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Thermal Boundary Layer Equation for Turbulent Rayleigh-Bénard Convection[1] EMILY SC CHING, Department of Physics, The Chinese University of Hong Kong, OLGA SHISHKINA, Max Planck Institute for Dynamics and Self-Organization, SUSANNE HORN, Department of Mathematics, Imperial College, SEBASTIAN WAGNER, Max Planck Institute for Dynamics and Self-Organization — Turbulent Rayleigh-Bénard convection, consisting of a fluid confined between two horizontal plates, heated from below and cooled from above, is a paradigm system for studying turbulent thermal convection, which is ubiquitous in nature. In turbulent Rayleigh-Bénard convection, there are viscous boundary layers near all rigid walls and two thermal boundary layers, one above the bottom plate and one below the top plate. The classical Prandtl-Blasius-Pohlhausen theory has often been used to describe the mean velocity and temperature boundary layer profiles but systematic deviations are known to exist. These deviations are due to turbulent fluctuations. In this talk, we report a new thermal boundary layer equation for turbulent Rayleigh-Bénard convection derived for Prandtl number (Pr) greater than 1, which takes into account the effects of turbulent fluctuations by using the idea of an eddy thermal diffusivity. Solving this equation, we have obtained two analytical mean temperature profiles for $\mathrm{Pr} \sim 1$ and $\mathrm{Pr} \gg 1$. These two theoretical predictions are shown to be in excellent agreement with the results of our direct numerical simulations for Pr=4.38 (water) and Pr=2547.9 (glycerol).

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