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ADVANCES IN MODELLING AND SIMULATION FOR HIGH-SPEED AERODYNAMICS

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ABSTRACT

Recent years have witnessed a renewed interest in developing high-speed flight technology [1]. For instance, commercial aircraft manufacturers are heavily investing in hypersonic technology that can dramatically reduce intercontinental passenger flight time making same-day global round trips a reality. The wide range of atmospheric and flow conditions corresponding to different altitudes and Mach numbers that a hypersonic vehicle undergoes presents a huge challenge to aerodynamic design, propulsion, and flow control [2]. At lower altitudes, where the flow is regarded as continuum, the effect of turbulence is critical, whereas at higher altitudes, flow rarefaction due to low-density effects becomes important. This warrants high-fidelity numerical models that can reliably simulate these conditions, at all altitudes, accurately.

The progress in numerical schemes, computational fluid dynamics (CFD) software, rarefied gas dynamics models, and high-performance computing, has enabled advances through large-scale high-fidelity simulations of high-speed flows. However, much of the flow physics associated with hypersonic vehicles and their propulsion system remain poorly understood, especially for those related to boundary layer transition, shock-wave/boundary layer interaction and non-equilibrium thermodynamics. In terms of engineering applications, the adaptability of the turbulence models, which were usually developed targeting incompressible flows, is also not clear for supersonic/hypersonic flows. At altitudes above 100km, modelling non-equilibrium aerothermodynamic effects due to low-density, real-gas effects, and chemical reactions associated with high-enthalpy, high-altitude flow conditions, continue to be a formidable challenge.

This mini-symposium will target and communicate on recent progress in CFD for supersonic and hypersonic aerodynamics at all altitudes. Topics of interest of this mini-symposium include, but are not limited to:

- High-performance computing of high-speed flows

- Numerical schemes, models, and algorithms
- Supersonic/hypersonic wall bounded flow and boundary layer control.
- Shock-wave/boundary layer interaction
- Turbulence modelling for high-speed flows
- Fluid–structure interaction in high-speed flows
- Application of CFD to supersonic/hypersonic engineering
- Direct simulation Monte Carlo (DSMC) and hybrid CFD-DSMC models for high-altitude flows
- Alternate models like Method of Moments, gas kinetics
- High temperature effects related to chemistry, ablation, etc.

REFERENCES

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