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A novel implicit finite volume scheme for hypersonic steady flow problems

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Implicit time discretization in computational fluid dynamics to compute steady state solution of hypersonic flows was a field of researches in the 70's-80's. Since then, only few novel methods have arised. It is suitable for computational efficiency to use implicit finite volume schemes to solve steady state for hyperbolic systems, because theoretically these schemes do not suffer from timestep restrictions to guarantee stability, unlike the explicit ones. Nonetheless, CFL like restrictions are still required in practice, especially for stiff numerical test cases such as high Mach number stationary flow with bow shocks around obstacles. Nowadays, the well-known Yee's method [3] is commonly used to solve CFD problems the implicit way. However, this method has no formal theoretical basis for systems of conservation laws [1]. Consequently, the increase of time step is driven by several ad-hoc parameters depending on the test case. The purpose of this presentation is to first study the mathematical environment of implicit finite volume schemes to enlight their weaknesses. Secondly, we will propose a new approach based on a more adequate linearization presented for the Roe scheme [2] for convenience, but in a general framework of finite volume schemes. The new method aims to be more robust and possibly more efficient regarding timestep restrictions. Numerical results will assess
this study.

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