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Experimental observations of direct laminar-turbulent transition in counter-rotating Taylor-Couette flow[1] CHRISTOPHER CROWLEY, MICHAEL KRYGIER, Georgia Inst of Tech, DANIEL BORRERO-ECHEVERRY, Reed College, ROMAN GRIGORIEV, MICHAEL SCHATZ, Georgia Inst of Tech — The transition to turbulence in counter-rotating Taylor-Couette flow typically occurs through a sequence of supercritical bifurcations of stable flow states (e.g. spiral vortices, interpenetrating spirals (IPS), and wavy interpenetrating spirals). Coughlin and Marcus have proposed a mechanism by which these laminar spiral flows undergo a secondary instability that leads to turbulence. We report the discovery of a counter-rotating regime ($Re_{\text{out}} = -1000$, $Re_{\text{in}} \approx 640$) of small aspect ratio/large radius ratio Taylor-Couette flow ($\Gamma = 5.26$ / $\eta = 0.91$), where the system bypasses the primary instability to stable laminar spirals and instead undergoes a direct transition to turbulence as the inner cylinder rotation rate is slowly increased. This transition is mediated by an unstable IPS state. We study the transition experimentally using flow visualization and tomographic PIV, and show that it is both highly repeatable and that it shows hysteresis as the inner cylinder rotation rate is decreased. As Re_{in} is decreased, the turbulent flow relaminarizes into an intermediate, stable IPS state. Decreasing Re_{in} further returns the system back to circular Couette flow.

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