Model for the transition between the buoyancy and rotation dominance in rotating Rayleigh–Bénard convection

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Thermally-induced buoyancy and rotation govern convection in many geophysical and astrophysical systems. The paradigm system with which to study such phenomena is rotating Rayleigh–Bénard convection (RBC), where the strength of buoyancy is reflected in the Rayleigh number Ra and that of the Coriolis force in the Ekman number Ek. How the heat transport, measured by the Nusselt number Nu, depends on Ra and Ek, and how this dependence changes when the flow undergoes the transition from the buoyancy-dominated (BD) to rotation-dominated (RD) regimes (with increasing rotation, Ek^{-1}, or decreasing thermal driving, Ra), remain important questions and have been the subject of many years of debate. In our recent *Annu. Rev. Fluid Mech.* (2023) paper[1], we suggest a unifying heat transport scaling model ($Nu - 1$ as a power function of Ra) which relates the scaling exponents in these two regimes. Knowing the scaling exponent in the BD regime, we can accurately estimate the exponent in the RD regime, after the transition. In particular, the larger exponent in the BD regime is related to a larger exponent in the RD regime, and we find the limiting values of these exponents. The theoretical results are well supported by measurements and direct numerical simulations. The theoretical ansatz for the BD-RD transition in rotating RBC can be transferred to the transitions in other fluid systems, for example, in magnetohydrodynamical flows, where the flow can be dominated by buoyancy in one regime and by magnetic field in the other.

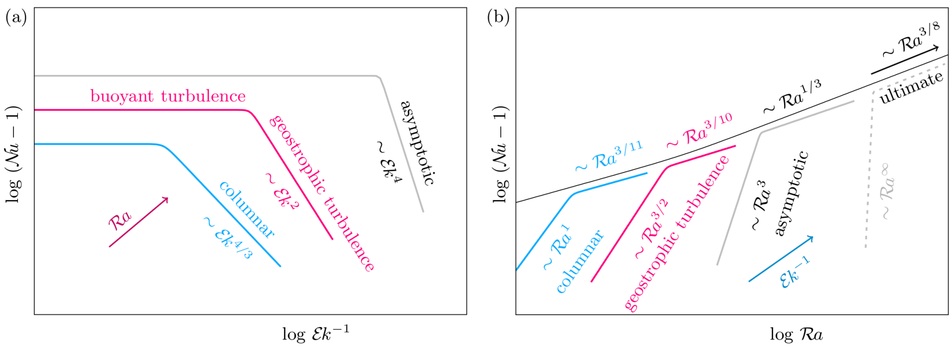

Figure 1: Scaling relations for the dimensionless convective heat transport $Nu-1$ versus (a) Ek^{-1} and (b) Ra, according to the theory. Adapted from Ecke & Shishkina[1].

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[1]Ecke & Shishkina, *Annu. Rev. Fluid Mech.* **55**, 603–638 (2023)