Researchers take exploration of key 'building block' particles into space

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New zero-gravity experiments at the International Space Station may offer fresh insight into a class of fine particles that make up materials and products we see every day — from milk, ink and cosmetics to electronics and 3D print technology. Credit: NASA

As part of SpaceX's CRS-19 resupply mission to the International Space Station (ISS) launched Dec. 5, researchers from NASA, New Jersey Institute of Technology (NJIT) and New York University (NYU) are set to begin a new scientific investigation to explore how a group of

microscopic particles considered key "building blocks" for materials and products here on Earth, known as colloidal particles, behave and form in zero-gravity.

The team's experimental payload of colloidal samples, which officially docked at the station Dec. 8, will be used to study for the first time what happens when colloidal particles are exposed to temperature changes in the absence of gravity under spaceflight conditions during a series of experiments to be conducted later this year, titled "Advanced Colloids Experiment (Temperature controlled) - ACE-T11."

Researchers say the ACE-T11 zero-gravity experiments offer a unique opportunity to learn new information about the fundamental physics driving the way in which colloidal particles disperse and remain suspended in mediums such as liquids to change their properties—potentially opening new doors in the field of "colloidal engineering" that may aid the manufacture of next-generation materials and products to improve daily life, as well as the success of future long-range flight missions in space.

"The experimental data we collect in the ISS will enable us to rigorously test and validate theories for phenomena underlying structure formation in colloids in a way that has never been done before," said Boris Khusid, NJIT professor of chemical and materials engineering and the study's principal investigator. "Through the ACE-T11 experiments, we are excited to learn the influence of various forces affecting the motion of colloidal particles, which could drastically shorten the design cycle times of apparatuses and processes for a broad range of current and future terrestrial and space applications."

Colloids are a system of nanometer-sized objects suspended in any combination of gas, liquid or solid mediums, and are one of three major types of mixtures along with solutions and suspensions. Common

examples of colloids include fog or mist when liquid droplets are dispersed in gas mediums, or smoke and dust when solid colloidal particles are dispersed in gas. Recently, guided manipulation of colloids has become a widespread means for manufacturing functional materials in electronics, photonics, life science, chemical industries, and recently, 3-D printing.

While the way in which various crystalline, liquid and glassy colloid structures form has often been studied on Earth for advancing such engineering applications, previous research has been limited partly due to influence of undesirable gravity-driven processes, such as particle sedimentation or jamming.

In a controlled, microgravity environment at the ISS, these particles will move 100,000 times slower with respect to one another than they would back on Earth, making them easier to study. The team will use spherical colloidal particles tagged with a fluorophore that were synthesized at NYU and high-resolution confocal microscopy at the station to observe how the particles dispersed in liquid synchronize their motion to form a repeating pattern as they are gradually introduced to increasing and decreasing temperatures.

According to NASA, the experiments—which will be remotely operated from the NASA Glenn Center Control Room—could enhance the way astronauts produce materials on future space missions, potentially having "huge implications for high-resolution 3-D printing because they may expand the number of materials that can be used to make 3-D printed objects."

"The ultimate goal is to elucidate 'how order comes spontaneously from disorder' by visualizing how these individual particles spontaneously form a crystal-like regular, repeating pattern that stays ordered even when they are brought back to Earth's gravity," said Khusid. "The results

of the experiments could advance the development of a strategy for control and manipulation of colloids at the unique ISS platform for 3-D printing of materials that cannot be replicated by terrestrial manufacturing."

SpaceX's 19th commercial supply mission was launched on the SpaceX Falcon 9 rocket and carried aboard the Dragon spacecraft from Space Launch Complex 40 at Cape Canaveral Air Force Station in Florida. The ACE-T11 experiments are among the mission's 2,600 kg of supplies and payloads that include critical materials to directly support dozens of the more than 250 science investigations and technology demonstrations planned during Expeditions 61 and 62 at the ISS.

Provided by New Jersey Institute of Technology

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