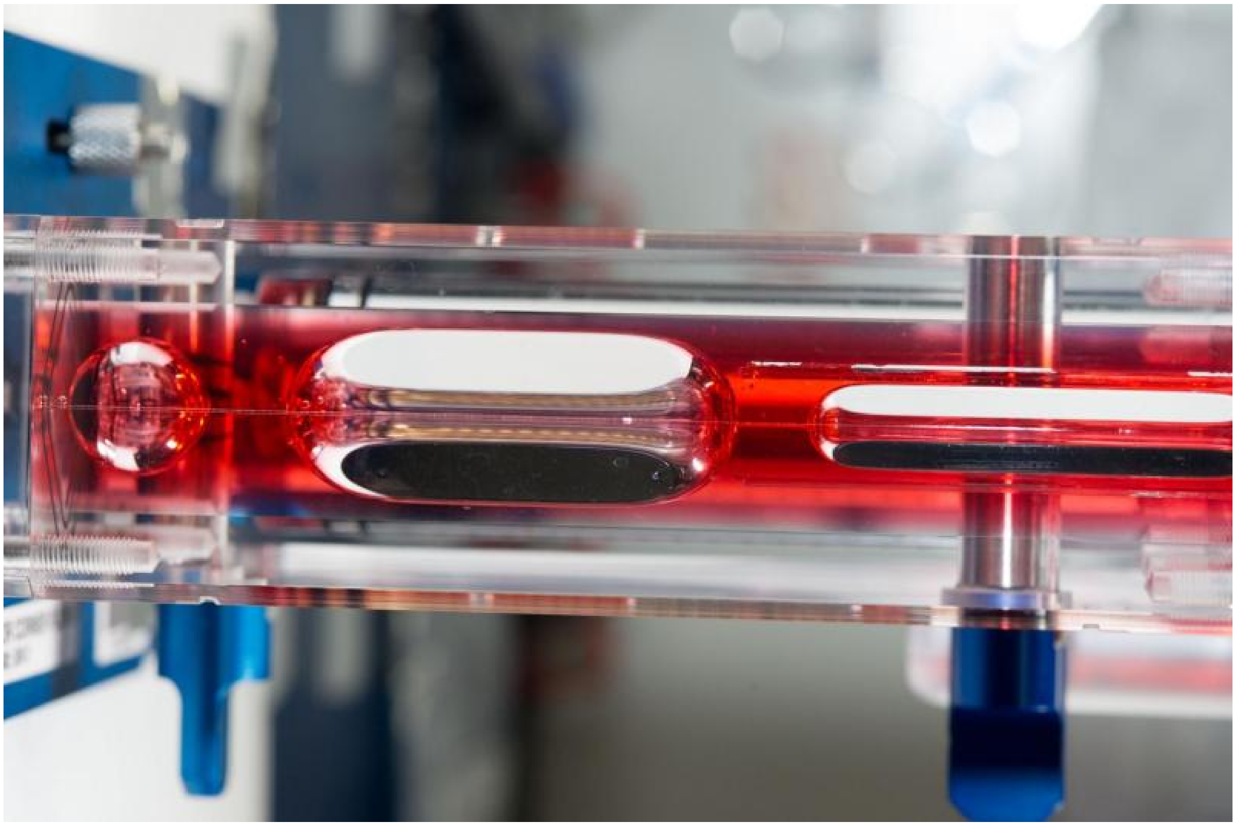
From fluids to flames, research on the space station is helping advance technology

August 19 2015, by Bill Hubscher



A view of a Capillary Flow Experiment (CFE) vessel was set up during a test run on the International Space Station. This investigation researches a liquid's ability to spread across a surface, and its impact in larger and various container shapes in microgravity environments. This work will improve our ability to quickly and accurately predict how related processes occur, allowing us to design better fuel tanks and water processing systems for life support. Credit: NASA

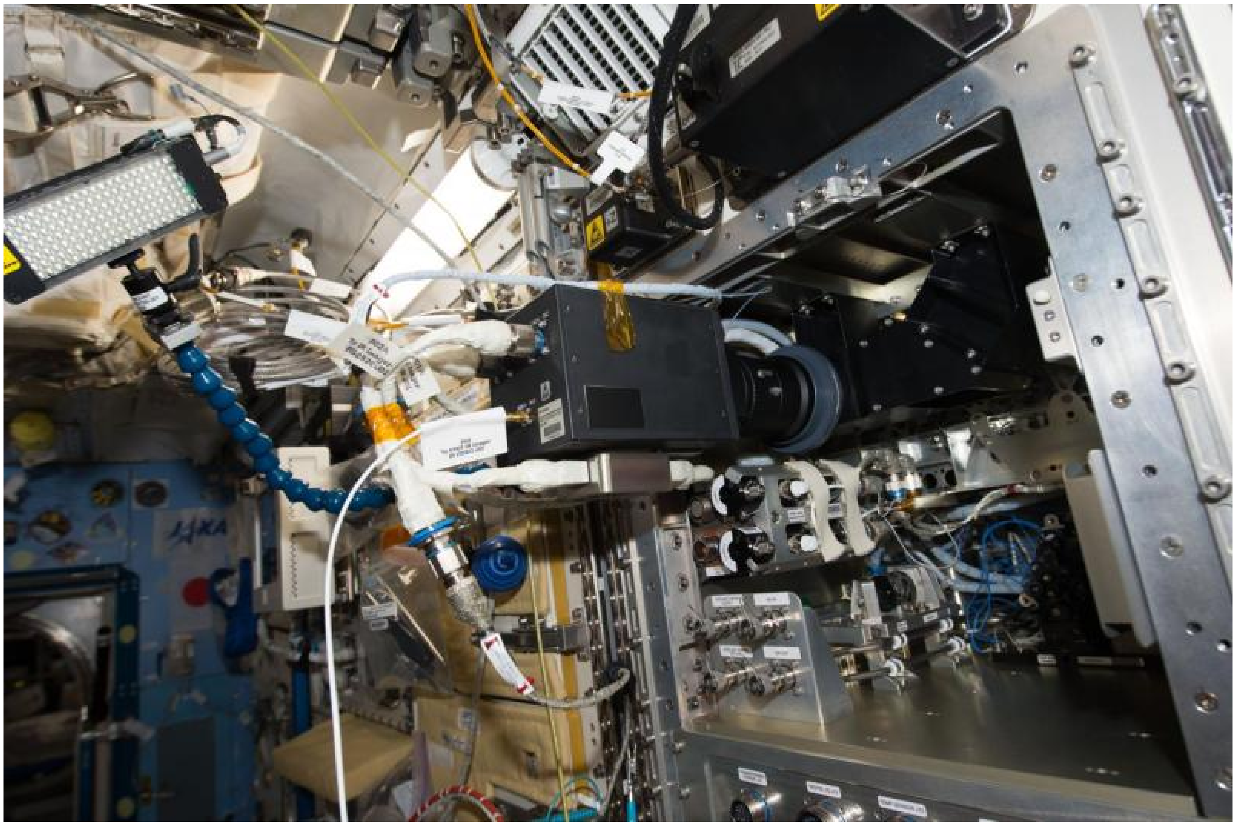
The International Space Station enables technological advances that benefit the planet and people who live on it. The new ISS Benefits for Humanity 2015 book highlights the contributions of this unique science laboratory orbiting more than 200 miles above Earth.

One of the studies explored the finer points of fluid dynamics, something that is experienced across the planet, but cannot quite be studied as carefully on Earth.

Fluid is everywhere in our lives, from the oceans and the molten core of our planet to the fuel in our vehicles and blood in our veins. A phenomenon called Marangoni convection is one of the fundamental principles of liquid motion and is revealed much more clearly in microgravity.

Marangoni convection is the tendency for heat and mass to travel in areas of higher surface tension within a liquid. To learn how heat is transferred in space, researchers suspend a silicone oil bridge between two small solid discs, one of which is slowly heated to cause convection. Scientists observe the flow patterns to learn how heat is transferred in microgravity, an effect that gravity masks on Earth. Understanding the physics of this convection will improve research in high-quality crystal growth, such as crystals used for semiconductors and optics, and in various micro-fluid applications, such as DNA examination on the space station and on Earth.

Another fluid study on the orbiting laboratory could lead to a low-energy medical device with enormous public health benefits. Capillary flow, also known as wicking, is the ability of a liquid to flow without the assistance of gravity and other external forces. For example, a paper towel will draw, or wick, liquid into it without having to move closer to the source. In the absence of gravity, the effect of capillary forces is more dramatic. The station's Capillary Flow Experiment (CFE) is a basic physics investigation that refined our understanding of how capillary action helps fluids flow.



The Japan Aerospace Exploration Agency's (JAXA) Dynamic Surf investigation is looking in to a phenomenon called Marangoni convection -- one of the fundamental principles of liquid motion which is revealed much more clearly in microgravity. Understanding the physics of this convection will improve research in crystals used for semiconductors and optics, and in DNA examination on the space station and on Earth. Credit: NASA

This principle can be applied to many fluid-handling systems, from fuel tanks to cooling systems to medical devices. A device currently in development will rely on the principles of capillary flow to use less energy and provide medical professionals with a valuable tool in diagnosing infectious diseases onsite in remote areas with limited resources. With onsite diagnosis and the reduced need for energy, less time would be needed between identifying diseases like HIV/AIDS or tuberculosis for beginning treatment.

A technology of tiny elements studied on the station could have applications in everything from braking systems and robotics to earthquake-resistant bridges and buildings. Investigating the Structure of Paramagnetic Aggregates from Colloidal Emulsions (InSPACE) is a set of experiments that is gathering fundamental data about Magnetorheological (MR) fluids. They are a type of smart fluid that tends to self-assemble into shapes when exposed to magnetic fields.

MR fluids change viscosity in a magnetic field and can even be made to change their arrangement at the nanoscale level, or one billionth of a meter. Such tiny distances are typical for molecules and atoms. When exposed to magnetic fields, MR fluids can quickly transition into a nearly solid state. When the magnetic field is removed, the MR fluids return to a liquid state. This process produces useful properties that can be harnessed for a variety of mechanical devices, from robotic motions to strong braking and clutch mechanisms.

From molecular to the global, a technology originating in orbit could reduce the problems of lost phones and running late for appointments. The Global Transmission Services 2 (GTS-2) investigation demonstrated that radio transmissions could be used to synchronize Earth-based clocks and watches and, eventually, to locate stolen cars and deactivate lost credit cards directly from space.

NASA astronaut Karen Nyberg works with the InSPACE-3 experiment in the Microgravity Science Glovebox (MSG) on the International Space Station. InSPACE-3 applies different magnetic fields to vials of colloids, or liquids with microscopic particles, and observes how fluids can behave like a solid. Results may lead to improvements in the strength and design of materials for stronger buildings and bridges. Credit: NASA

An antenna on the station currently transmits Coordinated Universal Time, also known as Greenwich Mean Time. These transmissions cover almost the entire Earth and can be received at a particular location several times daily. The signal is strong enough for small wristwatches to receive, and transmits accurate local time for different time zones, even taking into account daylight savings time.

The system's ground receivers accurately determine the position of the space station based on its transmission of signals. This ability could be used in reverse to determine the location of a receiver from the station; a capability that one day might enable an orbiting spacecraft to navigate a ground vehicle on a planet below.

A unique test facility for droplet combustion research on the space station could provide technology for better mileage and a very real possibility of reduced pollution on Earth. The Flame Extinguishing Experiments study (FLEX and FLEX-2) is revealing new insights into how fuel burns. Recent results of the FLEX investigations revealed a never-before-seen, two-stage burning event. While a heptane droplet of fuel appeared to extinguish, it actually continued to burn without a visible flame. Improved prediction of flame behavior during combustion could inform methods to reduce pollution and get better fuel mileage in engine design.

Thanks to the reduced gravity environment of the space station, we have new insights into multiple scientific disciplines. By investigating how new technologies operate in space, unexpected discoveries are possible, improving the quality of life for millions of people on Earth.

Provided by NASA

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