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Experimental study on surface deformation and surface wave of fluid convection with free surface

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Abstract: An optical diagnostic system consisting of Michelson interferometer with image processor has been developed for study of the kinetics of thermal capillary convection and buoyancy convection. This optical interferometer has been used to observe and measure surface deformation and surface wave of capillary convection and buoyancy convection in a rectangular cavity with different temperature's sidewalls. Fourier transformation is used to image processing. The quantitative results of surface deformation and surface wave have been calculated from the interference fringe pattern. With the increasing of temperature gradient, the liquid surface slant gradually. It's deformation has been calculated, which is related directly with temperature gradient. This is one of the characters introducing convection. Another interesting phenomenon is the inclining direction, which is different when the liquid layer is thin or thick. When the liquid layer is thin, convection is mainly controlled by thermocapillary effect. However, When the liquid layer is thick, convection is mainly controlled by buoyancy effect. Surface deformation in the present experiment are more and more declining in this process. The present experiment proved that surface deformation appears before the appearance of surface wave on fluid convection, it is related with temperature gradient, and the height of liquid layer, and lies on capillary convection and buoyancy convection. The present experiment also demonstrates that the amplitude of surface wave of thermocapillary-buoyancy convection is much smaller than surface deformation, the wave is covered by deformation.

Key words: Surface deformation, surface wave, thermocapillary convection, buoyancy convection, optical Interferometer