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Symmetry-breaking Hopf bifurcations to 1-, 2-, and 3-tori in small-aspect-ratio counter-rotating Taylor-Couette flow SEBASTIAN ALTMEYER, YOUNGHAE DO, Department of Mathematics, Kyungpook National University, FRANCISCO MARQUES, Department of Fisca Aplicada, Universitat Politecnica de Catalanya, JUAN M. LOPEZ, School of Mathematicl and Statistical Sciences, Arizona State University — Taylor-Couette flow in a small aspect-ratio wide-gap annulus in the counter-rotating regime is investigated by solving the full 3D Navier-Stokes equations. The system is invariant under rotations about the axis, reflection about the mid-plane, and time translations. A systematic investigation is presented, both in terms of the flow physics, the numerical simulations and from a dynamical systems perspective. The dynamics are primarily associated with the behavior of the jet of angular momentum that emerges from the inner cylinder boundary layer at about the mid-plane. The sequence of bifurcations as the rotation is increased consists of a Hopf bifurcation breaking the reflection symmetry and leading to an axisymmetric limit cycle associated to an invariant one-torus manifold with a spatio-temporal symmetry. This undergoes a Hopf bifurcation breaking axisymmetry, leading to quasi-periodic solutions evolving on a 2-torus that is only setwise symmetric due to precesion. These undergo a further Hopf bifurcation introducing a third incommensurate frequency leading to a 3-torus. On it,as the rotation is further increased, a SNIC bifurcation happens, destroying the 3-torus and leaving a pair of symmetrically related 2-tori states on which all symmetries of the system have been broken.

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