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What rotation rate maximizes heat transport in rotating RayleighBnard convection[1] RICHARD STEVENS, University of Twente, YANTAO YANG, Peking University, ROBERTO VERZICCO, University of Rome "Tor Vergata", DETLEF LOHSE, University of Twente — The heat transfer and flow structure in rotating RayleighBnard convection are strongly influenced by the Rayleigh (Ra), Prandtl (Pr), and Rossby (Ro) number. For $Pr > 1$ and intermediate rotation rates, the heat transfer is increased compared to the non-rotating case. We find that the regime of increased heat transfer is subdivided into a low and a high Ra number regime. For $Ra < 5 \times 10^8$ the heat transfer at a given Ra and Pr is highest at an optimal rotation rate, at which the thickness of the viscous and thermal boundary layer is about equal. From the scaling relations of the thermal and viscous boundary layer thicknesses, we derive that the optimal rotation rate scales as $1/Ro_{opt} \approx 0.12 Pr^{1/2} Ra^{1/6}$. For $Ra > 5 \times 10^8$ the above scaling for the optimal rotation rate does not hold anymore. It turns out that in the high Ra regime, the flow structures at the optimal rotation rate are very different than for lower Ra. Surprisingly, the heat transfer in the high Ra regime differs significantly for a periodic domain and cylindrical cells with different aspect ratios, which originates from the sidewall boundary layer dynamics and the corresponding secondary circulation.

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