Supersonic hydrogen combustion induced by shock waves LaTeX

F. De Vita*, M. Di Renzo† and G. Pascazio*

We present high fidelity simulations of the turbulent combustion of an air-hydrogen mixture induced by shock waves at high Mach number. This is the detonation mechanism adopted in the shock-induced combustion RAMjet (SHCRAMJet), a type of supersonic combustion RAMJet (SCRAMJet) for high Mach number flows (approximately greater than 5)[1]. A numerical simulation of the real SHCRAMJet exhibits several challenges: compressible flow at high Mach number; flow evolution under complex geometry; complex chemical reactions; long time evolution of the process to capture both high frequency and low frequency effects in the flow. To simplify the problem, we propose to perform three-dimensional direct numerical simulations of a turbulent boundary layer over a flat plate with an impinging shock wave. The fuel is modelled as a nine species mixutres of air and hydrogen with twenty-one chemical reactions. The shock wave is injected from the top of the domain, impacts on the bottom wall and induce the ignition of the mixture downstream of the impact region: Fig. 1 display the instantaneous density gradient magnitude contour in a streamwise/wall-normal plane, highlighting shock waves and the flame front. Simulations have been performed employing the recently developed solver HTR, dedicated for hypersonic aerothermodynamics[2]. We will present results about the ignition of the mixture, recirculation bubble size, effect of the combustion on the flow statistics, correlation between flow variables and checmical species composition.

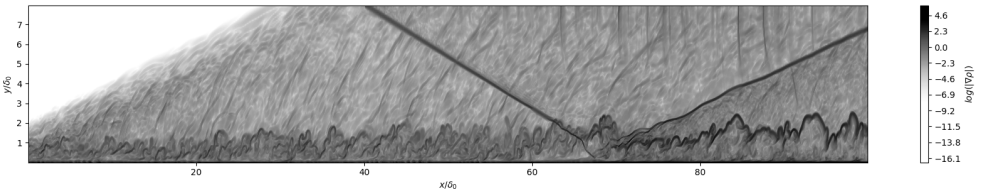

Figure 1: Contour of the magnitude of the density gradient in a streamwise/wall-normal plane.

*Dipartimento di Meccanica, Matematica e Management, Politecnico di Bari, Bari, Italia
†Dipartimento di Ingegneria dell'Innovazione, Universit'a del Salento, Lecce, Italia

[1]Urzay, *Annu Rev Fluid Mech* **50**, (2018)
[2]Di Renzo et al., *Comput Phys Commun* **255**, 107262 (2020)