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Effect of Global Acceleration on the Stability of a Thermoacoustically Coupled Shear Layer in a Backward-Facing Step Combustor JOEL VASANTH, SATYANARAYANAN CHAKRAVARTHY, Department of Aerospace Engineering, IIT Madras — The impact of the acoustic field on variable density flow in a step combustor is explored via a linear stability analysis of the low Mach number Navier-Stokes equations. In the equi-time scales limit, the acoustic feedback to the flow reduces to a global acceleration (GA) as a momentum source. The velocity profiles are parameterized by shear layer thickness δ and reverse flow ratio β. To close the equation set, the n-τ flame model is used. A local spatio-temporal perturbation analysis shows a shift in the absolutely/convectively unstable (AU/CU) transition boundaries towards the AU zone in the β-δ space as the flame response gain is increased. Further, the AU modes are less responsive to the acoustic feedback than the CU modes, affirming the semi-open/fully-closed loop mechanisms of acoustic feedback advanced in recent literature. Competing contributions of the vorticity equation source terms to the overall vorticity generation show that the GA is always destabilizing unlike the density gradient, which could be stabilizing under some conditions. The GA and the resultant of vorticity production and baroclinic vorticity are in phase under all conditions, which implies the forcing nature of the GA that unconditionally promotes combustion instability.

Joel Vasanth
PhD Candidate, Department of Aerospace Engineering, IIT Madras

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