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High-Reynolds-number effects in turbulent channel flow: evidence from DNS MATTEO BERNARDINI, SERGIO PIROZZOLI, PAOLO ORLANDI, University of Rome La Sapienza — The behavior of the incompressible turbulent channel flow is investigated through direct numerical simulation up to a Reynolds number ($Re_\tau \approx 4080$) at which phenomena typical of the asymptotic Reynolds number regime starts to be observed. Less than a decade of nearly-logarithmic variation is observed in the mean velocity profiles, with log-law constants $k \approx 0.386$, $C \approx 4.30$. A log layer is also observed in the spanwise velocity variance, as predicted by Townsend's attached eddy hypothesis, whereas the streamwise variance seems to exhibit a plateau, perhaps being still affected by low-Reynolds-number effects. Comparison with previous DNS data at lower Reynolds number suggests strong enhancement of the imprinting effect of outer-layer eddies onto the near-wall region. This mechanisms is shown to be associated with excess turbulence kinetic energy production in the outer layer, and it clearly reflects in flow visualizations and in the streamwise velocity spectra, which exhibit near-tonal behavior in the outer layer. Associated with the outer energy production site, we find evidence of a Kolmogorov-like inertial range, limited to the spanwise spectral density of u, whereas power laws with different exponents are found for the other spectra.

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