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Toroidal vortex development in a swirl-driven cavity RICHARD HEWITT, TOM MULLIN, University of Manchester, SIMON TAVENER, Colorado State University — We present the results of a combined experimental and numerical (axisymmetric, finite-element) investigation into steady secondary vortex flows in swirl-driven annular cavities. The flow is driven by the symmetric rotation of both end walls and an inner cylindrical boundary. In all cases the outer boundary of the flow domain is a stationary circular cylinder. At moderate Reynolds numbers, toroidal vortex structures arise either through the creation of stagnation points (in the meridional plane) at the inner bounding cylinder, or on the mid-plane of symmetry. A detailed description of the flow regimes is presented, suggesting that a cascade of such vortices can be created. Experimental results are reported that visualize some of the new states and confirm the prediction that they are stable to (mid-plane) symmetry breaking perturbations. We also consider how the minimum Reynolds number for such non-trivial flow structures behaves in the limit of small aspect ratios.

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