THREE-DIMENSIONAL POD ANALYSIS OF TRANSITIONAL CIRCULAR AND CHEVRON JETS

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ABSTRACT: This paper describes an experimental investigation on circular and chevron jets at *Re*=5000 by means of time-resolved tomographic particle image velocimetry[1]. Experiments are performed at kilo-hertz repetition rate in a tailored water jet facility where the measurements are conducted at the nozzle exit, in a conical volume of 10 jet diameters of axial extension. The scattered light is recorded by three CMOS cameras arranged along different azimuthal directions in a horizontal plane. The measurement of the instantaneous velocity vector field over a three-dimensional domain enables the evaluation of the complete velocity gradient tensor and the associated quantities, such as the vorticity vector. The proper orthogonal decomposition (POD) is applied to the velocity and the vorticity fields to objectively classify and describe the three-dimensional patterns of circular and chevron jets at transition[2]. In the circular jet, the most energetic modes show the presence of ring-like vortices, azimuthal instabilities and streamwise vortices, accompanied by a helical mode. In the chevron case, instead, streamwise vortices depart from the nozzle notches. Finally, following Powell's aeroacoustic analogy, the organization of the Lamb vector is analyzed by POD and the three-dimensional patterns of the most energetic modes are discussed for both the jet configurations.

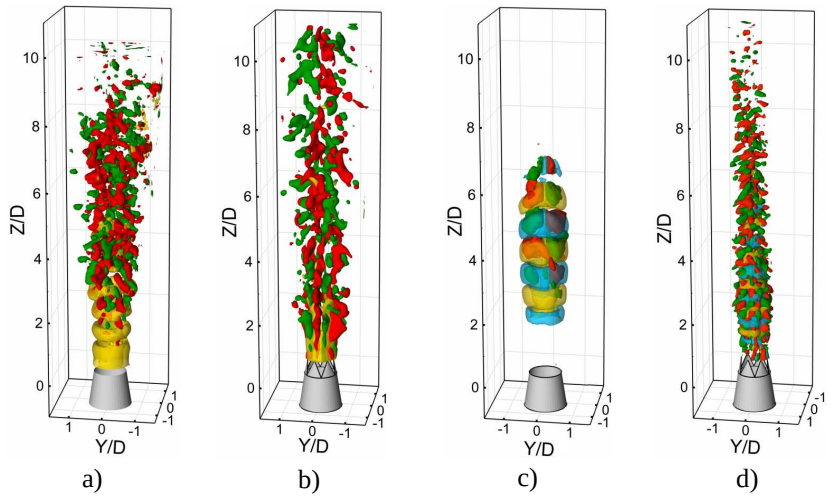

Fig. 1 Instantaneous iso-surfaces of azimuthal ($\omega_t D/W_j$=4, yellow) and radial vorticity ($\omega_r D/W_j$=1.2, green; $\omega_r D/W_j$=1.2, red) in circular (a) and chevron (b) jets; first mode of the Lamb vector (c-d), iso-surfaces of radial ($L_r D/W_j^2$=0.1, blue; $L_r D/W_j^2$=-0.1, yellow) and azimuthal ($L_t D/W_j^2$=0.1, green; $L_t D/W_j^2$=-0.1, red) components.

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