Two U.S. Experiments to Fly Aboard European Spacelab Facility in 1996

Space provides researchers a way to study the behavior of fluids when the forces of gravity are removed. The studies described here involve international cooperative research projects to study various aspects of fluid behavior in a microgravity environment. These projects utilize the Bubble Droplet Particle Unit (BDPU), which was built by the European Space Agency's (ESA) Technology Center in Noordwijk, The Netherlands. This Spacelab-based multiuser facility flew for the first time in July 1994 on the second International Microgravity Laboratory (IML-2). It is scheduled for reflight on the Life and Microgravity Sciences (LMS) mission in June 1996. This experiment hardware was designed primarily to conduct fluid physics experiments with transparent fluids. LMS will fly both European and U.S. investigations including experiments defined by Professor R.S. Subramanian of Clarkson University in Potsdam, New York, and Professor S.A. Saville of Princeton University, Princeton, New Jersey.

Professor Subramanian's experiment (a reflight from IML-2), *Thermocapillary Migrations and Interactions of Bubbles and Drops*, will study the bubble's (or droplet's) velocity and shape as it travels (or migrates) through another fluid that has a linear temperature distribution. During the experiment, local temperature gradients around the bubble will impose a surface tension gradient on the bubble interface and produce motion in the interface film. This motion will cause a jetting action that will propel the bubble toward the relatively hotter areas of the surrounding fluid. The LMS experiments will emphasize bubble (and droplet) pair interactions and different fluid combinations to expand the knowledge gained from the IML-2 experiment. The microgravity environment will isolate the thermocapillary phenomena from the normally dominant effects of buoyancy and natural convection on Earth. Results from these types of experiments have applications on Earth in ceramic and glass formation, as well as in metal and alloy solidification. Better understanding of these thermocapillary effects can lead, as well, to superior bubble management techniques for space-based crew life-support systems.

Professor Saville's experiment, *Studies in Electrohydrodynamics*, looks at the stabilizing effects of high-voltage electric fields on liquid columns. Liquid columns of a given length-to-diameter ratio will be established in microgravity and exposed to various electric field strengths. In the absence of an electric field, these columns will deform into increasingly amphoric shapes and eventually pinch off. The main scientific points of interest to be studied when the electric field is applied will be to determine what minimum electric field strengths are needed to maintain cylindrical columns and what minimum field strengths are required to prevent pinch off. Liquid columns in gas, as well as columns in other immiscible liquids, will be studied.

Long-term microgravity is particularly needed to study liquid columns that are surrounded by a gas. The liquid-in-liquid cases will be compared with similar ground-based experiments. These ground-based tests were done in a simulated low gravity for which the two liquids were density matched. Liquid-gas cases have the advantage of being

significantly easier to analyze because of simpler boundary conditions. Applications of improved models and theory from these experiments are expected in processes that involve liquid columns. These processes may, then, be improved through the use of electrohydrodynamics effects. Examples of these processes include fiber spinning, crystal growth, and liquid jets (e.g., for printers).

The Bubble Droplet Particle Unit facility and its various principal-investigator-specific test containers were designed and constructed under the European Space Agency's Technology Center management by various European-based contractors. NASA Lewis Research Center's function is to assist in the design and flight operations of the two U.S. Bubble Droplet Particle Unit experiments.