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Flow transitions in a differentially heated rotating channel of fluid

We study the primary flow transitions that occur in a differentially heated rotating channel of fluid by computing bifurcations in a model that uses the Navier–Stokes equations in the Boussinesq approximation. When the centrifugal buoyancy is neglected, the system is $O(2)$-symmetric. In this case, the flow transition corresponds to a symmetry-breaking steady-state bifurcation. We use numerical continuation to trace the transition over a wide range of the two parameters of interest. At isolated points along the transition curve, centre manifold reduction and normal forms are used to deduce the form of the bifurcating solutions. The solutions and transitions are approximated numerically from the large sparse systems that result from the discretization of the partial differential model equations.

The channel can be considered to be a simplification of the classical differentially heated rotating annulus fluid dynamics experiment. The results obtained for the channel show a remarkable quantitative correspondence with both experimental and theoretical results from the annulus.

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