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Compelling Research Will Flow at Fluid Dynamics Meeting: Wine swirling, heart valve action, detonating stars, and more

Baltimore, Md. – The latest news and discoveries from the science of fluid motion will be featured at the 64th Annual Meeting of the American Physical Society's (APS) Division of Fluid Dynamics (DFD), held November 20-22, 2011, at the Baltimore Convention Center near the scenic Inner Harbor section of Baltimore, Md. Researchers from around the globe will present noteworthy research covering the intricacies of flight, the workings of the human heart, the spread of disease, explosions, wine swirling, and more.

Journalists are invited to attend the meeting free of charge. Registration information is at the end of this release. Releases, meeting information, and contributions to the DFD Image and Video Galleries will be available at the Virtual News Room (*http://www.aps.org/units/dfd/pressroom/index.cfm)* approximately one week before the meeting.

The following summaries highlight a few of the meeting's many noteworthy presentations.

Highlights: Sunday, November 20

Peering inside the 'deflagration-to-detonation transition' of explosions: Explosions of reactive gases and the associated rapid, uncontrolled release of large amounts of energy pose threats of immense destructive power to mining operations, fuel storage facilities, chemical processing plants, and many other industrial applications. To gain a better understanding of what's going on during these explosions, U.S. Naval Research Laboratory research physicist Alexei Poludnenko, and Elaine Oran, senior scientist for reactive flow physics, teamed up with Sandia National Laboratories' Thomas Gardiner, principal member of technical staff, to study the deflagration-to-detonation (DDT) transition. This transition can occur in environments ranging from experimental and industrial systems on Earth to astrophysical thermonuclear supernovae explosions. Among their findings: A subsonic flame evolving in the presence of sufficiently intense turbulence can spontaneously form a detonation both in reactive gases on Earth as well as in the interior of the exploding white dwarf stars – providing a missing link for the current theoretical models of thermonuclear Type Ia supernovae. The talk, "Deflagration-to-detonation transition in unconfined media," is at 5:19 p.m. on Sunday, Nov. 20, 2011, in Room 326. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-001628.pdf.

Building Better Flapping Fliers: Flapping mini-robots that can maneuver in tight spaces could be ideal for search-and-rescue operations – for example, in collapsed buildings. However, current versions of such micro-air vehicles are "violently unstable," says fluid dynamicist Leif Ristroph of New York University. "Without some very good sensory feedback strategies, they quickly spin out of control and tumble from the air." Looking for more stable designs, Ristroph, Bin Liu of Brown University, and their colleagues analyzed the behavior of paper "bugs" of a variety of shapes (including cones, pyramids, umbrellas, and saucer-shaped UFOs) flying in a "flapping-flight wind tunnel" – a low-frequency woofer loudspeaker, turned upward, and fitted with a metallic cap and a clear cylinder in which the bugs fly; when the speaker is turned on, it shakes the air in the cylinder up-and-down, mimicking the effect of active flapping. The surprising result? Top-heavy designs are the most stable. The talk, "The importance of being top-heavy: Intrinsic stability of flapping flight," is at 3:29 p.m. on Sunday, Nov. 20, 2011, in Room 309. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-001525.pdf

How Mosquitoes Fly in the Rain: Mosquitoes are as adept at flying in rainstorms as under clear skies. That's puzzling: Why aren't the bugs – which each weigh 50 times less than a raindrop – battered and grounded by those falling drops? In fact, say David Hu, an assistant professor of mechanical engineering and biology at the Georgia Institute of Technology, and his graduate research assistant Andrew Dickerson, mosquitoes *are* hit by raindrops. Hu, Dickerson, and colleagues measured the impact forces of drops on both free-flying mosquitoes and custom-built mosquito "mimics" (small Styrofoam spheres of mosquito-like size and mass), and captured the interactions using high-speed video. The mosquitoes' low mass and speed – and thus low inertia – mean that the raindrops are largely unaffected by the collisions. Thus, the drops don't splash *on* the bugs. "The most probable impact is one that rotates the mosquito instead of pushing it vertically downward," Hu says. Indeed, Hu and company's video analysis shows that, after pushing past the mosquitoes, falling drops have lost very little speed, and in turn, mosquitoes have gained very little momentum from the collision, enabling them to continue their flight undeterred. The talk, "How mosquitoes fly in the rain," is at 2:10 p.m. on Sunday, Nov. 20, 2011, in Room 309. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-001064.pdf

Highlights: Monday, November 21

Engineers Devise Shoe Sampling System for Detecting Trace Amounts of Explosives: The ability to efficiently and unobtrusively screen for trace amounts of explosives on airline passengers would improve travel safety – without invoking the ire of inconvenienced fliers. Toward that end, mechanical engineer and fluid dynamicist Matthew Staymates of the National Institute of Standards and Technology (NIST) in Gaithersburg, Md., and colleagues have developed a prototype air sampling system that can quickly blow particles off the surfaces of shoes and suck them away for analysis. The NIST engineers developed several different versions of the system. "One particular device is a kiosk-style instrument that people step into, never having to physically remove their shoes for sampling," Staymates explains. "Air jets are located in strategic locations and used to dislodge particles from the shoe surface, and a large blower establishes a bulk flow field that ensures all liberated particles are transported in the appropriate direction." The talk, "Design and characterization of an aerodynamic shoe sampling system for screening trace explosive materials," is at 10:56 a.m. on Monday, Nov. 21, 2011, in Room 312. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-000062.pdf.

Ingredients involved in 'splashing' revealed: The sight of a droplet striking and splashing off of a solid surface is a common experience, and "splashing" plays a central role in the transport of pollutants and the spread of diseases, but the actual physical ingredients and mechanisms involved in splashing aren't all that well understood. A team of Brown University and Harvard University researchers has discovered that there is indeed more involved in splashing than previously believed. "In recent studies, it was highlighted that the surrounding air plays an important role in the splashing process. Decreasing the ambient pressure inhibits splashing," explains Julie Albagnac, a postdoctoral research associate in engineering at Brown. "The observations led to a hypothesis of the existence of a thin layer of air trapped between the drop and the surface." To better understand droplet splashing, the researchers wanted to observe and measure this layer of trapped air because splashing may occur even before actual contact of the drop on the surface, while the drop is still spreading on an air film. The splashing/spreading of a droplet doesn't seem to be an on/off situation, according to the team. A transition regime exists between the spreading and splashing, which they observed by changing either the impact velocity or the ambient pressure while the other is fixed. The talk, "Splashing or not," is at 11:35 a.m. on Monday, Nov. 21, 2011, in Room 307. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-001596.pdf

Mechanism of Wine Swirling Explained: Wine drinkers know that swirling a good vintage around in a glass aerates the wine and releases its bouquet. Just how the process – known as "orbital shaking" – works, however, has been something of a mystery. Fluid dynamicists have long observed that orbital shaking generates a wave that propagates around the inner edge of the glass, churning the liquid as it travels. "The formation of this wave has probably been known since the introduction of glass or any other kind of cylindrical bowl, but what has been lacking is a description of the physics related to the mixing and oxygenation," says Mohamed Farhat, senior scientist at the Ecole Polytechnique Federale de Lausanne in Switzerland. To figure out how the mixing occurs, Farhat and his colleagues generated such waves in clear cylinders and used state-of-the-art instrumentation to track the motion of traveling waves and measure the liquid velocity. The researchers found that "as the wave propagates along the glass wall, the liquid is displaced back and forth from bottom to top and from the center to the periphery," Farhat explains. "This pumping mechanism, induced by the wave, is more pronounced near the free surface and close to the wall, which enhances the mixing." The research team also discovered that, "for a given glass shape, the mixing and oxygenation may be optimized with an appropriate choice of shaking diameter and rotation speed," he says. The talk, "'Oenodynamic': hydrodynamics of wine swirling," is at 12:01 p.m. on Monday, Nov. 21, 2011, in Room 318. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-002246.pdf

Highlights: Tuesday, November 22

From Turbine Erosion to Supernovae: Cavitation bubbles' violent collapse gives insight into a wide range of fluid phenomena: Almost twenty-five thousand feet above the Earth's surface, on European Space Agency (ESA) parabolic flight number 42, a carefully staged fluid dynamical drama unfolds. An electrical spark in a drop of water creates a bubble of hot vapor. As the bubble rapidly expands and cools, pressure from the surrounding liquid pushes back, forcing a violent collapse. The ensuing shock waves reverberate inside the water drop, generating secondary bubbles whose implosion near the surface sends thin, hair-like jets shooting outward. It all happens in the blink of an eye, but the high-speed cameras of a research team from the Ecole Polytechnique Federale de Lausanne (EPFL) in Switzerland have for the first time captured the action with 24,000-frames-per-second precision. The formation and collapse of bubbles within fluids can be a big engineering problem. Called cavitation, the process may erode vital pieces of mechanical equipment such as turbines or propellers. Seeking to better understand the dynamics of cavitation bubbles within liquid drops, the EPFL team created this type of bubble in microgravity conditions aboard the ESA parabolic flight. The microgravity was important because it allowed the team to form nearly spherical marble-sized drops of liquid, and eliminated the additional variable of gravitational pressure. The team's results reveal high-speed jets of water and strong pressure shock waves that could indeed damage nearby surfaces. But perhaps more surprising was the way the jets that resulted from asymmetrically placed bubbles resembled images of some supernovae in binary star systems. The talk, "Bubbles in drops: from cavitation to exploding stars," is at 1:29 p.m. on Tuesday, Nov. 22, 2011, in Room 303. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-002087.pdf

New Design for Mechanical Heart Valves: The heart's valves are asymmetrical. This arrangement, says fluid mechanicist Marija Vukicevic from the University of Trieste (now a researcher at Clemson University), naturally drives blood flow along the lateral wall of the ventricle; from there, blood takes a smooth turn, creating a large vortex that redirects the blood toward the aorta (the main blood vessel of the heart), through which it exits out into the body. Mechanical heart valves, however, are symmetric in design, and that, Vukicevic and colleagues have found, disrupts the flow of blood. To see if a more natural, asymmetric design could improve blood flow, Vukicevic, along with Gianni Pedrizzetti of the

University of Trieste and colleagues created aluminum models of asymmetric valves, similar in size to the valves of an adult human heart. The valves were tested in a mock ventricle, made of silicon, through which they could visualize fluid flow. The pattern and rate of flow through the valves, the researchers found, closely matched that of a healthy heart. “We recommend that industries test asymmetric prototypes for mitral valve replacement,” Vukicevic says. The talk, “Experimental study of asymmetric heart valve prototype,” is at 3:44 p.m. on Tuesday, Nov. 22, 2011, in Room 324-325. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-000190.pdf

Robojelly Gets an Upgrade: Underwater robot learns to swim more like the real thing: Engineers at Virginia Polytechnic Institute and State University (VirginiaTech) in Blacksburg, Va., have developed a robot that mimics the graceful motions of jellyfish so precisely that it has been named Robojelly. Developed for the Office of Naval Research in 2009, this vehicle was designed to conduct ocean underwater surveillance, enabling it potentially to detect chemical spills, monitor the presence of ships and submarines, and observe the migration of schools of fish. Recently, a team at VirginiaTech has improved the performance of this silicone swimmer, enabling it to better overcome the limitations of its artificial skin and better mimic the true motion of a jellyfish. To move through the water, the natural animal uses the bell section of its body, which deforms and contracts to provide thrust. The lower, or lagging, section of the bell is known as the flexible margin, and it deforms slightly later in the swimming process than the rest of the bell. Until recently, however, Robojelly lacked this crucial piece of anatomy in its design. Villanueva and his colleagues tested a number of alternate designs for their robot, some with and without an analog to a flexible margin. They are looking to understand the effect of the flexible margin on vortex formation and subsequently on thrust production and efficiency. The talk, “Effects of a flexible margin on Robojelly vortex structures,” is at 3:05 p.m. on Tuesday, Nov. 22, 2011, in Room 324. Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-001706.pdf

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MORE MEETING INFORMATION

The 64th Annual DFD Meeting is hosted by the Johns Hopkins University, the University of Maryland, the University of Delaware and the George Washington University. Howard University and the U.S. Naval Academy are also participating in the organization of the meeting. It will be held at the Baltimore Convention Center, located in downtown Baltimore, Md. All meeting information, including directions to the Convention Center, is at: *http://www.dfd2011.jhu.edu/index.html*

USEFUL LINKS

Main Meeting Web Site: *http://www.dfd2011.jhu.edu/index.html*
Search Abstracts: *http://meeting.aps.org/Meeting/DFD11/Content/2194*
Directions and Maps: *http://www.dfd2011.jhu.edu/venuemaps.html*

PRESS REGISTRATION

Credentialed full-time journalists 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 Charles Blue (cblue@aip.org, 301-209-3091).

SUPPORT DESK FOR REPORTERS

A media-support desk will be located in the exhibit area. Press announcements and other news will be available in the Virtual Press Room (see below).

VIRTUAL PRESS ROOM

The APS Division of Fluid Dynamics Virtual Press Room will be launched in mid-November and will feature news releases, graphics, videos, and other information to aid in covering the meeting on site and remotely. See: *http://www.aps.org/units/dfd/pressroom/index.cfm*