) ENERGY: Deep-Ocean Electricity
3) SECURITY: Predicting Fall-Out from Urban Nuke
4) CLIMATOLOGY: Aquatic Creatures Mix Ocean Water
5) SPORTS: Groovy Golf Balls**
6) GREENHOUSE GAS: Predicting the Fate of Underground Carbon**
7) GEOPHYSICS: Journey to the Center of the Earth, in Maryland
8) ENERGY: Generating Electricity from the Motion of Cars and Trucks
9) RAINDROPS: Ripping Drips**

**NOTE: Images may be obtained for the stories indicated by emailing *jbardi@aip.org*

1) WIND FARM DESIGN BORROWS STRATEGY FROM SCHOOLING FISH
Last year, the United States overtook Germany to become the largest producer of wind energy in the world. This capped a five year expansion of U.S. wind power during which capacity increased by about a third every year.

Robert Whittlesey and John Dabiri of the California Institute of Technology have developed a potentially more efficient wind farm design that maximizes the efficiency of land usage. They based their approach on the way that fish school.

"When fish swim, they shed tiny vortices in their wake," says Dabiri. "By schooling together, they can potentially help each other swim by transferring energy between one another through these vortices."

Applying these same principles, Whittlesey and Dabiri have designed a wind farm of closely-spaced vertical-axis turbines (a design different from the more familiar propeller-type horizontal axis wind turbines). Their farm is arranged with the turbines closely spaced, so that as each is turned by the wind, it both extracts energy for itself and also helps to direct the flow of wind to the other turbines.

They made measurements of turbines designed by a Southern California energy company and fed the data into a computer model designed to optimally space the turbines. Their computations show that the power-per-acre of a wind farm could be increased a hundredfold. Next, the researchers will build a test field with real turbines and make actual energy production measurements.

The presentation "Fish schooling as a basis for wind farm design" by Robert Whittlesey and John Dabiri of the California Institute of Technology is scheduled for 5:19 p.m. on Monday, November 23, 2009. Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/111920*

2) OCEAN ELECTRICITY

In trying to produce electricity while reducing fuel costs and mitigating global climate change from burning fossil fuels, engineers look to a diverse range of energy sources. One potentially potent store of energy is the irrepressible activity of the ocean. To date, ocean generation of power has not become commercially viable. Machines that convert surface waves into electricity are difficult to protect during storms. Floating on the surface, they sometimes do not survive beyond a year's operation.

Tapping ocean surface waves from below might offer a long-term alternative to surface-based wave energy converters. According to Stefan Siegel, a scientist at the United States Air Force Academy, waves in deep water have greater aggregate energy and energy density. "Deep" in this case means a depth of at least half a wavelength of ocean waves; for example, if a typical ocean wave has a wavelength of 100-150 meters, the depth for power generation would be at least 50-75 meters. At his talk Siegel will describe computer simulations of ocean waves in deep water and experiments made in a water wave tank. He and his colleagues also plan to begin tests in a larger wave tank at the Oregon State University next year.

What would an energy-harvesting machine look like? The device would consist mainly of a cycloidal propeller with a 12-meter radius. The trial apparatus to be deployed in the Oregon State University wave tank is about one-tenth this size. In a few years the researchers hope to build a quarter or even half scale version of the full design for ocean testing. Although energy efficiency numbers are difficult to predict, Siegel expects that deep-water generation should be more efficient than wind turbines or tidal generators. In fact, since the energy in the wave entering the conversion device can be nearly entirely converted to useful energy, the mechanical efficiency could, in principle, exceed 90 percent.

The talk, "Deep Ocean Wave Cancellation Using a Cycloidal Turbine" by Stefan Siegel, Tiger Jeans, and Thomas McLaughlin of the U.S. Air Force Academy is at 12:06 p.m. at Tuesday, November 24, 2009. Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/112236*

3) NUCLEAR WEAPONS: PREDICTING THE UNTHINKABLE

If a nuclear weapon were detonated in a metropolitan area, how large would the affected area be? Where should first responders first go? According to physicist Fernando Grinstein, we have some initial understanding to address these questions, but fundamental issues remain unresolved.

"The predictive capabilities of today's state-of-the-art models in urban areas need to be improved, validated and tested," says Grinstein. "Work in this area has been limited primarily because of lack of consistent funding."

At the upcoming DFD meeting, Adam Wachtor -- a student who worked with Grinstein at the Los Alamos National Laboratory in New Mexico -- will present his efforts to improve the way that models track the movement of radioactive fall-out carried by the wind. His wind models track the aftermath of a plume of hot gas released by a small, one-ton device in a typical urban setting at a three-meter resolution.

Current models use wind direction and wind speed to draw a predicted cone-shape area of fall-out. Wachtor's results show that these models are too simple in some ways. For instance, they do not include the complex dynamics of wind movements around buildings, which can concentrate fall-out preferentially in certain areas. They also indicate that small changes in the location of the blast and the temperature of the plume released can have a large effect on the contamination patterns.

The simulation is part of a larger coordinated effort between DHS (FEMA), the National Laboratories, DTRA, NRL, and private contractors, each of which has concentrated on a different piece of the project. Other studies have shown that, depending on the situation, buildings can provide some degree of shielding from the radiation.

The hope of the researchers collaborating in this effort is to eventually provide practical information to guide first responders. "We're preparing for [a possible] crisis," says Grinstein -- however unthinkable it may be.

The presentation "Effects of release characteristics on urban contaminant dispersal" by Adam Wachtor of the University of California, Irvine is at 8:00 a.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/110717*

4) AQUATIC CREATURES MIX OCEAN WATER

Understanding mixing in the ocean is of fundamental importance to modeling climate change or predicting the effects of an El Niño on our weather. Modern ocean models primarily incorporate the effects of winds and tides. However, they do not generally take into account the mixing generated by swimming animals.

More than 60 years ago, oceanographers predicted that the effect of swimming animals could be profound. Accounting for this effort has proven difficult, though, so it has not entered into today's models.

Now Kakani Katija and John Dabiri at the California Institute of Technology have developed a way to estimate the extent of "biogenic" mixing. After conducting field measurements on swimming jellyfish, they built models of how animals mix the waters ocean-wide and concluded that the effect may be extensive.

"Swimming animals may contribute to ocean mixing on the same level as winds and tides," says Katija. "This necessitates the inclusion of biogenic mixing sources in ocean circulation and global climate models."

Most of this mixing is due to the displacement created by the movement of animal bodies through the water -- rather than by the turbulence that is stirred up by fish as they swim. This displacement is found to depend primarily on the shape of the animal rather than the dynamics of the animal's swimming motion.

Moreover, says Katija, only a small part of the mixing comes from the mighty creatures that inhabit the deep. Most of it is due to meeker, but much more plentiful, animals -- the tiny krill, copepods, and other small critters that make up the vast majority of organisms swimming in the ocean.

The presentation, "A Darwinian mechanism for biogenic ocean mixing" by Kakani Katija and John Dabiri of the California Institute of Technology is at 11:22 a.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/110811*

5) GROOVY GOLF BALLS

In golf, balls are driven a long way up a fairway and then deposited in a cup with the fewest possible strokes. To accomplish this goal, balls are designed to experience minimum aerodynamic drag (which holding the ball back in its long flight) and adequate lift (which gives drive shots a long hang time), while allowing for a fair amount of control for putting. Golf balls generally have dimples, shallow depressions that produce air turbulence in such a way as to reduce drag and allow the ball to travel farther than perfectly smooth balls without reducing lift. Are other designs just as good?

Haecheon Choi and his colleagues at the Seoul National University in Korea are seeking the answer to this question. They scored a smooth ball with grooves in a pattern that makes it look a bit like a soccer ball. Tests showed that dimpled balls travel slightly farther than grooved balls. But grooved balls are better than dimpled balls for putting because the larger smooth surface reduces putting errors. Choi says that dimples impart an intrinsic 1-to-3-degree uncertainty in putting. This, he suggests, might be reduced with the use of grooved balls. Although Choi and his team are testing new groove configurations, ultimately golfers will decide the optimal configuration.

The presentation, "Aerodynamics of a golf ball with grooves" by Jooha Kim, Kwangmin Son, and Haecheon Choi of Seoul National University is at 11:22 a.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/111481*

6) PREDICTING THE FATE OF UNDERGROUND CARBON

One strategy for mitigating greenhouse gases is to inject compressed carbon dioxide into natural aquifers made of permeable rock soaked with brackish salt water. Carbon dioxide is less viscous and less dense than the water, and, once injected, it rises to the top of the aquifer. The permeable rock usually lies underneath a dense, impermeable "cap rock," that traps the gas deep underground for long periods of time.

Cap rocks are often tilted, however, and as the carbon dioxide rises through the aquifer, it can slip out, eventually making its way back into the atmosphere. Engineers seek to avoid leakage by mapping potential reservoirs and using theoretical tools to predict carbon dioxide flow.

Doctoral students Christopher MacMinn and Michael Szulczewski and Professor Ruben Juanes of the Massachusetts Institute of Technology have developed a new modeling methodology for determining the capacity of potential reservoirs and for assessing the risks of leakage. The tool takes into account key aspects of the underlying physics to predict the shape and pattern of flow when carbon dioxide is injected into a deep underground aquifer.

"Our new modeling tool is analytical rather than numerical, which means it incorporates the three primary physical mechanisms by which carbon dioxide is trapped in briny substrate -- structural, capillary and dissolution trapping -- into a single, comprehensive mathematical expression that can be solved quickly," says MacMinn. "This makes it possible for us to alter key parameters, such as the aquifer permeability, the fluid viscosities or the tilt of the cap rock, and within seconds, predict how the plume of carbon dioxide will migrate through the subsurface."

Before, each parameter change in a numerical model added hours or days to the time it took a computer to model discrete sections of the substrate and pull all these together into a prediction of carbon dioxide behavior under those limited circumstances. Engineers would have needed to run dozens if not hundreds of these to incorporate all the likely parameter permutations, making this an infeasible means of assessment. The hope now is that engineers and geologists may be able to use this new modeling tool to quickly and inexpensively determine whether carbon dioxide would escape from a geological reservoir.

The presentation "Post-Injection Migration of CO2 in Saline Aquifers subject to Groundwater Flow, Aquifer Slope, and Capillary Trapping" by Christopher MacMinn, Michael Szulczewski, and Ruben Juanes of the Massachusetts Institute of Technology is at 11:48 a.m. on Monday, November 23, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/111611*

7) JOURNEY TO THE CENTER OF THE EARTH, IN MARYLAND

Scientists at the University of Maryland have built a model of the Earth's interior consisting of a 3-meter-diameter outer sphere, a concentric 1-meter inner sphere, and liquid filling the space between the two spheres. Two 350-horsepower motors rotate the spheres independently around a vertical axis. With this model, similar to a smaller experiment underway in Grenoble, France, the researchers simulate the behavior of Earth's solid inner core and its fluid outer core. The Maryland team is studying the fluid dynamics of the Earth's core and hopes to learn about how the Earth's magnetic field changes over time.

In the Maryland experiment the core is modeled with an electrically-conducting fluid of liquid sodium. Although this fluid is electrically neutral overall, like the fluid core of the Earth, the sodium atoms donate electrons to a flowing electric current, which in turn produces magnetic fields.

An earlier 60-centimeter-wide model, comparable to a machine in Grenoble, France and other labs, was used for similar studies. Magnetic fields were produced in the earlier experiment, but they did not realistically mimic the fields produced inside the Earth. In the larger 3-meter apparatus, sodium has not yet been loaded in. While general mechanical tests are underway, water is being used instead. At the same time, the team has discovered that the water data is scientifically valuable.

Santiago Andres Triana, one of the model builders at Maryland, says that he and his colleagues were surprised when they initially sped up both inner and outer spheres to the same speed; the fluid in between never caught up. What they find is that the rotational axis of the fluid precesses. This subtle progression results from the fact that the whole apparatus, as well as the University and the state of Maryland are rotating around once a day. The forces set in play by this motion are analogous to the complex gravitational forces of the Moon and Sun that cause a precession of the Earth's rotational axis over a period of 26,000 years. The results of the Earth model offer practical knowledge that can be applied to the study of liquid fuel in rotating spacecraft, says Triana.

The presentation, "Precession in a laboratory model of the Earth's core" by Santiago Triana, Daniel Zimmerman, and Daniel Lathrop of the University of Maryland is at 4:01 p.m. on Monday, November 23, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/111850*

8) GENERATING ELECTRICITY FROM AIR FLOW AROUND MOVING CARS AND TRUCKS

A group of researchers at the City College of New York is developing a new way to generate power for planes and automobiles based on materials known as piezoelectrics, which convert the kinetic energy of motion into electricity.

About a half-inch by one inch in size, these devices might be mounted on the roof or tail of a car or on an airplane fuselage where they would vibrate inside a flow, producing an output voltage. The power generated would not be enough to replace that supplied by the combustion engines, but it could run some system -- such as batteries that would be used to charge control panels and other small electronic devices such as mobile phones.

Led by CCNY professor Yiannis Andreopoulos, the researchers are currently attempting to optimize these devices by modeling the physical forces to which they are subjected in different air flows -- on the roof of a car, for instance, or on the back of a truck.

When the device is placed in the wake of a cylinder -- such as on the back of a truck -- the flow of air will cause the devices to vibrate in resonance, says Andreopoulos. On the roof of car, they will shake in a much more unsteady flow known as a turbulent boundary layer. In Minneapolis, Andreopoulos and his colleagues will present wind tunnel data showing how the devices work in both situations.

"These devices open the possibility to continuously scavenge otherwise wasted energy from the environment," says Andreopoulos.

The presentation, "Harvesting energy in the wake of a circular cylinder using piezoelectric materials" by Dogus H. Akaydin, Niell Elvin, and Yiannis Andreopoulos of the City College of New York is at 8:00 a.m. on Sunday, November 22, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/110728*

The presentation, "Harvesting energy from turbulence in boundary layers by using piezoelectric generators" by Yiannis Andreopoulos, Dogus H. Akaydin, and Niell Elvin of the City College of New York is at 8:52 a.m. on Monday, November 23, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/111223*

9) RIPPING DRIPS

A new study shows that the size assortment of raindrops striking the ground comes entirely from the fragmentation of larger drops and not from the interaction among drops as they fall. Raindrops build up in size high in clouds. Eventually their weight becomes large enough and they begin to fall. Emmanuael Villermaux and his colleagues at the Aix-Marseille Universite in France have taken photographs showing the process by which these larger drops invariably fragment into tinier pieces as they fall. Typically the drops flatten out into a sort of thin film. The film then balloons. Further resistance by the oncoming air stream eventually tears the balloon to shreds, which finally constitute the shower of daughter droplets formed from the original larger drop. A plot of the numbers of drops with diameters from zero up to about 8 millimeters, shows an exponential falloff in the distribution of drop sizes. This is accounted for by the fragmentation hypothesis of droplet formation.

The presentation, "Single drop fragmentation is the source of raindrops size distribution" by Emmanuel Villermaux and Benjamin Bossa of Aix-Marseille Universite, IRPHE is at 8:52 a.m. on Monday, November 23, 2009.
Abstract: *http://meetings.aps.org/Meeting/DFD09/Event/111300*

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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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