HEAT FLUX MEASUREMENTS UNDER STRONGLY NON-OBERBECK BOUSSINESQ CONDITIONS

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Many convection systems in nature and engineering are driven by very large temperature differences between the coldest and the hottest areas. As a result, fluid properties vary significantly within the system and the Oberbeck-Boussinesq (OB) approximations are violated. We use sulfur-hexafluoride (SF_6) in a Rayleigh-Bénard (RB) setup to investigate how deviations from the OB approximations influence the heat flux. Pressure (P) and temperature (T) of the working fluid are above their critical values, where the fluid properties are very sensitive to changes in T and P. Different measurements are done with the temperature difference between bottom and top plate (ΔT), the average temperature (T_{av}), and the pressure chosen such that the Prandtl (Pr) and Rayleigh number (Ra) are kept constant, while the variations of the fluid properties across the cell (X_{NOB}[1]) change. In this way, we can directly measure how changes in X_{NOB} affect the heat flux. Since X stands for any fluid property ($X = \alpha$, ν, $\kappa \ldots$) the parameter space that needs to be investigate is very large. Nevertheless, our preliminary results suggest different regimes, where the heat flux is either increased or decreased for increasing X_{NOB}. These regimes are separated by lines of maximal and minimal X in the T_{av}-P parameter space. Our results also contribute to a better understanding of RB convection under OB conditions, since one can tune to some extend the conditions at the boundary layers and see the affect of such changes onto the heat transport.

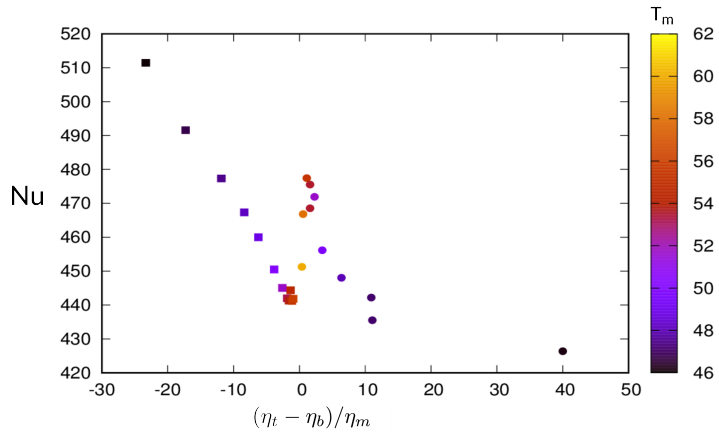

Figure 1: The Nusselt number as a function of the normalised difference of $\eta = \alpha/\kappa\nu$ between the top and the bottom plate at $Ra = 4.2 \times 10^{11}$ and $Pr = 3.5$. Squares correspond to data taken in the liquid-like region, bullets correspond to data taken in the gas-like region.

[1]Deviations from the OB approximation are expressed by the difference of a fluid property X at the top and the bottom of the cell ($X_{NOB} = (X_t - X_b)/X_m$).

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