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Experimental and numerical study of direct laminar-turbulent transition in Taylor-Couette flow[1] CHRISTOPHER J. CROWLEY, MICHAEL KRYGIER, Georgia Institute of Technology, DANIEL BORRERO-ECHEVERRY, Willamette University, ROMAN O. GRIGORIEV, MICHAEL F. SCHATZ, Georgia Institute of Technology — The transition to turbulence in large aspect ratio Taylor-Couette flow (TCF) occurs via a sequence of supercritical bifurcations of stable flow states (e.g. spiral vortices, interpenetrating spirals (IPS), and wavy interpenetrating spirals). We previously reported the discovery of a direct laminar-turbulent transition in a TCF system with counter-rotating cylinders ($\mathrm{Re}_o = -1000$, $\mathrm{Re}_i \approx 640$) and a small aspect ratio ($\Gamma = 5.26$) as Re_i is slowly increased. This transition is mediated by an unstable IPS state. As Re_i is decreased, the turbulent flow first relaminarizes into an intermediate, stable IPS state, before returning to circular Couette flow. In this talk we will present the study of this transition experimentally using tomographic PIV and direct numerical simulations with realistic boundary conditions, and show that it is both highly repeatable and that it shows hysteresis. The transition between both the IPS and turbulent states exhibits statistics consistent with chaotic attractor transitioning to a chaotic repeller. The IPS state is accessed from a subcritical transition and is inaccessible when the inner cylinder is originally accelerated on the way up to turbulence, suggesting that a finite amplitude perturbation is required to reach it.

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Chris Crowley
Georgia Institute of Technology

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