Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

On non-Oberbeck-Boussinesq effects in Rayleigh-Benard convection in air ZHENHUA WAN, BEN WANG, QI WANG, SHU-NING XIA, QUAN ZHOU, DE-JUN SUN, University of Science and Technology of China — Direct numerical simulations (DNS) of non-Oberbeck-Boussinesq (NOB) Rayleigh-Bénard (RB) convection are performed in two-dimensional (2-D) and three-dimensional (3-D) cells. Perfect air is chosen as the operating fluid and the Prandtl number (Pr) is fixed to 0.71 for the reference state. Strong NOB effects are induced by large temperature differences at moderate Rayleigh numbers (Ra). Due to top-down symmetry breaking under NOB conditions, an increase of the centre temperature T_c is found compared to the arithmetic mean temperature T_m, and the shifts of T_c are strongly dependent on Rayleigh number Ra and temperature differential ϵ. The NOB effects on the Nusselt number (Nu) are quite small ($< 2\%$). The power-law scalings of Nu versus Ra are robust against NOB effects, even though the temperature difference reaches up to 240 K. The Reynolds numbers Re, as well as the scalings of Re versus Ra, are also insensitive to NOB effects. It is noteworthy that the influence of NOB effects on Nu and Re in 3-D RB flow is weaker than its 2-D counterpart.

Zhen-Hua Wan
University of Science and Technology of China

Date submitted: 19 Jul 2019 Electronic form version 1.4