The influence of the density ratio on the linear frequency response of low-density jets

WILFRIED COENEN, ALEJANDRO SEVILLA, Área de Mecánica de Fluidos, Dpto. de Ingeniería Térmica y de Fluidos, Universidad Carlos III de Madrid, Spain, LUTZ LESSHAFFT, Laboratoire d’Hydrodynamique (LadHyX), École Polytechnique - CNRS, France — Low-density jets support global self-sustained oscillations when the jet-to-ambient density ratio is sufficiently small, a phenomenon that has been linked to the presence of a region of local absolute instability in the underlying parallel base flow. However, the use of local stability analysis requires introducing ad-hoc criteria to match the experimental observations (see Coenen & Sevilla, J. Fluid Mech. 713, 2012, and references therein). In this work we therefore use a global approach, where the wavepacket structures are temporal eigenmodes of the linearized equations of motion in a 2D domain. The resulting eigenvalue spectra show that, when the density ratio is decreased, a discrete eigenmode becomes increasingly dominant, eventually reaching a positive growth rate for a certain critical density ratio. For the particular case of a He/air jet, this critical density ratio, as well as the corresponding oscillation frequency, is in good quantitative agreement with the experiments of Hallberg & Strykowski (J. Fluid Mech. 569, 2006). The influence of the density ratio on the linear frequency response of the jet under globally stable conditions is also investigated.

1Supported by Spanish MINECO under project DPI 2011-28356-C03-02.