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MULTIPHASE FLOW AND PHASE CHANGE IN MICROGRAVITY: FUNDAMENTAL RESEARCH AND STRATEGIC RESEARCH FOR EXPLORATION OF SPACE

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ABSTRACT

NASA is preparing to undertake science-driven exploration missions. The NASA Exploration Team's vision is a cascade of stepping stones. The stepping-stone will build the technical capabilities needed for each step with multi-use technologies and capabilities. An Agency-wide technology investment and development program is necessary to implement the vision. The NASA Exploration Team has identified a number of areas where significant advances are needed to overcome all engineering and medical barriers to the expansion of human space exploration beyond low-Earth orbit. Closed-loop life support systems and advanced propulsion and power technologies are among the areas requiring significant advances from the current state-of-the-art. Studies conducted by the National Academy of Science's National Research Council and Workshops organized by NASA have shown that multiphase flow and phase change play a crucial role in many of these advanced technology concepts. Lack of understanding of multiphase flow, phase change, and interfacial phenomena in the microgravity environment has been a major hurdle. An understanding of multiphase flow and phase change in microgravity is, therefore, critical to advancing many technologies needed.

Recognizing this, the Office of Biological and Physical Research (OBPR) has initiated a strategic research thrust to augment the ongoing fundamental research in fluid physics and transport phenomena discipline with research especially aimed at understanding key multiphase flow related issues in propulsion, power, thermal control, and closed-loop advanced life support systems. A plan for integrated theoretical and experimental research that has the highest probability of providing data, predictive tools, and models needed by the systems developers to incorporate highly promising multiphase-based technologies is currently in preparation. This plan is being developed with inputs from scientific community, NASA mission planners and industry personnel.

The fundamental research in multiphase flow and phase change in microgravity is aimed at developing better mechanistic understanding of pool boiling and ascertaining the effects of gravity on heat transfer and the critical heat flux. Space flight experiments conducted in space have shown that nucleate pool boiling can be sustained under certain conditions in the microgravity environment. New space flight experiments are being developed to provide more quantitative information on pool boiling in microgravity. Ground-based investigations are also being conducted to develop mechanistic models for flow and pool boiling.

An overview of the research plan and roadmap for the strategic research in multiphase flow and phase change as well as research findings from the ongoing program will be presented.

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