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Rich 3-tori dynamics in small-aspect-ratio highly counter-rotating Taylor-Couette flow – reversal of spiraling vortices SEBASTIAN ALTMAYER, BJÖRN HOF, Institute of Science and Technology Austria, 3400 Klosterneuburg, Austria, FRANCISCO MARQUES, Department of Fisca Aplicada, Universitat Politècnica de Catalunya Girona s/n, Modul B4 Campus Nord, 08034 Barcelona, Spain, JUAN M. LOPEZ, School of Mathematical and Statistical Sciences, Arizona State University, Tempe, Arizona 85287, USA — We present numerical simulations concerning the reversal of spiraling vortices in short highly counter-rotating cylinders. Increasing the differential cylinder rotation results in global flow-inversion which develops various different and complex flow dynamics of several quasi-periodic solutions that differ in their number of vortex cells in the bulk. The dynamics change from being dominated of the inner cylinder boundary layer to be dominated by the outer cylinder boundary layer. Solutions exist on either two or three tori invariant manifolds whereby they appear as symmetric or asymmetric states. We find for either moderate and high inner cylinder rotation speed the quasi-periodic flow to consist of only two vortex cells but differ in its spiraling direction. These both flows live on 2-tori but differ in number of symmetries. While for the quasi-periodic flow at lower rotation speed a pair of symmetrically related 2-tori exists the quasi-periodic flow at higher rotation speeds is symmetric living on a single 2-torus. In addition these both flows differ due to their dominant azimuthal m modes. The 2-tori states are separated by an further quasi-periodic flow living on pair of symmetrically related 3-tori and offer periodical competition between a two and three vortex cell states.

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