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Mechanism of axis-switching in low aspect-ratio rectangular jets
NAN CHEN, HUIDAN (WHITNEY) YU, Indiana University-Purdue University Indianapolis (IUPUI) — Axis-switching (AS) refers to the change in the orientation of the major axis of the jet from initial spanwise to later lateral direction. This phenomenon is of great interest both from fundamental physics and practical application points of view. AS is most noticeable in square and low aspect-ratio (AR) rectangular jet flows. It has been reported experimentally and computationally that square jet and rectangular jets switch the major axis 45^0 and 90^0 respectively. In this work we explore the mechanism of AS phenomenon through direct numerical simulation using lattice Boltzmann method for 5 rectangular jets with different aspect ratios at relatively low Reynolds numbers. We identified the three characteristic regions of jet flow that are potential core (PC), characteristic decay (CD), and axisymmetric decay (AD) regions. It is found that 45^0 (square jet) and 45^0 first then 90^0 (rectangular jets) AS occur in the CD region. The correlation between jet propagate velocity and coherent structure shows that the 45^0 AS occurs close to the entrance of CD region where the correlation gets the maximum value, indicating that the 45^0AS is driven mainly by the jet propagatation. The 90^0AS appears close to the end of the CD region and doesn't show unified relation to the correlation for different jets. The mechanism of 90^0AS is more complicated because both jet propagation and boundary condition contribute the driven. Meanwhile, flow pattern and vortices are closely looked into to reveal the mechanism of AS phenomena.

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