

Toward realistic jet-installation noise prediction using LBM

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Prediction of the noise source encountered in next-generation propulsion systems of aircraft, such as Ultra-High Bypass Ratio (UHBR) turbofan engines, is addressed in this work using the Lattice Boltzmann Method (LBM). While increasing the fan diameter reduce jet noise, the engine's proximity to the wing can generate more installation noise. Due to the complex geometry and flow characteristics of UHBR engines, along with the long simulation time required to converge aeroacoustic simulations, the LBM represents an appealing alternative for studying the jet-installation noise of UHBR engines [1]. To address this, a hybrid LBM approach was developed and applied to analyze high-speed compressible flows in the *ProLB* solver [2, 3, 4]. The methodology is first validated on the flow and noise radiated by an isothermal round jet at Mach number $M=0.9$ and Reynolds number $Re = 1 \times 10^6$ [5]. Subsequently, a simulation of the DJINN Baseline isolated nozzle is performed (illustrated in Fig. 1) and compared with experimental data.

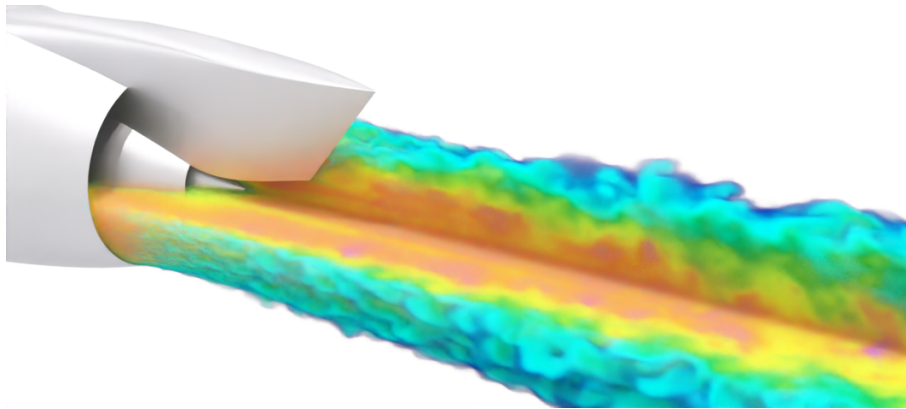


Fig. 1: Instantaneous view of the velocity magnitude on the DJINN Baseline isolated nozzle

References

- [1] L. Rego, F. Avallone, D. Ragni, & D. Casalino. Jet-installation noise and near-field characteristics of jet-surface interaction. *Journal of Fluid Mechanics*, 895, 2020.
- [2] F. Renard, G. Wissocq, J.-F. Boussuge, and P. Sagaut. A linear stability analysis of compressible hybrid lattice Boltzmann methods. *Journal of Computational Physics*, 446:110649, 2021.
- [3] Y. Feng, P. Boivin, J. Jacob, and P. Sagaut. Hybrid recursive regularized thermal lattice Boltzmann model for high subsonic compressible flows. *Journal of Computational Physics*, 394:82–99, 2019.
- [4] F. Renard, Y. Feng, J.-F. Boussuge, and P. Sagaut. Improved compressible hybrid lattice Boltzmann method on standard lattice for subsonic and supersonic flows. *Computers & Fluids*, 219:104867, 2021.
- [5] G. A. Brès, P. Jordan, V. Jaunet, M. Le Rallic, A. V. G. Cavalieri, A. Towne, S. K. Lele, T. Colonius, and O. T. Schmidt. Importance of the nozzle-exit boundary-layer state in subsonic turbulent jets. *Journal of Fluid Mechanics*, 851:83–124, 2018.

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