Abstract Submitted
for the DFD07 Meeting of
The American Physical Society

Reconsidering turbulent natural convection in a differentially heated vertical channel ABOLFAZL SHIRI, WILLIAM K. GEORGE, Chalmers University of Technology — The turbulent natural convection boundary layer next to heated vertical surfaces was originally considered by George and Capp (IJHMT 1979). By recognizing the existence of a constant heat flux layer, but the absence of a constant stress layer (due to gravity), they postulated the existence of a buoyant sublayer in which the buoyancy flux from the wall, $g\beta F_o$, was the crucial parameter. Using it they postulated the existence of inner and outer scales for temperature and velocity. Asymptotic matching led to cube root and inverse cube root profiles for the mean velocity and temperature profiles respectively, and $\mathrm{Nu} \sim \mathrm{C(Pr)}\ \mathrm{Ra}^{1/3}$ for the wall heat transfer. The theory has generally been found to be in excellent agreement with numerous studies over the past three decades for the temperature and heat transfer relations, but the velocity scaling has always been problematical. This work reconsiders the velocity scaling, and shows the GC result to be inconsistent with the momentum integral. We argue instead that the proper inner velocity should be $u_i = (g\beta\Delta T_w\ h)^{1/2}$, where h is the channel width. This is in turn proportional to the friction velocity, hence sets the friction law.

William K. George
Chalmers University of Technology

Date submitted: 03 Aug 2007 Electronic form version 1.4