Global mode analysis of the stabilization of bluff-body wakes by base bleed

E. SANMIGUEL-ROJAS, A. SEVILLA, C. MARTÍNEZ-BAZÁN, Universidad de Jaen (Spain) — Base bleed is a simple and well-known means of stabilizing the wake behind slender bodies with a blunt trailing edge. In the present research, we investigate the global instability properties of the laminar-incompressible flow using a spectral domain decomposition method to perform the global stability analysis. In particular, we describe the flow instability characteristics as a function of the Reynolds number, \( \text{Re} = \rho W_\infty D / \mu \), and the bleed coefficient, defined as the bleed-to-freestream velocity ratio, \( C_b = W_b / W_\infty \), where \( D \) is the diameter of the body, \( \rho \) and \( \mu \) the density and viscosity of the free stream, respectively. A first stationary bifurcation for, \( \text{Re} \approx 364 \), is found, and a second oscillatory bifurcation for, \( \text{Re} \approx 598 \), with a Strouhal number, \( \text{St} = 0.105 \), both for the most unstable azimuthal mode \( |m| = 1 \). We also report the existence of a critical bleed coefficient to stabilize both the first, \( C_{b1}^* = C_{b1}^*(\text{Re}) \), and the second, \( C_{b2}^* = C_{b2}^*(\text{Re}) \), bifurcations such as \( C_{b1}^* > C_{b2}^* \) for the range of Reynolds number under study, \( 0 \leq \text{Re} \leq 2000 \). For \( \text{Re} > 600 \) the same kind of bifurcations are found for the azimuthal modes \( |m| = 2 \) and \( |m| = 3 \), which exhibit similar behaviors as the \( |m| = 1 \) mode with respect to the critical bleed coefficient.

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