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Identifying turbulent shadowing of 3D Exact Coherent Structures from measurements of 2D-2C velocity measurements in small-aspect-ratio Taylor-Couette flow[1] CHRISTOPHER J CROWLEY, WESLEY TOLER, JOSHUA PUGHE-SANFORD, KENDRA SANDS, 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 on the role of ECS in 3D turbulence focused mainly on open flows in small computational domains with streamwise-periodic boundary conditions that differ 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 closed 3D turbulent flow by directly comparing experimental measurements with ECS computed numerically in a small-aspect-ratio ($\Gamma = 1$) turbulent Taylor-Couette flow with radius ratio $\eta = 0.71$ which does not require the use of Taylor's hypothesis. We show that shadowing of ECS by turbulent flow can be detected by comparing time-resolved 2D-2C velocity measurements in a 2D plane of the flow with the corresponding slice of an ECS.

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