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Author: Prof. Antonio Viviani
Seconda Universita' di Napoli, Italy, antonio.viviani@unina2.it

INFLUENCE OF AN INTERFACIAL HEAT RELEASE ON NONLINEAR BUOYANT-THERMOCAPILLARY WAVES UNDER THE ACTION OF AN IMPOSED TEMPERATURE GRADIENT

Abstract

Stability of convective flows in systems with an interface has been a subject of an extensive investigation at the past few decades (for a review, see [1]).Several classes of instabilities have been found. It is known that the stability problem for the mechanical equilibrium in a system with an interface is not self-adjoint,thus an oscillatory instability is possible. The hydrodynamic and thermal interaction between convective flows on both sides of the interface can produce oscillations. Under experimental conditions, the temperature gradient is not perfectly vertical and the horizontal component of the temperature gradient appears.The appearance of this component changes the situation completely: at any small values of the Marangoni number, the mechanical equilibrium becomes impossible, and a convective flow takes place in the system.Thus, it is reasonable to consider the influence of the horizontal component of the temperature gradient on convective regimes developed in the system.The influence of the horizontal component of the temperature gradient on convective oscillations in a two-layer system filling a closed cavity with rigid heat-insulated lateral walls, has been considered in [2].It was shown that the horizontal component of the temperature gradient could lead to the violation of the symmetry conditions and the appearance of asymmetric oscillatory flows.There are various physical phenomena that can be the origin of a heat release on the interface.For example, the interfacial heat release accompanies an interfacial chemical reaction and the evaporation.The presence of a constant, spatially uniform heat releaseat the interface can also lead to the appearance of an oscillatory instability [3].In the present work, the influence of an interfacial heat release on nonlinear traveling waves, developed under the action of an imposed temperature gradient in the 47v2 silicone oil-water system with periodic boundary conditions on the lateral boundaries, has been studied.The wide range of the modified Grashof number values, corresponding to heat sinks and heat sources has been considered. It is found that the presence of the heat release on the interface can change the sequence of bifurcations and lead to the development of new oscillatory regimes in the system. Specifically, synchronization of the frequencies lead to the appearance of the period-three phase trajectory, which has not been observed in the absence of the heat release. It is shown that rather intensive interfacial heat sinks completely suppress the fast traveling wave and lead to the development of the slow wave, moving in the direction of an imposed temperature gradient.