Abstract Submitted
for the DFD08 Meeting of
The American Physical Society

Asymptotic Solutions of the 2D Oberbeck–Boussinesq Equations in the Large Rayleigh Number, Moderate Prandtl Number Limit[1] GREG CHINI, University of New Hampshire, STEPHEN COX, Nottingham University — Boussinesq thermal convection in a horizontal layer between isothermal stress-free boundaries is the archetypal convection problem. In both natural and technological applications, the Rayleigh number Ra generally exceeds the threshold for linear instability of the conduction state by orders of magnitude, so the high-Ra limit of the governing equations is of particular interest. It is therefore remarkable that the structure of steady-state convection cells has not yet been established, except in the further limiting case of infinite Prandtl number (Pr). Here, we rectify this situation by presenting the first large-Ra asymptotic analysis of the classical Rayleigh–Bénard convection problem with $Pr = O(1)$. We derive both details of the flow and a corresponding bulk heat transport coefficient, as a function of the cell aspect ratio. Predictions of our asymptotic theory are corroborated using full pseudospectral numerical simulations.

[1]GPC gratefully acknowledges funding from NSF CAREER Award 0348981.

Greg Chini
University of New Hampshire

Date submitted: 04 Aug 2008 Electronic form version 1.4