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Stability Criteria Of The Advection Equation Using High Order Mimetic Runge Kutta Methods

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The numerical solution of a partial differential equation is said to be numerically stable when the errors stay bounded at each time step of the calculation. Stability is guaranteed by imposing a bound on the ratio of the spatial and temporal discretization sizes. This condition is commonly referred to as the CFL criteria (or the Courant number). Mimetic discretization methods are structure-preserving schemes that mimic the divergence and gradient operators by discretizing the extended Gauss' divergence theorem. The Castillo-Grone coefficients discretize the extended Gauss' divergence theorem in the generalized inner product norm, and can achieve high orders of accuracy. In this work, we calculate the CFL criteria using an eigenvalue stability analysis for the 1D advection equation using the Mimetic spatial discretization and Runge Kutta (RK) temporal schemes. Mimetic schemes of orders 2, 4 and 6 are considered, with RK schemes of orders 2, 3, 4 and 6. The proposed methodology can be readily extended to the advection equation of higher dimensions. We also present an extension of this work for the wave equation in 1D and higher dimensions.