Abstract Submitted
for the DFD17 Meeting of
The American Physical Society

Temperature boundary layer profiles in turbulent Rayleigh-Benard convection[1] EMILY S.C. CHING, Chinese University of Hong Kong, MOHAMMAD S. EMRAN, Max Planck Institute for Dynamics and Self-Organization, SUSANNE HORN, University of California, Los Angeles, OLGA SHISHKINA, Max Planck Institute for Dynamics and Self-Organization — Classical boundary-layer theory for steady flows cannot adequately describe the boundary layer profiles in turbulent Rayleigh-Benard convection. We have developed a thermal boundary layer equation which takes into account fluctuations in terms of an eddy thermal diffusivity. Based on Prandtl's mixing length ideas, we relate the eddy thermal diffusivity to the stream function. With this proposed relation, we can solve the thermal boundary layer equation and obtain a closed-form expression for the dimensionless mean temperature profile in terms of two independent parameters: $\theta(\xi) = \frac{1}{b}\int_0^{b\,\xi} [1 + \frac{3a^3}{b^3}(\eta - \arctan(\eta))]^{-c}\, d\eta$, where ξ is the similarity variable and the parameters a, b, and c are related by the condition $\theta(\infty) = 1$. With a proper choice of the parameters, our predictions of the temperature profile are in excellent agreement with the results of our direct numerical simulations for a wide range of Prandtl numbers (Pr), from Pr=0.01 to Pr=2547.9.

[1]OS, ME and SH acknowledge the financial support by the Deutsche Forschungsgemeinschaft (DFG) under grants Sh405/4-2 (Heisenberg fellowship), Sh405/3-2 and Ho 5890/1-1, respectively.

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Date submitted: 28 Jul 2017 Electronic form version 1.4