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Airfoil stall interpreted through linear stability analysis DENIS BUSQUET, ONERA, MATTHEW JUNIPER, University of Cambridge, FRANCOIS RICHEZ, OLIVIER MARQUET, DENIS SIPP, ONERA — Although airfoil stall has been widely investigated, the origin of this phenomenon, which manifests as a sudden drop of lift, is still not clearly understood. In the specific case of static stall, multiple steady solutions have been identified experimentally and numerically around the stall angle. We are interested here in investigating the stability of these steady solutions so as to first model and then control the dynamics. The study is performed on a 2D helicopter blade airfoil OA209 at low Mach number, $M \sim 0.2$ and high Reynolds number, $Re \sim 1.8 \times 10^6$. Steady RANS computation using a Spalart-Allmaras model is coupled with continuation methods (pseudo-arclength and Newton's method) to obtain steady states for several angles of incidence. The results show one upper branch (high lift), one lower branch (low lift) connected by a middle branch, characterizing an hysteresis phenomenon. A linear stability analysis performed around these equilibrium states highlights a mode responsible for stall, which starts with a low frequency oscillation. A bifurcation scenario is deduced from the behaviour of this mode. To shed light on the nonlinear behavior, a low order nonlinear model is created with the same linear stability behavior as that observed for that airfoil.

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