Transition of Thermocapillary Convection

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ABSTRACT

Transition of fluid convection to chaos in dissipative dynamical systems is a subject of great interest for both its theoretical and practical aspects in the fluid mechanics. Extensive studies have shown that there are several routes of the buoyant natural convection to chaos depending on parameters of the dissipative dynamical systems such as the Rayleigh number, the Prandtl number and geometry aspect.

Another important type of natural convection is thermocapillary convection driven by the surface-tension gradient prominent in fluid systems with interface in the microgravity condition or in small-scaled terrestrial configurations. The thermocapillary convection has become one of the fundamental subjects in the microgravity fluid physics and space fluid/heat management. However, most studies now available were focused on the onset of oscillatory thermocapillary convection, the initial regime of the route to chaos. A further transition of the thermocapillary convection is still an attractive open question.

In present study, transition of the thermocapillary convection has been investigated numerically in configurations of floating half zone and liquid layer. Several modes, e.g. period oscillatory convection, quasi-period oscillatory convection, a series of successive period doubling bifurcations, of the thermocapillary convection are reported through the temperature measurements and the corresponding analysis of frequency spectra are provided. The most interesting part of the transition of the thermocapillary convection is that in the practical range of the driving force, the thermocapillary convection shows a unique phenomenon instead of transition to chaos.