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Phenomenology of turbulent convection[1] MAHENDRA VERMA, ANANDO CHATTERJEE, ABHISHEK KUMAR, Indian Institute of Technology Kanpur, RAVI SAMTANEY, King Abdullah University of Science and Technology — We simulate Rayleigh-Bénard convection (RBC) in which a fluid is confined between two thermally conducting plates. We report results from direct numerical simulation (DNS) of RBC turbulence on 4096^3 grid, the highest resolution hitherto reported, on 65536 cores of Cray XC40, Shaheen II, at KAUST. The non-dimensional parameters of our simulation are: the Rayleigh number $\mathrm{Ra} = 1.1 \times 10^{11}$ (the highest ever for a pseudo-spectral simulation) and Prandtl number of unity. We present energy flux diagnostics of shell-to-shell (in wave number space) transfer. Furthermore, noting that convective flows are anisotropic due to buoyancy, we quantify anisotropy by subdividing each wavenumber shell into rings and quantify ring energy spectrum. An outstanding question in convective turbulence is the wavenumber scaling of the energy spectrum. Our pseudo-spectral simulations of turbulent thermal convection coupled with novel energy transfer diagnostics have provided a definitive answer to this question. We conclude that convective turbulence exhibits behavior similar to fluid turbulence, that is, Kolmogorov's $k^{-5/3}$ spectrum with forward and local energy transfers, along with a nearly isotropic energy distribution.

[1]The supercomputer Shaheen at KAUST was utilized for the simulations.

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