Stable schemes for weakly compressible flows

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In this talk, we consider the Euler equations at low Mach number which happen to form a singularly perturbed system of differential equations, as pressure is scaled by a factor depending on the inverse of the Mach number. It is well-known that, given suitable boundary and initial conditions (*well-prepared data*), there is a continuous limit as the Mach number tends to zero; this limit is the incompressible Euler equations.
Capturing the flow for a finite Mach number efficiently and accurately is a very difficult endeavour. In computational fluid dynamics (CFD), explicit time-integration schemes are typically preferred over implicit ones due to better accuracy properties. However, in the low Mach case, these schemes impose a CFL condition that is typically overly restrictive. Implicit schemes, on the other hand, possess all the good stability properties, but tend to smear out the solution. The optimal solution would be of course to combine explicit and implicit time integration schemes, resulting in IMEX schemes. The crucial part in using IMEX schemes is a suitable identification of stiff (to be treated implicitly) and nonstiff parts (to be treated explicitly).
In the work presented here, we consider IMEX schemes based on a recently developed splitting of the convective flux into stiff and nonstiff parts, making use of the incompressible limit solution. We discuss stability and accuracy properties of the resulting method and show comparisons to other low Mach solvers.

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