Abstract Submitted
for the DFD10 Meeting of
The American Physical Society

Direct route to turbulence in a rotating boundary layer

BERTRAND VIAUD, CReA-French Air Force, ERIC SERRE, M2P2-CNRS, JEAN-MARC CHOMAZ, Ladhyx-CNRS — The transition to turbulence in a rotating boundary layer is analysed via DNS in an annular cavity made of two parallel co-rotating disks of finite radial extent, fed by a forced inflow at the hub. A former investigation [Viaud et al. JFM 2008] has established the existence of a primary subcritical bifurcation to nonlinear global mode with angular phase velocity and radial envelop coherent with the so-called elephant mode theory. When the Reynolds number based on the forced throughflow is increased above a threshold value for the existence of the nonlinear global mode, a large amplitude impulsive perturbation gives rise to a self-sustained saturated wave which is itself globally unstable. A second front appears in the lee of the primary where small-scale instability develops with characteristics indicating a Floquet mode of zero azimuthal wavenumber. This secondary instability leads to a very disorganized state, defining transition to turbulence. This transition, linked to the secondary instability of a global mode, confirms for the first time on a real flow the possibility of a direct transition to turbulence through an elephant cascade, a scenario up to now only observed on the Ginzburg–Landau model. Further work investigates the sensitivity of this scenario to environmental parameters, namely the streamwise extent of the flow, the incoming noise level, or the amplitude of the initial perturbation.

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Date submitted: 05 Aug 2010

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