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Supergravitational turbulent thermal convection.[1] HECHUAN JIANG, Tsinghua University, XIAOJUE ZHU, Harvard University, DONGPU WANG, Tsinghua University, SANDER G. HUISMAN, University of Twente, CHAO SUN, Tsinghua University — Thermally driven turbulent flows are ubiquitous in many natural phenomena and in industries, such as atmospheric circulations, oceanic flows, flows in the fluid core of planets, and energy generations. The key issue of turbulent thermal convection is understanding the coupling dynamics of the turbulent flow structures and global heat transfer for high Rayleigh numbers. Therefore, in recent years much attention has been paid to finding ways of increasing Rayleigh number. In this work, we present a novel approach to boost the Rayleigh number in thermal convection by exploiting centrifugal acceleration and by rapidly rotating a cylindrical annulus to reach an effective gravity of 60 times Earth's gravity. We show that in the regime where the Coriolis effect is strong, the scaling exponent of the Nusselt number with the Rayleigh number exceeds 1/3 once the Rayleigh number is large enough. Remarkably, the convective rolls revolve in prograde direction, signifying the emergence of zonal flow. The present findings open a new avenue on the exploration of high Rayleigh number turbulent thermal convection, and will improve the understanding of the flow dynamics and heat transfer processes in geophysical and astrophysical flows, and other strongly rotating systems.

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