Abstract Submitted
for the DFD05 Meeting of
The American Physical Society

Non-Oberbeck-Boussinesq effects in strongly turbulent Rayleigh-Benard convection G. AHLERS, E. BROWN, D. FUNFSCHILLING, Santa Barbara, S. GROSSMANN, Marburg, D. LOHSE, Twente — Non-Oberbeck-Boussinesq (NOB) effects on the heat flux in strongly turbulent Rayleigh-Benard convection in water are investigated both experimentally and theoretically. In the experiment, the heat current and the temperature at the horizontal mid-plane are measured for three samples of different heights, but constant aspect ratio. For the largest temperature differences the kinematic viscosity and the thermal expansion coefficient due to their temperature dependence vary by more than a factor of two between the top and bottom plates. The Oberbeck-Boussinesq (OB) approximation of temperature independent material parameters thus is no longer valid. Nevertheless, the Nusselt number Nu is only slightly smaller (at most 1.5%) than in the next larger sample with the same Ra number, where the material constants are still basically height-independent. The Reynolds numbers in the OB and NOB case even agree within experimental precision (2%). Theoretically, we account for the robustness of Nu and Re with respect to NOB corrections by extending the unifying theory for scaling in thermal convection to the NOB case. The NOB modifications at top and bottom boundary layer turn out to nearly compensate each other, so that the net NOB effects on Nusselt and Reynolds remain minor.

Detlef Lohse
Univ. of Twente

Date submitted: 15 Jul 2005 Electronic form version 1.4