Contribution ID: **79** Type: **Oral Presentation**

A relaxation method for nonlinear convection-diffusion processes with discontinuous terms

Monday 19 May 2025 14:05 (15 minutes)

We propose a mathematical relaxation method for nonlinear partial differential equations of convection-diffusion type discontinuous terms and computational applications [1,2]. We reformulate the underlying convection-diffusion problem as a system of hyperbolic equations coupled with relaxation terms. In contrast to existing literature on relaxation modeling (see, e.g., [3,4] and the references cited therein), where the solution of the reformulated problem converges to certain types of hyperbolic conservation laws as the limit of equations involving regularizing higher order terms in the possible mixed diffusive/dispersive limit, our formalism treats the augmented problem as a system of coupled hyperbolic equations with relaxation acting on both the convective flux and the source term [1,2,5]. We have shown the new system of equations satisfies Liu's sub-characteristic condition. Further, we present several one-dimensional numerical experiments, including nonlinear convection-diffusion problems with discontinuous coefficients motivated by discontinuous capillary pressure for two-phase flows in porous media, aiming to illustrate the feasibility of the approach.

[1] E. Abreu, W. Lambert, A. M. Espírito Santo and John Perez. A relaxation approach to modeling properties of hyperbolic-parabolic type models, Communications in Nonlinear Science and Numerical Simulation, Volume 133 (2024). LINK: https://doi.org/10.1016/j.cnsns.2024.107967.

[2] E. Abreu, P. Ferraz, W. Lambert. A study of non-equilibrium wave groups in two-phase flow in high-contrast porous media with relative permeability hysteresis, Communications in Nonlinear Science and Numerical Simulation, (2023). LINK: https://doi.org/10.1016/j.cnsns.2023.107552.

[3] J. Hu, S. Jin and Q, Li, Asymptotic-preserving schemes for multiscale hyperbolic and kinetic equations. Handb Numer Anal 2017;18:103-29. LINK: https://doi.org/10.1016/bs.hna.2016.09.001

[4] S. Jin, L. Pareschi and G. Toscani, Diffusive relaxation schemes for multiscale discrete-velocity kinetic equations. SIAM J Numer Anal 1998;35(6):2405-39. LINK: https://doi.org/10.1137/S0036142997315962

[5] E. Abreu, A. Bustos, P. Ferraz and W. Lambert (2019), A Relaxation Projection Analytical-Numerical Approach in Hysteretic Two-Phase Flows in Porous Media. Journal of Scientific Computing, v.79, p.1936. LINK: https://link.springer.com/article/10.1007%2Fs10915-019-00923-4

Country

Brazil

Acceptance of the Terms & Conditions

Click here to agree

Student Awards

References

E. Abreu, Associate Professor, Department of Applied Mathematics – http://www.ime.unicamp.br/~eabreu/ | University of Campinas - UNICAMP, Brazil – https://www.unicamp.br/en

Authors: Dr ESPÍRITO SANTO, Arthur (Universidade Federal do Rio Grande do Sul); ABREU, Eduardo (University of Campinas, Sao Paulo, Brazil); Prof. PÉREZ, John (Instituto Tecnologico Metropolitano –ITM, Medellín, Colombia); LAMBERT, Wanderson (UNIFAL)

Presenter: ABREU, Eduardo (University of Campinas, Sao Paulo, Brazil)

Session Classification: MS07

Track Classification: (MS07) Mathematical and numerical methods for multi-scale multi-physics, nonlinear coupled processes