Sensitivity Analysis for the Stability and Control of Spiral Vortex Breakdown ELENA VYAZMINA, JOSEPH NICHOLS, JEAN-MARC CHOMAZ, PETER SCHMID, Laboratoire d'Hydrodynamique (LadHyX), Ecole Polytechnique — The physical origin of spiral vortex breakdown is investigated using the direct and adjoint Navier-Stokes equations linearized around axisymmetric vortex breakdown. The axisymmetric solution is computed using a Newton solver for the steady nonlinear Navier-Stokes equations. As a result of the so-called convective non-normality the direct and adjoint global modes for helical perturbations are located downstream and upstream, respectively. In particular, the adjoint mode is dominant in the recirculation bubble where the flow is thus most sensitive to periodic forcing. The wave modes region, defined as the overlap region between the adjoint and direct global modes, allows us to determine whether the wake of the recirculation region or the recirculation region itself causes the spiral vortex breakdown.

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