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The scaling transition of Nu number and boundary layer thickness in RB convection HONG-YUE ZOU, SKLTCS,COE,Peking Univ., XI CHEN, Department of Mechanical Engineering, Texas Tech Univ., ZHEN-SU SHE, SKLTCS,COE,Peking Univ. — A quantitative theory is developed for the vertical mean temperature profile (MTP) and mean velocity profile (MVP) in turbulent Rayleigh-Benard Convection (RBC), which explains the experimental and numerical observations of logarithmic law in MTP and the Rayleigh number (Ra)-dependence of its coefficient A. The theory extends a symmetry analysis of canonical wall-bounded turbulent flows, which allows to extract accurate Ra scaling of the sublayer, buffer layer and log-layer thicknesses from the empirical data over a wide range of Ra. In particular, the scaling of the multi-layer thicknesses predicts that the log-law coefficient A follows a -0.121 scaling, which agrees well with the experimental data. More interestingly, a scaling transition is discovered for the kinetic sublayer thickness around Ra of 1010, which yields a scaling transition of Nu from 1/3 to 0.38. We also develop a new explanation for mean temperature logarithmic law: the effect of inverse pressure gradient drives plumes upwards near the side wall, and yields a similarity between temperature and momentum transport in the vertical direction.

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