Mardi 22 juin

à 14h00

IMFT - Amphithéâtre Nougaro

Allée du Professeur Camille Soula 31400 Toulouse

Global modes and non-linear spectral analysis of the jet in cross flow

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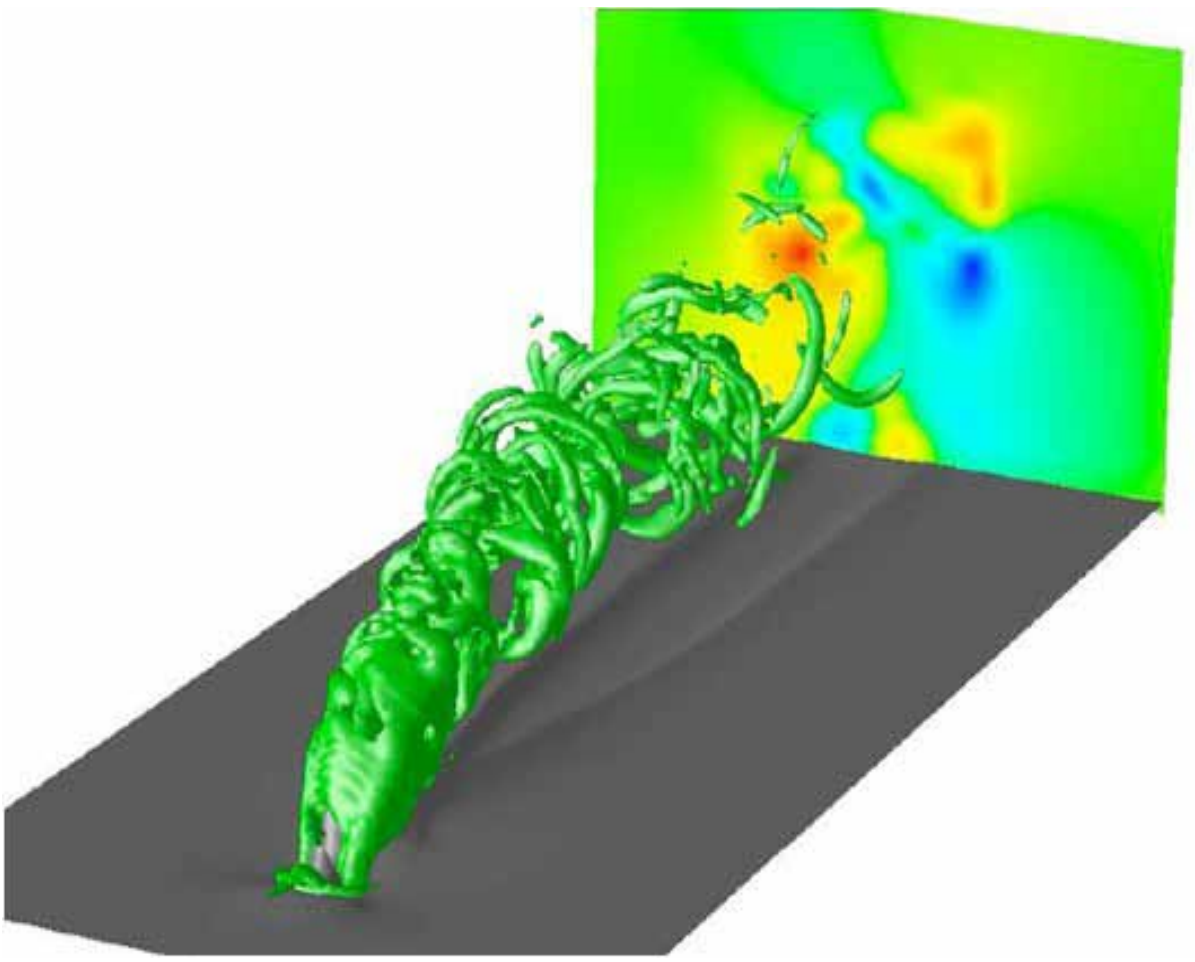

A linear stability analysis shows that the jet in crossflow is characterized by selfsustained global oscillations for a jet-to-crossflow velocity ratio of 3. A fully threedimensional unstable steady-state solution and its associated global eigenmodes are computed by direct numerical simulations and iterative eigenvalue routines. The steady flow, obtained by means of selective frequency damping, consists mainly of a (steady) counter-rotating vortex pair (CVP) in the far field and horseshoe-shaped vortices close to the wall. High-frequency unstable global eigenmodes associated with shear-layer instabilities on the CVP and low-frequency modes associated with shedding vortices in the wake of the jet are identified. Furthermore, different spanwise symmetries of the global modes are discussed. This work constitutes the first simulation-based global stability analysis of a fully three-dimensional base flow.

We also present a technique for describing the global behaviour of complex nonlinear flows by decomposing the flow into modes determined from spectral analysis of the Koopman operator, an infinite-dimensional linear operator associated with the full nonlinear system. These modes, referred to as Koopman modes, have an associated temporal frequency and growth rate and may be viewed as a nonlinear generalization of global eigenmodes of a linearized system. They provide an alternative to proper orthogonal decomposition, and in the case of periodic data the Koopman modes reduce to a discrete temporal Fourier transform. The Arnoldi method used for computations is identical to the dynamic mode decomposition, which can be thought of as an algorithm for finding Koopman modes. We illustrate the method on an example of a jet in crossflow, and show that the method captures the and elucidates the associated spatial structures.

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