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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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