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Experimental evidence of exact coherent structures in small-aspect-ratio Taylor-Couette flow[1] CHRISTOPHER J. CROWLEY, Georgia Institute of Technology, MICHAEL C. KRYGIER, Sandia National Laboratories, WESLEY TOLER, ROMAN O. GRIGORIEV, MICHAEL F. SCHATZ, Georgia Institute of Technology — Recent work suggests that the dynamics of turbulent wall-bounded flows are guided by unstable solutions to the Navier-Stokes equation that have nontrivial spatial structure and temporally simple dynamics. These solutions, known as exact coherent structures (ECS), are presumed to play a key role in a fundamentally deterministic description of turbulence. Prior work in 3D fluid flows computed ECS in streamwise-periodic domains that differed from the inflow-outflow boundary conditions of corresponding experimental tests, which relied on the use of Taylor's hypothesis to obtain laboratory measurements. Here we report evidence for ECS in a 3D turbulent flow by directly comparing experimental measurements with numerical simulations at the same parameter values and boundary conditions in a small-aspect-ratio ($\Gamma = 1$) turbulent Taylor-Couette flow with radius ratio $\eta = 0.71$. To detect an ECS, time-resolved 3D-3C velocity measurements were performed in the entire flow domain and compared to exact solutions of the Navier-Stokes equation obtained via fully-resolved direct numerical simulation.

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