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Three-dimensional short-wavelength instabilities in the near-wake of a circular cylinder YOGESH JETHANI, KAMAL KUMAR, A. SAMEEN, MANIKANDAN MATHUR, Department of Aerospace Engineering, Indian Institute of Technology - Madras — We perform local stability analysis of the near-wake region of two-dimensional flow past a circular cylinder for Reynolds number in the range $Re \in [10, 300]$. The local stability equations that govern the leading-order amplitude of short-wavelength perturbations are solved along closed fluid particle trajectories in the numerically simulated flow-fields for both the steady ($Re \leq 45$) and unsteady vortex-shedding ($Re > 45$) regimes; the study is further complemented with analysis on time-averaged flows for $50 \leq Re \leq 300$. For steady and time-averaged flow, the inviscidly most unstable regions occur either at the core or at the edge of the separation bubble, with elliptic instability as the dominant mode for all $Re$. The effectiveness of viscous damping in eliminating the inviscid instabilities and the validity of the WKBJ approximation in the present context are studied. In the unsteady vortex-shedding regime, two types (I and II) of closed trajectories are identified for all $Re$ and the inviscid growth rates as a function of $Re$ are plotted for both. For type I trajectory, a bifurcation occurs at $Re \approx 250$. Potential relevance of our results in understanding the transition from steady flow to vortex-shedding and the subsequent secondary instabilities are discussed.

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