Paper ID: 23045
oral

MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Sciences Onboard the International Space Station and Beyond - Part 1 (6)

Author: Dr. Satoshi Matsumoto
Japan Aerospace Exploration Agency (JAXA), Japan

Prof. Shinichi Yoda
Japan Aerospace Exploration Agency (JAXA), Japan

VELOCITY AND TEMPERATURE FIELDS OF THERMOCAPILLARY CONVECTION IN LIQUID BRIDGE UNDER MICROGRAVITY CONDITION

Abstract

Marangoni convection is a surface-tension-driven flow which driving force is localized at the only surface. In general, surface tension becomes high with decreasing temperature. When a temperature difference exists along surface, the surface is pulled toward low temperature region and convection in liquid occurs. It is well known that the flow of fluid transits from laminar to oscillatory, chaotic, finally turbulence due to convective instabilities which is the interesting root principles of fluid motion. Whether or not, there is "universality" to the phenomenon among several types of flow. If not, what is "singularity"? This is the fundamental question in fluid dynamics. We address the wonder of transition on Marangoni convection which is revealed in an absence of gravity. In order to observe internal flow of Marangoni convection experimentally, the ultrasonic velocity profiler (UVP) was employed. The ultrasonic transducers were embedded in liquid bridge supporting rod. An ultrasonic bust wave with 8 MHz frequency is emitted at the tip of transducers into liquid bridge. Large diameter liquid bridge is needed to equip the transducers. The liquid bridge of 50 mm diameter was used. A working fluid was silicone oil of 5 mm2/s viscosity, which Prandtl number is 68. Microgravity condition is needed to form the large liquid bridge, and so the International Space Station (ISS) is utilized. Liquid bridge is suspended between a pair of solid disks (50 mm in diameter). The length of liquid bridge is variable up to 62.5 mm. Small amount of fine particles (30 μm in diameter) is mixed into liquid bridge for flow visualization. With increasing the temperature difference, the convection becomes more complicated after the transition from laminar to oscillatory flow, finally chaotica and trubulant flow would appear. These transition processes are observed in detail. We employ Fluid Physics Experiment Facility (FPEF) mounted in Ryutai Rack inside KIBO Pressurized Module. Experiment is conducted in combining FPEF and an experiment unique hardware which is exchangeable according to the purpose of investigation and is called "Experiment Cell". We characterize several flow patterns by using UVP and temperature fluctuation near the free surface. The transition process to a turbulent flow can be detected when Marangoni number becomes greater than 175000.