THE LOCAL TEMPERATURE MEASUREMENTS IN ROTATING RAYLEIGH-BÉNARD CONVECTION WITH $PR = 12.3$

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We report experimental results for heat transport and temperature statistics of slowly rotating turbulent thermal convection of a fluid with Prandtl number $Pr = 12.3$ in a cylindrical sample of Diameter D and height L with aspect ratio $\Gamma \equiv D/L = 1.00$. The data span the Rayleigh-number (Ra) range $2 \times 10^{10} < Ra < 4 \times 10^{11}$. They revealed a number of sharp transitions as the inverse Rossby number $1/Ro$ was increased. Measurements were obtained at several vertical locations z/L (z is the distance from the bottom plate) for radial positions $\xi \equiv 1 - r/(D/2) = 1.00$ (r is the horizontal distance from the vertical centerline) and $\xi = 0.063$. Within our resolution the ratio $Ro_c/Ro_{c,2}$ of the critical Rossby number Ro_c for the the onset of Ekman vortices to the transition Rossby number $Ro_{c,2}$ at the second transition was 1.75 and independent of Ra and Pr. For $Ro_c/Ro < 1$ the time-averaged temperature Θ was independent of $1/Ro$ and depended logarithmically on z/L. For $1 < Ro_c/Ro < 1.75$ and $\xi = 1.00$ (on the centerline) Θ varied faster with z/L and reached the temperature near the sidewall ($\xi = 0.063$). For $Ro_c/Ro > 1.75$ and $z/L < 0.1$ Θ varied linearly with z/L and for $\xi = 1.00$ was larger than for $\xi = 0.063$. The temperature variance σ^2 can be described well by the power law $\sigma^2 \sim (z/L)^{-\zeta}$ up to our largest $Ro_c/Ro \simeq 20$. The temperature distribution at the sample center was exponential at $Ro_c/Ro = 0$ and evolved to Gaussian at $Ro_c/Ro = 1$.
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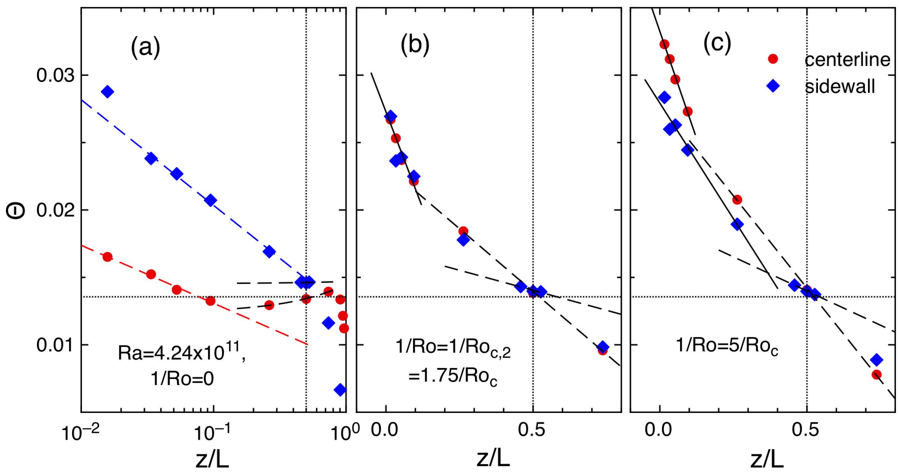

Figure 1: $\Theta(z)$ at $\xi = 1.00$ (along the centerline) and $\xi = 0.063$ (near the sidewall) as a function of z/L at $Ra = 4.24 \times 10^{11}$ for different $1/Ro$. (a): $1/Ro = 0$; (b): $1/Ro = 1.75/Ro_c$; (c): $1/Ro = 5/Ro_c$. Vertical dashed lines: the sample centre at $z/L = 0.50$; horizontal dashed lines: the centre temperature for $1/Ro = 0$.

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