IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Fluid and Materials Sciences (2)

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THE ACTION OF SPATIAL HEAT RELEASE MODULATION AT THE INTERFACE ON NONLINEAR FLOWS IN TWO-LAYER SYSTEMS

Abstract

The interfacial convection in liquid layers has been extensively studied in the past few decades, due to its importance in microgravity engineering and microfluidics. Several classes of instabilities have been found by means of the linear stability theory for purely thermocapillary flows and for buoyant-thermocapillary flows. There are various physical phenomena that can be the origin of a heat release or heat consumption at the interface. For example, the interfacial heat release accompanies an interfacial chemical reaction and the heat sink can be caused by evaporation. An important problem is controlling the development of instability. A possible way of controlling the pattern selection is a spatial modulation of the control parameter, which can simplify the dynamics and make it more predictable. In the present work, we consider nonlinear flows in the 47v2 silicone oil-water system under the action of a spatial modulation of the heat release/consumption at the interface. Periodic boundary conditions on lateral walls, corresponding to laterally infinite two-layer system are considered. Numerical simulations are performed by means of a finite-difference method. It is found that the spatial heat release modulations can lead to the development of new nonlinear regimes. Specifically, it is shown that in the case of heat sinks, the spatial modulation can lead to the appearance of pulsating traveling waves moving in one direction (from the right to the left-hand side) and pulsating traveling waves changing the direction of propagation. In the case of heat sources, under the action of spatial modulations the period doubling, period-four and period-eight bifurcations have been obtained.