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Transverse jet shear layer instabilities and their control

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The jet in crossflow, or transverse jet, is a canonical flowfield that has relevance to engineering systems ranging from dilution jets and film cooling for gas turbine engines to thrust vector control and fuel injection in high speed aerospace vehicles to environmental control of effluent from chimney and smokestack plumes. Over the years, our UCLA Energy and Propulsion Research Lab's studies on this flowfield have focused on the dynamics of the vorticity associated with equidensity and variable density jets in crossflow, including the stability characteristics of the jet's upstream shear layer. A range of different experimental diagnostics have been used to study the jet's upstream shear layer, whereby a transition from convectively unstable behavior at high jet-to-crossflow momentum flux ratios to absolutely unstable flow at low momentum flux and/or density ratios is identified. These differences in shear layer stability characteristics have a profound effect on how one employs external excitation to control jet penetration, spread, and mixing, depending on the flow regime and specific engineering application. These control strategies, and challenges for future research directions, will be identified in this presentation.