Master Thesis / Bachelor Thesis

Extension of lattice Boltzmann method toward highly compressible flows

Over the last few decades, the lattice Boltzmann method (LBM) has been successfully applied to an increasing number of flow problems, such as incompressible flows, multiphase flows, and aeroacoustic applications, among others. Due to the simplicity and locality of its underlying algorithm, favorable parallelization properties as well as low numerical dissipation and dispersion, the LBM not only rivals, but in many cases surpasses classical computational fluid dynamics (CFD) methods based on the discretization of the Navier-Stokes equations in terms of efficiency.
Since the classical LBM features error terms that are only negligible for small Mach numbers and constant temperature, it cannot be applied to strongly compressible flows as well as flows featuring large temperature differences. In an effort to replicate the successes achieved with the LBM in the weakly compressible regime, many researchers are looking for ways to extend the classical formulation such that it can deal with the above-described flows. While these research efforts have partly been successful, high Mach numbers and temperature differences continue to pose a challenge for the LBM and more research is required to further increase the range of flow regimes that can be efficiently simulated using the LBM.
This thesis aims to lay the groundwork to use the above-mentioned extended LB models in the institute's in-house flow solver m-AIA. Once the basic framework is implemented and validated, it can be extended to test further model extensions pertaining to compressible LBM. In the long run, the aim is to progressively increase the complexity of test cases and range of flow regimes that can be efficiently simulated using the LBM.

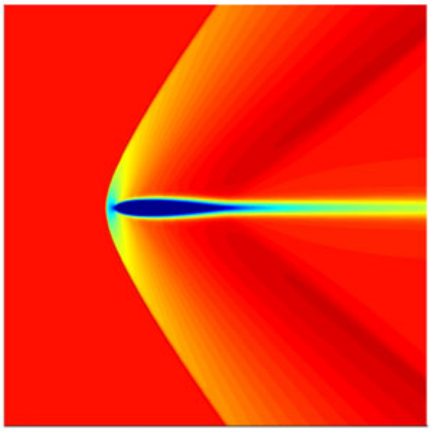

Fig. 1: Airfoil in supersonic flow [1] .

Research aspects

- Learn the fundamentals of LBM
- Build on existing flow solver
- Work on academic validation cases
- Develop new methods

You ...

- ... are searching for an interesting thesis in the field of CFD
- ... have advanced programming experience (preferably C++ and python)
- ... are eager to learn new skills and able to work in an independent manner

If you are interested, please contact incl. CV and transcript of records:

Contact: Jean-Marc Heinricy, M.Sc.
Lehrstuhl für Strömungsmechanik und Aerodynamisches Institut
Wüllnerstr. 5a, 52062 Aachen
Mail: jm.heinricy@aia.rwth-aachen.de

[1] S.A. Hosseini et al., Phil. Trans. R. Soc. A 2020; 378. http://dx.doi.org/10.1098/rsta.2019.0399