National Aeronautics and Space Administration

Glenn Research Center
Cleveland, Ohio

Physics of Colloids in Space: Glenn Research Center's First Fluid Physics Payload on the International Space Station

The Physics of Colloids in Space (PCS) investigation is to be conducted in an EXPRESS (**EX**pedite the **PR**ocess of **E**xperiments to **S**pace **S**tation) Rack within the U.S. Laboratory Module (Destiny) on the International Space Station from flight 6A (April 2001) to flight UF–2 (March 2002). This experiment will gather data on the basic physical properties of colloids by studying three different colloid systems with the objective of understanding how they grow and behave, and with the long-term goal of learning how to steer their growth in order to create new materials.

This experiment was conceived by David Weitz of Harvard University along with Peter Pusey of the University of Edinburgh. The investigation is managed by Mike Doherty of the Microgravity Science Division at NASA Glenn Research Center and is supported by the NASA Marshall Space Flight Center Microgravity Research Program Office and NASA Headquarters Office of Life and Microgravity Science and Applications.

A colloid is a system of fine particles suspended in a fluid. Such varied systems as aerosols, foams, paints, pigments, cosmetics, milk, salad dressings, and biological cells are common examples of colloidal dispersions or suspensions. Though these products are routinely produced and used, scientists still have much to learn about the underlying properties of colloidal systems, knowledge which could lead to improvements in the processing and performance of everyday products. Also, a deeper understanding of the properties of colloids may enable scientists to manipulate the physical structures of colloids—a process called "colloidal engineering" for the manufacture of completely new materials and products.

Figure 1. Binary colloidal alloy.

The experiment will focus on the growth and behavior of three different classes of colloid mixtures of tiny manmade particles of either polymethyl methacrylate (PMMA) or silica or polystyrene; these will include samples of binary colloidal crystal alloys, samples of colloid-polymer mixtures and samples of colloidal gels. Binary colloidal crystal alloys are dispersions of two different size particles in a stabilizing fluid (figure 1). Colloid-polymer mixtures are solutions of mono-disperse particles mixed with a nonadsorbing polymer in a stabilizing fluid, where the phase behavior—solid, liquid, and gas—is controlled by the concen-tration of the polymer. Colloidal gels include aqueous solutions of particles, in this case aggregated on-orbit with a salt solution, to form fractal structures. The structure, stability, and equilibrium properties of all the samples, as well as their structure, dynamics, and mechanical properties, will be studied.

The PCS experiment hardware is composed of an avionics unit and a test section unit, accommodated side-by-side in an EXPRESS Rack (figure 2). The PCS hardware relies on the EXPRESS Rack systems for power, cooling, and communication (for data and commanding from the ground). The avionics section provides the power distribution, data acquisition and processing, and command and data communication for the experiment. The test section is a sealed enclosure assembly that houses all diagnostic components and eight colloid samples in a rotating carousel (figure 3). The carousel and rotary stage position any of the eight samples into the three diagnostic stations. Two of the stations are for visual imaging; one is a full sample view and the other is a magnified view. The third station is for laser light-scattering diagnostics. The samples scatter light at different degrees of intensity and positions based on the type and size of structures formed. To enable the light scattering and the visual imaging, the samples are contained in a glass optical sample cell (figure 4), which supports low-angle and Bragg-scattering imaging via digital video cameras, as well as dynamic and static light-scattering via Avalanche Photo Diodes (APD's).

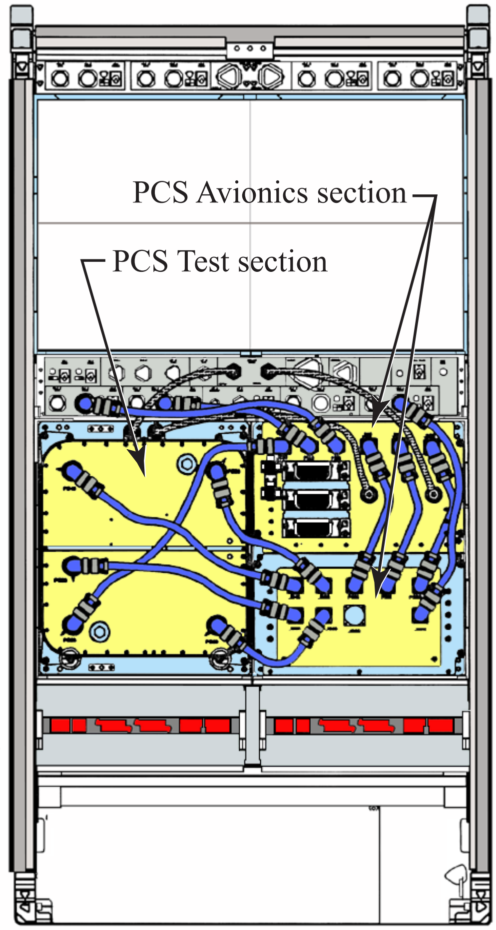

Figure 2. PCS in EXPRESS Rack.

Experiment operations consist of mixing the colloid samples to eliminate any sedimentation and to produce a uniform distribution of particles in the solution. Once mixed, the particles will begin to crystallize and the diagnostic measurements are initiated. The measurements are taken for each sample periodically (a few times each week) over several months on-orbit. The diagnostic data will provide growth information, the shape of the structures formed, and other physical properties of the structures.

The experiment will be operated remotely from the NASA Glenn Research Center's Telescience Support Center in Cleveland, Ohio, and at an established remote site at Harvard University in Cambridge, Massachusetts. The two locations will permit daily operation of the experiment. Data will be stored on-orbit on removable hard drives with portions of the data transmitted in real time to ground stations.

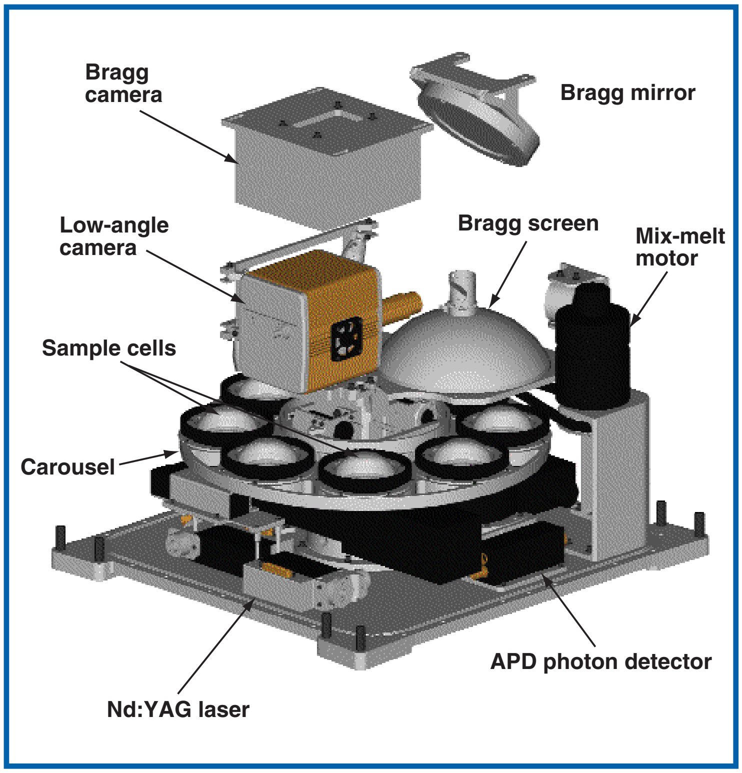

Figure 3. Test section internals.

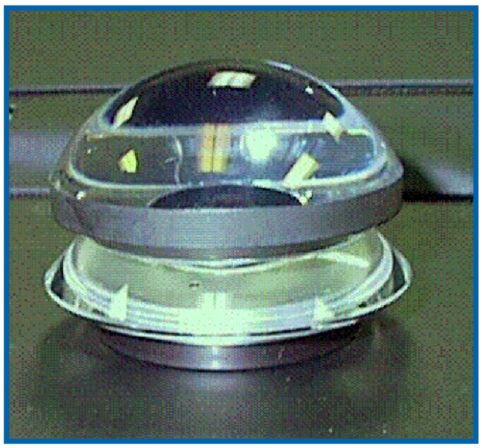

Figure 4. Optical sample cell.

Complete diagnostic data files can be downlinked at the conclusion of a day's operations when Space Station resources are available. These data will be analyzed to determine the sample growth status and used to evaluate and plan future experiment runs.

Upon completion of the experiment, the test section, avionics sections, and PCS stowage items are transferred to the space shuttle for the return trip to Earth.

The engineering, design, development, and operations of the Physics of Colloids in Space is being performed under NASA contract NAS3-99154 (Zin Technologies).

For more information, visit the
NASA Glenn Physics of Colloids in Space Website at
http://microgravity.grc.nasa.gov/6712/PCS.htm

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