Title: Truly multi-dimensional all-speed methods for the Euler equations

Author: Wasilij Barsukow (CNRS / Institut de Mathématiques de Bordeaux, France)

Abstract: Numerical diffusion, added to stabilize explicit finite volume methods for the Euler equations, usually makes the method unsuitable for low Mach number computations. Here, two new strategies to deal with this problem are proposed. First, instead of removing terms in the diffusion (or rescaling them), they are complemented in a way to make appear the divergence. It is shown that this modification achieves the same as low Mach number fixes of the usual kind, but comes at the advantage of not modifying the one-dimensional method, and thus having much better stability properties. This method is truly multi-dimensional, i.e. the flux through an interface also depends on the values in cells adjacent to the endpoints of the edges (corners). Second, it is shown that a central method for acoustics can be stabilized using one of the variants of leap-frog time integration, yielding an explicit method without the usual diffusive terms, and thus without a low Mach number problem. It is shown how such a method can be extended to the Euler equations by only including upwind diffusion for the advective operator. The proposed methods are automatically all-speed, i.e. able to deal with both low and high Mach number flow.

References:
- Wasilij Barsukow: All-speed numerical methods for the Euler equations via a sequential explicit time integration, 2023 accepted (https://arxiv.org/abs/2301.12423)
- Wasilij Barsukow: Truly multi-dimensional all-speed schemes for the Euler equations on Cartesian grids, J. Comp. Phys. 435 (2021), 110216 (https://arxiv.org/abs/2103.02621)