



## Make Mine a Double-Shot, Zero-G Espresso

*Funky-looking space cups are a new option for astronauts aboard the International Space Station, allowing them to smell and enjoy hot beverages thanks to research on the behavior of fluids in space*

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For More Information:

Jason Socrates Bardi

[jbardi@aip.org](mailto:jbardi@aip.org)

240-535-4954

@jasonbardi

WASHINGTON, D.C., November 23, 2015 -- Would you rather slurp coffee from a bag or sip it from a cup?

Sometimes the little things in life can make all the difference -- and when you are in orbit above the planet Earth, like the crew aboard the International Space Station, this is especially true. Did you know that astronauts are accustomed to drinking beverages from bags due to safety concerns over spillage?

So you can imagine how six funky-looking cups crafted from a 3-D printed transparent polymer are making spending time in space a more enjoyable experience.

Astronauts' responses when testing out the cups so far range from "Hey, you can smell the coffee," to "This is eerily like drinking on Earth." Or the cup simply elicits happy eruptions of laughter because the astronauts readily confess they hadn't expected it to work.

Last year, it was big news when Italy sent an espresso machine up to the Space Station for Samantha Cristoforetti, an Italian European Space Agency astronaut. This, of course, inspired a team of researchers to study the related strange fluids phenomena in low gravity -- such as espresso crema formation and settling, capillary interfaces, and containment of potentially hazardous drinks within a spacecraft.

To do this, the researchers designed a cup that exploits surface tension as opposed to gravity and, during the American Physical Society's 68<sup>th</sup> Annual Meeting of the Division of Fluid Dynamics, Nov. 22-24, 2015, in Boston, Mass., they'll present their findings about how it's working out aboard the Space Station.

The cup works so well that the crew is able to cruise around, do flips, and even toss them back and forth -- while drinking beverages such as fruit juice, fruit smoothies and coffee.

"Wetting conditions and the cup's special geometry create a capillary pressure gradient that drives the liquid forward toward the face of the drinker," explained Mark Weislogel, one of the team members who is a senior scientist for IRPI LLC, an Oregon-based R&D and consulting firm specializing in fluid-thermal engineering, as well as a professor of mechanical engineering at Portland State University.

Unlike drinking a beverage from a bag, "your nose is closer to the beverage, which makes it easier to actually smell it while drinking," he added. "An astronaut can drain the cup in sips or one long gulp in much the same manner as on Earth ... without tipping their head, without gravity. It's a stable situation -- even though drinking scalding liquids from open containers while aboard the International Space Station is generally considered a safety concern."

Of the six cups currently aboard the Space Station, five hold 150mL, while the sixth is a 60mL demitasse specifically intended for espresso. The cups are complexly shaped and demonstrate that specific control of liquids can be maintained in low-gravity environments -- but with completely different fluidics principles at play than on Earth.

"We're enjoying watching the astronauts have fun, but also collecting plenty of data on large capillary interface configurations, stability, flow rates, transients, etc.," said Weislogel. "We've received great support for this project from U.S. astronauts Scott Kelly and Kjell Lindgren, and Japanese astronaut Kumiya Liu."

Since this is a microgravity fluids experiment, if the team "is able to design spacecraft fluids systems with the same confidence as for a terrestrial system, we'll be in a great position to succeed in more complex missions in space with greater performance and security," Weislogel noted.

The next step for the team is to apply their knowledge of low-gravity capillary fluidics phenomena to design more reliable life-support systems for the Space Station and future spacecraft.

"Management of water, liquid fuels, coolants, and even drinks, when the influence of gravity is negligible, is a delightful challenge," added Weislogel. "If this can be accomplished passively, without moving parts, by special control of wetting properties, container shape, and surface tension, we're all in. We love watching and studying the large liquid surfaces that can dominate fluid behavior in space. And if astronauts are enjoying their coffee in a richer, deeper manner than before ... well, that's nice too."

Presentation #L28.4, "Drinking in Space: The Capillary Beverage Experiment," is authored by Andrew Wollman, Mark Weislogel, Ryan Jenson, John Graf, Donald Pettit, Scott Kelly, Kjell Lindgren and Kimiya Yui. It will be at 4:44 p.m. on Monday, Nov. 23, 2015 in room 309 of the Hynes Convention Center in Boston, Mass.

ABSTRACT: <http://meetings.aps.org/Meeting/DFD15/Session/L28.4>

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#### **MEETING INFORMATION**

The 68th Annual Division of Fluid Dynamics Meeting will be held at Hynes Convention Center in Boston, Mass. from Nov. 22-24, 2015. More meeting information: <https://apsdfd2015.mit.edu/>

#### **REGISTERING AS PRESS**

Any journalist, full-time or freelance, may attend the conference free of charge. Please email: <[jbardi@aip.org](mailto:jbardi@aip.org)> and <[dfdmedia@aps.org](mailto:dfdmedia@aps.org)> and include "DFD Press Registration" in the subject line.

#### **ONSITE AND ONLINE PRESS ROOMS**

Workspace will be provided on-site during the meeting. The week before the meeting, news, videos and graphics will be made available on the Virtual Press Room: <http://www.aps.org/units/dfd/pressroom>

#### **LIVE MEDIA EVENT**

A press briefing featuring a selection of newsworthy research talks will be streamed live from the conference at 1:00 p.m. ET on Monday, Nov. 23. For more information, email [jbardi@aip.org](mailto:jbardi@aip.org).

#### **ABOUT THE APS DIVISION OF FLUID DYNAMICS**

The Division of Fluid Dynamics (DFD) of the American Physical Society (APS) 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. DFD Website:  
<http://www.aps.org/units/dfd/index.cfm>

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Mark Weislogel  
markmweislogel@gmail.com

**Image captions:**

1. Italian ESA astronaut Samantha Cristoforetti enjoying a beverage in a special demitasse espresso cup designed for low-gravity conditions aboard the International Space Station.
1. NASA/AP Photo
2. This space cup operates via siphon action.