ADAPTIVE EXPONENTIAL MULTI-OPERATOR SPLITTING FOR MHD

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ABSTRACT

We construct splitting methods for the solution of the equations of magnetohydrodynamics (MHD). The physical and mathematical properties of the involved operators imply that splittings into three or even four operators with positive coefficients are appropriate for a physically correct and efficient solution of the equations of motion. To obtain a solution approximation with reliable accuracy efficiently, adaptive choice of the time-steps is important particularly in the light of the unsmooth dynamics of the system. Thus, we construct new method coefficients in conjunction with associated error estimators by optimizing the leading local error term similarly as in [1]. The new coefficients are given in the collection

`https://www.asc.tuwien.ac.at/auzinger/splitting/`

As a proof of concept, we demonstrate that adaptive splitting faithfully reflects the solution behavior also in the presence of a shock for the viscous Burgers equation, which serves as a simplified model problem displaying several features of the Navier–Stokes equation for incompressible flow, see [2].

References

[1] W. Auzinger, H. Hofstätter, D. Ketcheson, O. Koch, *Practical splitting methods for the adaptive integration of nonlinear evolution equations. Part I: Construction of optimized schemes and pairs of schemes*, BIT Numer. Math. 57/1 (2017), pp. 55–74.

[2] O. Koch, K. Acar, W. Auzinger, F. Kupka, and B. Moser, *Adaptive exponential multi-operator splitting for MHD*, submitted. Preprint available from `https://arxiv.org/abs/2302.01092`.

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