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Onset of chaos in helical vortex breakdown at low Reynolds number SIMON PASCHE, EPFL - LMH, FRANÇOIS GALLAIRE, EPFL - LFMI, FRANÇOIS AVELLAN, EPFL - LMH — Swirling jet flows are generally characterized by two non-dimensional parameters: the swirl and the Reynolds number. Bubble, spiral or double spiral vortex breakdown as well as columnar vortex are part of the observed dynamics when these two control parameters are varied. This rich dynamic produces strong mixing that is traditionally investigated in the framework of Lagrangian chaos, with typical applications to combustion chambers. In contrast to chaotic advection, Eulerian chaos has not been reported for such open flows. Here, Eulerian chaos is studied through direct numerical flow simulations of an unconfined Grabowsky and Berger vortex using the incompressible Navier-Stokes solver NEK5000. At a fixed swirl number, a sequence of periodic, quasiperiodic, chaotic, quasiperiodic and periodic states is observed as the Reynolds number increases from 200 to 300. Therefore, Fourier spectrum, Poincaré section map, sensitivity to initial condition and largest Lyapunov exponent are computed to identify the chaotic window which results from the nonlinear interaction between a self-sustained single helical mode, triggered by an upstream bubble breakdown, and other helical modes. Finally, a route to chaos in the incompressible Navier-Stokes equations is sketched.

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