Shear layer modes competition in Open Cavity Flow: Experimental and Numerical Exploration of 3D features through a 3D DMD analysis.

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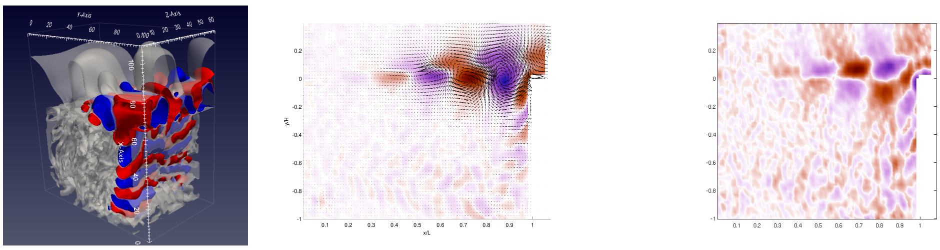
ABSTRACT

Open cavity flows are well known for enhancing characteristic self-sustaining oscillations [1]. It was shown, in numerical simulations of the flow, that a proper orthogonal decomposition (POD) is able to properly discriminate between coherent structures within the shear layer, from those inside the cavity [2]. Moreover, the time evolution of these coherent structures, in the shear layer, also exhibit the characteristic self-sustained oscillations of the flow. However, in [2], the flow oscillations did not exhibit any mode switching phenomenon, since only one mode was mainly amplified within the shear layer. In the case where two dominant modes are in competition, POD fails to extract each mode independently, since both are strongly coherent with respect to each other.

In contrast, Dynamical Mode Decomposition (DMD)[3,4] naturally extracts the shear layer coherent structures associated with each dominant mode. Shear layer modes are often assumed to be roughly 2D coherent structures, *ie* without significant variations in the spanwise direction. This is due to the fact that self-sustained oscillations in the shear layer result from a Kelvin-Helmholtz instability, which is intrisically two dimensional.

The study is based on time-resolved PIV in a streamwise plane and 3D numerical datasets. By considering the divergence of the 2D velocity field constitutive of the two shear layer dynamical modes, we show that shear layer modes clearly exhibit spanwise velocity gradients. The DMD analysis of the 3D numerical dataset (see figure 1) confirms the complex 3D behaviour of the shear layer oscillations.



(a) (b) (c)

Figure 1: The 3D organization of a shear layer mode.(a): 3D dynamical mode from DNS. (b): 2D dynamical mode from PIV measurement. (c): divergency field of the 2D dynamical mode.

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