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The near-wall region of highly turbulent Taylor-Couette flow

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— Direct numerical simulations of the Taylor-Couette (TC) problem, the flow between two coaxial and independently rotating cylinders, have been performed. The study focuses on TC flow with mild curvature (small gap) with a radius ratio of $\eta = r_i/r_o = 0.909$, an aspect ratio of $\Gamma = L/d = 2\pi/3$, and a stationary outer cylinder. Three inner cylinder Reynolds of $1 \cdot 10^5$, $2 \cdot 10^5$ and $3 \cdot 10^5$ were simulated, corresponding to frictional Reynolds numbers between $Re_\tau \approx 1400$ and $Re_\tau \approx 4000$. An additional case with a large gap, $\eta = 0.5$ and driving of $Re = 2 \cdot 10^5$ was also performed. Small-gap TC was found to be dominated by spatially-fixed large-scale structures, known as Taylor rolls (TRs). TRs are attached to the boundary layer, and are active, i.e. they transport angular velocity through Reynolds stresses. For small-gap TC, evidence for the existence of logarithmic velocity fluctuations, and of an overlap layer, in which the velocity fluctuations collapse in outer units, was found. Profiles consistent with a logarithmic dependence were also found for the angular velocity in large-gap TC, albeit in a very reduced range of scales.

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