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Numerical investigation of direct laminar-turbulent transition in counter-rotating Taylor-Couette flow MICHAEL KRYGIER, ROMAN GRIGORIEV, Georgia Institute of Technology — A direct transition from laminar to turbulent flow has recently been discovered experimentally in the small-gap Taylor-Couette flow with counter-rotating cylinders. The subcritical nature of this transition is a result of relatively small aspect ratio, $\Gamma = 5.26$; for large Γ the transition is supercritical and involves an intermediate stable state (Coughlin & Marcus, 1996) – interpenetrating spirals (IPS). We investigate this transition numerically to probe the dynamics in regimes inaccessible to experiments for a fixed $Re_o = -1000$ by varying Re_i. The numerics reproduce all the experimentally observed features and confirm the hysteretic nature of the transition. As Re_i is increased, the laminar flow transitions to turbulence, with an unstable IPS state mediating the transition, similar to the Tollmien-Schlichting waves in plane Poiseuille flow. As Re_i is decreased, turbulent flow transitions to a stable, temporally chaotic IPS state. This IPS state further transitions to either laminar or turbulent flow as Re_i is decreased or increased. The stable IPS state is reminiscent of the pre-turbulent chaotic states found numerically in plane Poiseuille flow (Zammert & Eckhardt, 2015), but previously never observed experimentally.

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