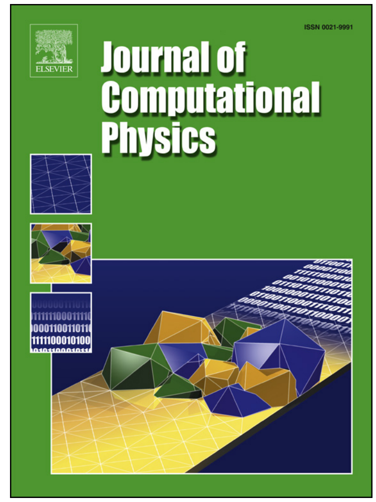

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PII: S0021-9991(17)30018-9
DOI: http://dx.doi.org/10.1016/j.jcp.2017.01.008
Reference: YJCPH 7070

To appear in: *Journal of Computational Physics*

Received date: 11 September 2016
Revised date: 4 December 2016
Accepted date: 6 January 2017

On consistency and rate of convergence of Flux Reconstruction for time-dependent problems

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Abstract

This study is directed at a rigorous characterization of the consistency and convergence of discontinuous finite element schemes formulated using Flux Reconstruction (FR). We show that the FR formulation is consistent for linear advection and converges to the exact solution for any scheme that is stable in the von Neumann sense. The numerical solution for a scheme of polynomial order P is composed of $P+1$ eignemodes, of which, one and exactly one is 'physical' such that it exhibits the analytical dispersion behavior in the limit of asymptotic grid resolution. The remaining P modes are 'spurious' such that the fraction of energy received by them from the initial condition vanishes in the asymptotic limit. On grid refinement, the rate of convergence of the numerical solution is a function of time, starting from a short-time rate at $t = 0^+$, associated with interpolation, and asymptotically approaching a long-time rate as $t \to \infty$, associated with numerical differentiation. Both these rates can be inferred directly from the eigensystem of the numerical derivative operator. We verify these analytical expectations using simple experiments in 1-D and 2-D.

Keywords: Flux Reconstruction, Discontinuous Galerkin, consistency, rate of convergence, dispersion, dissipation
2000 MSC: 65M12, 65M15, 65M60

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