

# Accepted Manuscript

Multidimensional Riemann problem with self-similar internal structure – Part III– A multidimensional analogue of the HLLI Riemann solver for conservative hyperbolic systems

Dinshaw S. Balsara, Boniface Nkonga

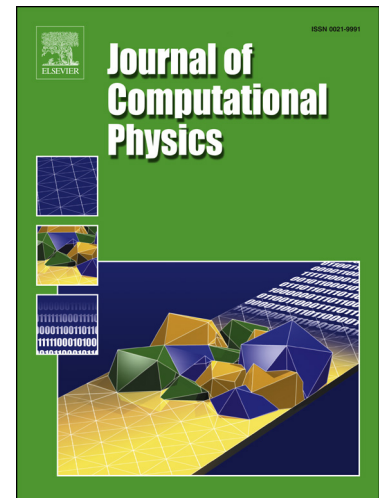
PII: S0021-9991(17)30421-7  
DOI: <http://dx.doi.org/10.1016/j.jcp.2017.05.038>  
Reference: YJCPH 7385

To appear in: *Journal of Computational Physics*

Received date: 18 December 2016  
Revised date: 16 May 2017  
Accepted date: 18 May 2017

Please cite this article in press as: D.S. Balsara, B. Nkonga, Multidimensional Riemann problem with self-similar internal structure – Part III– A multidimensional analogue of the HLLI Riemann solver for conservative hyperbolic systems, *J. Comput. Phys.* (2017), <http://dx.doi.org/10.1016/j.jcp.2017.05.038>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.



# Multidimensional Riemann Problem with Self-Similar Internal Structure – Part III– A Multidimensional Analogue of the HLLI Riemann Solver for Conservative Hyperbolic Systems

By

Dinshaw S. Balsara<sup>1</sup> and Boniface Nkonga<sup>2</sup>

<sup>1</sup>Physics Department, University of Notre Dame, USA (dbalsara@nd.edu)

<sup>2</sup>Université de Nice-Sophia Antipolis, UMR CNRS & Inria Sophia Antipolis, France  
(boniface.nkonga@unice.fr)

## Abstract

Just as the quality of a one-dimensional approximate Riemann solver is improved by the inclusion of internal sub-structure, the quality of a multidimensional Riemann solver is also similarly improved. Such multidimensional Riemann problems arise when multiple states come together at the vertex of a mesh. The interaction of the resulting one-dimensional Riemann problems gives rise to a strongly-interacting state. We wish to endow this strongly-interacting state with physically-motivated sub-structure. The fastest way of endowing such sub-structure consists of making a multidimensional extension of the HLLI Riemann solver for hyperbolic conservation laws. Presenting such a multidimensional analogue of the HLLI Riemann solver with linear sub-structure for use on structured meshes is the goal of this work. The multidimensional MuSIC Riemann solver documented here is universal in the sense that it can be applied to any hyperbolic conservation law.

The multidimensional Riemann solver is made to be consistent with constraints that emerge naturally from the Galerkin projection of the self-similar states within the wave model. When the full eigenstructure in both directions is used in the present Riemann solver, it becomes a complete Riemann solver in a multidimensional sense. I.e., all the intermediate waves are represented in the multidimensional wave model. The work also presents, for the very first time, an important analysis of the dissipation characteristics of multidimensional Riemann solvers. The present Riemann solver results in the most efficient implementation of a multidimensional Riemann solver with sub-structure. Because it preserves stationary linearly degenerate waves, it might also help with well-balancing. Implementation-related details are presented in pointwise fashion for the one-dimensional HLLI Riemann solver as well as the multidimensional MuSIC Riemann solver.

Several stringent test problems drawn from hydrodynamics, MHD and relativistic MHD are presented to show that the method works very well on structured meshes. Our results demonstrate the versatility of our method. The reader is also invited to watch a video

Download English Version:

<https://daneshyari.com/en/article/4967250>

Download Persian Version:

<https://daneshyari.com/article/4967250>

[Daneshyari.com](https://daneshyari.com)