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STUDY ON THE VOLUME RATIO EFFECT AND TRANSITION PROCESSES OF THERMOCAPILLARY CONVECTION IN AN OPEN ANNULAR LIQUID POOL ABOARD A RECOVERABLE SATELLITE

Abstract

Thermocapillary convection is one of the most important research topics in microgravity fluid physics. A space experimental study on the thermocapillary convection in an open annular liquid pool has been conducted on the SJ-10 satellite of China. Oscillations of thermocapillary convection in an annular pool is investigated when the difference in temperature exceeded a certain threshold. The shape effects on the flow instability is researched by changing the volume ratio, Vr, which denotes the ratio of the liquid volume to the volume of the cylindrical gap between the walls. Under a certain volume ratio, the flow pattern will transform from the steady state to the oscillation state accompanied with directional propagating hydrothermal waves with the increasing of the temperature difference. The nonlinear dynamics of travelling waves, standing waves, and counter-propagating waves is studied. The standing wave appears near the onset of convection and transitions to the travelling wave. With a similar mechanism, counter-propagating waves with m=3 and m=4 occur in some cases at the onset. Additionally, counter-propagating waves also act as a transitional mode when the travelling wave transitions from m=4 to m=3. The travelling wave is very stable, but it develops to standing waves or Benjamin-Feir instability under highly supercritical conditions.

Key words: space experiment, transition process, volume ratio (Vr), standing wave, travelling wave, bifurcation