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Dynamics and statistics of weakly turbulent Taylor-Couette flow in terms of Exact Coherent Structures[1] JOSHUA PUGHE SANFORD, ROMAN GRIGORIEV, Georgia Inst of Tech — Coherent structures are believed to play an important role in fluid turbulence. Transitional flows of Newtonian fluids provide an ideal setting for understanding and quantifying their impact on the dynamics and statistics of turbulence, where coherent structures correspond to unstable solutions of the Navier-Stokes equation. Previous studies have gone so far as to suggest that a single unstable solution can describe both the physical mechanism sustaining turbulence in wall-bounded flows and its statistical properties, such as the mean flow profile. Our study of low-aspect-ratio ($\eta = 1/2$, $\Gamma = 1$) Taylor-Couette flow at Reynolds number of order 1000 illustrates that – outside of minimal flow units – a rather large number of unstable solutions is needed to describe turbulence. We produce quantitative evidence that turbulent flow shadows numerous relative periodic orbits (RPOs) – the most common type of unstable solutions in this geometry. We also show that, while the mean flow profiles of turbulence and individual RPOs may be similar, there are significant quantitative differences in the associated observables, such as the torque exerted by the fluid on the cylinders.

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