Turbulent thermal convection across a stable liquid-liquid interface

Hailong Huang[1], Xiaozhou He[2], and Penger Tong*[3]

[1]the Hong Kong University of Science and Technology – Hong Kong SAR China
[2]Harbin Institute of Technology at Shenzhen – China
[3]the Hong Kong University of Science and Technology – Hong Kong SAR China

Abstract

We report a systematic study of turbulent thermal convection across two vertically stacked layers of immiscible fluids, FC770 and water, with a stable liquid-liquid interface even when each fluid layer is under turbulent convection (1). The normalized mean temperature profile q(z) and temperature variance profile W(z) as a function of distance z from the interface are measured along the central vertical axis of the cylindrical convection cell with varying temperature difference across the cell. From the measured mean temperature and temperature variance profiles, we find a unique twin-boundary-layer structure across the liquid interface, with one twin boundary layer (BL) on each side. The measured q(z) and W(z) in each fluid layer are found to have the scaling forms q(z/l) and W(z/l), respectively, with varying BL thickness l, and their functional forms are well described by the equations for a BL attaching to a solid conducting plate, so long as a thermal slip length L_T is introduced to account for the convective heat flux passing through the liquid interface. While the obtained q(z/l) and W(z/l) for the twin BLs share the same scaling forms, they nevertheless have different BL thicknesses l and slip lengths L_T in the two fluid layers.
@This work was partly supported by the Research Grants Council of Hong Kong SAR.
(1) H.-L Huang, Y. Wang, W. Xu, X.-Z. He, and P. Tong, Turbulent thermal convection across a stable liquid-liquid interface, Phys. Rev. Fluids **9**, 033502 (2024).

*Speaker