Espresso in space

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This espresso space cup was specifically designed for the low-gravity environment aboard the International Space Station.

Espresso-loving astronauts, rejoice! You may soon be able to enjoy your beloved beverage in space, thanks to a new cup designed specifically to defy the low-gravity environments encountered aboard the International Space Station (ISS).

Italy is preparing to send an espresso machine to the ISS, and so a team of researchers crafted a special cup to allow astronauts to drink in space in a manner similar to the one experienced on Earth—by replacing the role of gravity with the forces of surface tension. (Leave it to researchers in caffeine-loving Portland, Ore. to come up with that idea.)

During the American Physical Society's Division of Fluid Dynamics (DFD) Meeting, Nov. 23-25, 2014, in San Francisco, Calif., Nathan Ott, a high school student working with Mark Weislogel, a professor in the Thermal and Fluid Sciences Group at Portland State University, and Drew Wollman, a researcher within that same group, will describe studying and working with a variety of capillary fluidic effects to enable espresso in gravity-free environments.

Espresso, for those unfamiliar with it, is distinguished primarily by a complex low-density colloid of emulsified oils. And, due to gravity, these oils rise to the surface to form a foam lid called the "crema"—the reliable production of which can make or break the reputations of baristas everywhere.

"Because the variety of espresso drinks is extensive, we made specific property measurements to assess the effects of wetting and surface tension for 'Italian' espresso, caffè latte and caffè Americano," explained Weislogel. "For some people, the texture and aromatics of the 'crema' play a critical role in the overall espresso experience. We show that in low-gravity environments this may not be possible, but suggest alternatives for enjoying espresso aboard spacecraft."

This quest for alternatives led to the design of the special 3-D printable "espresso space cup," which thankfully "fell from math."

"The shape of the container can passively migrate fluid to desired locations without moving parts—using passive forces of wetting and surface tension," said Weislogel. "Its geometry is the 'smart' part, which operate the fluids-control system without requiring pumps or centrifugal forces."

The primary challenge of the design, according to Weislogel, is making it work for a wide variety of poor wetting conditions which are typically associated with water-based beverages. "Fortunately, espresso is considered an oily drink, which means that it works nicely," he added.

Now that Weislogel and colleagues have demonstrated control guided by math, rapid 3-D printing and rapid drop tower tests to confirm the cup's performance in low-gravity environments, their methods will advance technology readiness levels for spacecraft—while reducing the need for costly tests in space. "This process almost ensures desired performance the first time the device is used in space," he said.

Their work also has a much wider reach beyond espresso. "We're striving to use our new methods to reassess all fluid systems aboard spacecraft—including cooling systems, fuel tanks, water processing equipment for life support, plant and animal habitats, medical fluids, foods, etc.," noted Weislogel.

It's an exciting time because tools are readily available now to design advanced equipment for use in space with far greater reliability than previously possible. "The era of the ISS is the perfect time to develop and demonstrate these tools as we continue to explore our solar system," Weislogel said.

More information: meetings.aps.org/Meeting/DFD14/Session/L2.8

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