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Portfolio Paper

Fluid Art of Turbulence in Unsteady Non-Penetrative Thermal Convection

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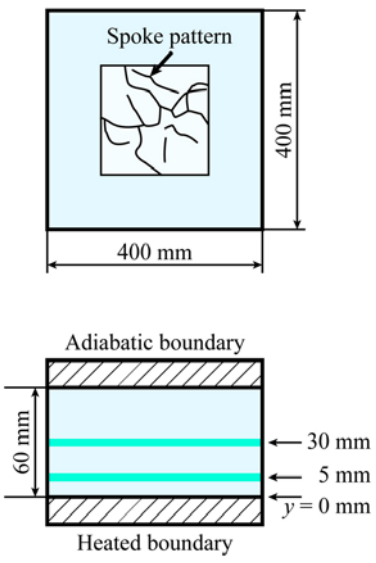

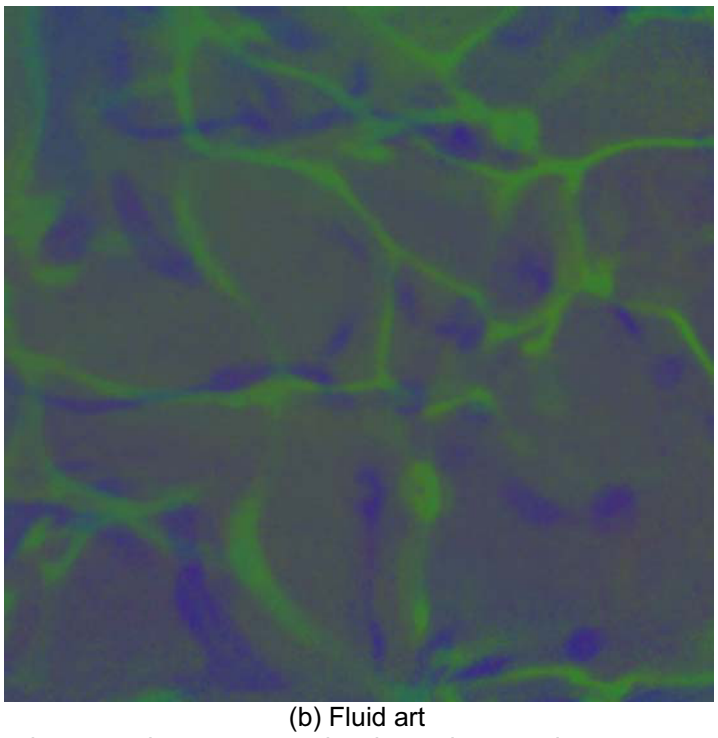

(a) Experimental test section (b) Fluid art

Fig. 1. Fluid art of turbulence in unsteady non-penetrative thermal convection.

This portfolio paper demonstrates a beautiful pattern of the spoke structure of thermal convection of horizontal fluid layer, which is visualized by liquid crystal tracers sensitive to temperature changes illuminated by white light sheet[(1), (2)]. The experimental test section Fig. 1(a) is used for the unsteady non-penetrative thermal convection, which consists of the test vessel having a square horizontal dimension of 400 mm × 400 mm and 60 mm in height. Working fluid water is heated from below using a heater mat of 300 W, while it is insulated at the upper boundary by acrylic-resin material. The flux Rayleigh number is 6.5×10^8 to confirm the turbulent state. The target area is 100 mm × 100 mm in the central test section.

The simultaneous flow visualization in the fluid layer near the heated wall and that in the convection layer are carried out using a pulsed-light illumination system. The light sheet thickness is 5 mm in the average. The visualizations are conducted in the horizontal planes at 5 mm from the heated boundary and at 30 mm in the middle of the fluid layer. These visualizations Fig. 1(b) indicate the presence of spoke pattern in the fluid layer and they show some movements in horizontal direction. Although the spoke pattern near the wall (green color) shows a complex line pattern, the pattern deforms in the convection layer (violet color) due to the presence of highly turbulent three-dimensional flow. Finally, such movements of the spoke pattern show beautiful harmony in space for generating fluid art[(3), (4)].

References : (1) Fujisawa, N. and Adrian, R .J., Journal of Visualization, 1-4 (1999), 355-364. (2) Funatani, S. and Fujisawa, N., Meas Sci Technol, 13 (2002), 1197-1205. (3) Fujisawa, N. et al., Journal of Visualization, 10-2 (2007), 163-170. (4) Burge, P., Journal of Visualization, 10-2 (2007), 171-178.