

Title: Asymptotic Preserving IMEX Time Integrators for Low Mach Number Hydrodynamics and Quasineutral Plasma

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Abstract

We consider some distinguished sound-proof models of the compressible Euler equations of atmospheric flows and the quasineutral model of the Euler-Poisson equations of plasma fluids. All these models can be obtained as singular limits of the governing hydrodynamic equations, and robust numerical approximation of the limits is a challenging task. We design and analyse numerical schemes for the singularly perturbed fluid equations in the so-called asymptotic preserving (AP) framework. The time discretisation is realised by using implicit-explicit (IMEX) Runge-Kutta (RK) methods and the space discretisation by a finite volume technique. Uniform stability and accuracy throughout the asymptotic regime, preservation of meteorologically relevant structures, well-balancing property for steady states, and the compliance with the transition of governing equations are established for the proposed schemes. The results of numerical case studies demonstrate the robustness and efficacy of the schemes under consideration.