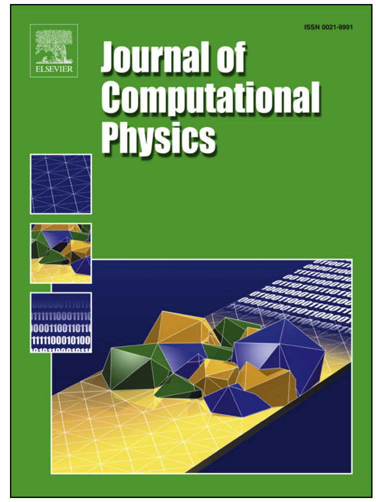
Accepted Manuscript

A Third-Order Moving Mesh Cell-Centered Scheme for One-Dimensional Elastic-Plastic Flows

Jun-Bo Cheng, Weizhang Huang, Song Jiang, Baolin Tian



PII: S0021-9991(17)30589-2
DOI: http://dx.doi.org/10.1016/j.jcp.2017.08.018
Reference: YJCPH 7520

To appear in: *Journal of Computational Physics*

Received date: 2 January 2017
Revised date: 22 July 2017
Accepted date: 8 August 2017

A Third-Order Moving Mesh Cell-Centered Scheme for One-Dimensional Elastic-Plastic Flows

Jun-Bo Cheng* Weizhang Huang† Song Jiang‡ Baolin Tian§

A third-order moving mesh cell-centered scheme without the remapping of physical variables is developed for the numerical solution of one-dimensional elastic-plastic flows with the Mie-Grüneisen equation of state, the Wilkins constitutive model, and the von Mises yielding criterion. The scheme combines the Lagrangian method with the MMPDE moving mesh method and adaptively moves the mesh to better resolve shock and other types of waves while preventing the mesh from crossing and tangling. It can be viewed as a direct arbitrarily Lagrangian-Eulerian method but can also be degenerated to a purely Lagrangian scheme. It treats the relative velocity of the fluid with respect to the mesh as constant in time between time steps, which allows high-order approximation of free boundaries. A time dependent scaling is used in the monitor function to avoid possible sudden movement of the mesh points due to the creation or diminishing of shock and rarefaction waves or the steepening of those waves. A two-rarefaction Riemann solver with elastic waves is employed to compute the Godunov values of the density, pressure, velocity, and deviatoric stress at cell interfaces. Numerical results are presented for three examples. The third-order convergence of the scheme and its ability to concentrate mesh points around shock and elastic rarefaction waves are demonstrated. The obtained numerical results are in good agreement with those in literature. The new scheme is also shown to be more accurate in resolving shock and rarefaction waves than an existing third-order cell-centered Lagrangian scheme.

Key Words. Elastic-plastic flows; Cell-centered Lagrangian scheme; Moving mesh method; High order scheme; Hypoelastic constitutive model
Abbreviated title. A third-order moving mesh scheme for elastic-plastic flows

*Laboratory of Computational Physics, Institute of Applied Physics and Computational Mathematics, Beijing, China (*cheng_junbo@iapcm.ac.cn*)
†Department of Mathematics, the University of Kansas, Lawrence, KS 66045, U.S.A. (*whuang@ku.edu*)
‡Laboratory of Computational Physics, Institute of Applied Physics and Computational Mathematics, Beijing, China (*jiang@iapcm.ac.cn*)
§Laboratory of Computational Physics, Institute of Applied Physics and Computational Mathematics, Beijing, China (*tian_baolin@iapcm.ac.cn*)