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Moving-boundary simulation of tumor growth with a second-order positivity-preserving finite volume method

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Abstract

We present a second-order positivity-preserving finite volume scheme for avascular tumor growth on a moving domain. The model couples a convection-diffusion PDE for the cell density with a nonlinear ODE for the tumor radius, forming a free-boundary system in which the domain evolves with the solution [1]. The scheme combines monotonic upstream-centered scheme for conservation laws reconstruction 'MUSCL', flux-corrected transport, and time integration scheme, with the radius equation in exponential form guaranteeing strict positivity at every step. Validation by the method of manufactured solutions confirms spatial order 2 [2] [3]. Same benchmarks tests on the coupled system establish exact geometric conservation, mass conservation to machine precision, and unconditional positivity under non-monotone radius dynamics [4]. Applied to realistic biological scenarios, the scheme captures aggressive growth, transient equilibrium, and therapeutic shrinkage, demonstrating its ability to simulate realistic tumor evolution while preserving physical constraints [5].

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References

- [1] J. Droniou et al. "Numerical Solution of a Two Dimensional Tumour Growth Model with Moving Boundary." *Journal of Scientific Computing*, 85 (2020).
- [2] Nikhil Manoj et al. "A positivity preserving second-order scheme for multi-dimensional system of non-local conservation laws." *ArXiv*, abs/2412.18475 (2024).
- [3] Zhiming Gao et al. "A Second-Order Positivity-Preserving Finite Volume Scheme for Diffusion Equations on General Meshes." *SIAM J. Sci. Comput.*, 37 (2015).
- [4] Xianyi Zeng et al. "On finite volume discretization of infiltration dynamics in tumor growth models." *Advances in Computational Mathematics*, 45 (2018): 3057 - 3094.
- [5] Abdelaziz Ben Lahbib; Lahcen Azrar; Martine D. Ben Amar "Stochastic analysis of tumor microenvironment dynamics: Interplay between cytotoxic T-cells and cancer-associated fibroblasts" submitted to *The European Physical Journal Plus*, 2026.