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Contact: Charles E. Blue
(301) 209-3091

From Turbine Erosion to Supernovae: Cavitation Bubbles' Violent Collapse Gives Insight into a Wide Range of Fluid Phenomena

Baltimore, Md. – 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 team will present their findings at the 64th Annual Meeting of the American Physical Society's (APS) Division of Fluid Dynamics (DFD), held in Baltimore, Md., Nov. 20 – 22.

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.

"In the final stage of their lives [Type II supernovae] collapse under their own weight, almost as if they were empty inside," says team member Mohamed Farhat, who notes that similar processes could be at work in both the collapse of cavitation bubbles in spherical water drops and the collapse of larger spherical fluids, such as stars or gas clouds. The team is currently collaborating with supernovae researchers at Oxford University to further investigate possible parallels between the two phenomena. And while cresting the top of an arc in an Airbus A300 Zero-G plane gave team members the exciting opportunity to experience weightlessness, their new line of research returns them to a weighed down world, as they study the direct effects that gravity has on cavitation. Initial results indicate gravity itself can play a role in the formation of jets during bubble collapse, Farhat says.



The talk, "Bubbles in drops: from cavitation to exploding stars," is at 1:29 p.m. on Tuesday, Nov. 22, in Room 303.

Abstract: http://absimage.aps.org/image/MWS_DFD11-2011-002087.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 features 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>