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Discrete tones around airfoils: a global stability analysis.[1]
MIGUEL FOSAS DE PANDO, PETER J. SCHMID, LadHyX, CNRS-Ecole Polytechnique, DENIS SIPP, ONERA - DAFE — Airfoil self-noise stems from an interaction between the airfoil surface, the boundary layers and the wake. At moderate Reynolds number and small angles of attack, the acoustic spectrum is dominated by discrete tones correlated to the ringing of coherent structures localized in the vicinity of the trailing edge. Local stability analyses show strong amplification of hydrodynamic instabilities in the frequency range of acoustic tones, suggesting an interplay between sound waves and instabilities. However, owing to the intrinsic limitations of local approaches, a satisfactory explanation of the tonal-noise phenomenon is still missing. We present a global stability analysis of the mean-flow linearized dynamics. Features of the global modes spectrum and of the resolvent norm will be discussed. The least-stable direct modes show a link between the suction-side boundary layer, the near wake dynamics, and acoustic radiation; conversely, the corresponding adjoint modes pinpoint at the pressure side as the location of maximum sensitivity. Although the linearized operator is stable, the resolvent norm shows substantial energy amplification. Finally, the pressure-side, suction-side and wake dynamics will be analyzed in isolation to assess their respective contribution to the overall process.

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