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THE WAVENUMBERS SELECTION OF SUPERCRITICAL MARANGONI-BÉNARD CONVECTION

Abstract

The wavenumbers selection of supercritical Marangoni-Bénard convection has been studied experimentally in a single liquid layer at a large aspect ratio, which has been heated uniformly bellow. The surface temperature and the temperature difference have been measured by the infrared thermography camera and the thermocouple, respectively. The two dimensional Fourier transformation has carried on the thermographic image to analyse the wavenubers of the temperature field. The fundamental frequency corresponds to the cell size of the convection, and the harmonic wave corresponds to the emergence of sub-cell on high supercritical convection. (1)It has been observed that the cell size decreases when the Marangoni number (Ma) slightly beyond the critical Ma number of the onset, while the increase of cell size begin when Ma number is over a threshold. The spectra of 2D Fourier transformations show the fundamental wavenumber of the flow increases first before the decreases as the Ma is increase linearly, since the fundamental wavenumber is in inverse proportion to the cell size. As the supercritical convection cell shape changes from hexagon to irregular polygon, the spectra of 2D Fourier transformation give more precise result of fundamental wavenumber than the traditional method of counting the number of the cell tediously. (2)When the Ma reaches a large number, the cell become larger but breaks into several half size sub-cells. The boundary of the sub-cell is weaker than the one between larger cells, though it strengthens at a higher Ma. The emergence of the sub-cells can attribute to higher harmonic effect which is the nonlinear behavior of the convection. The spectra analysis shows that the higher harmonic waves become stronger when increase the Ma. Also the time-dependency and quasi-periodicity of the sub-cell's generating and vanishing occur when the Ma is large enough. The minimum wavenumber exist, likely due to the oversize cell breaks into sub-cells and split off from the large cell.