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Transition to turbulence in the rotor boundary layer ERIC SERRE, CNRS-M2P2, EUNOK YIM, DENIS MARTINAND, Aix-Marseille Univ., CNRS, Centrale Marseille, M2P2, JEAN-MARC CHOMAZ, LadHyX, CNRS-Ecole Polytechnique, ART ET SCIENCE TEAM, INSTABILITY, TUBULENCE CONTROL TEAM — This work brings new insights on the way that turbulence occurs in the rotating disk boundary layer. It takes part in the debate initiated by the pioneering work of Lingwood in the ninetees suggesting the possibility of a direct route. The rotating disk boundary layer of a closed rotor-stator cavity is investigated here using direct numerical simulation and linear stability analysis. The mean flow along the rotor matches the von Karman self-similarity solution, except at the edge, where the flow is more unstable due to shear and centrifugal effects, eventually leading to a strong source of perturbations. DNS shows that the transition is governed at moderate rotation rates by edge-driven global modes, below the c/a transition, and at large rotation rates by self-sustained rotor layer global modes. These latter, are the superposition of various unstable modes that account for a gentler front than expected theoretically. This result explains the discrepancy observed in the growth rates between LSA and DNS in azimuthal sectors on the one side, and experiments and present simulations on the other side. Furthermore, these results show that fully nonlinear simulations are mandatory to reproduce experimental observations.

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