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Structure preserving methods for time-fractional reaction-diffusion problems

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Fractional differential models are powerful tools for describing complex phenomena characterized by memory effects, anomalous diffusion, and long-range interactions, with applications in mechanics, biology, chemical engineering, and other fields. However, their numerical solution poses challenges in terms of accuracy and computational cost; moreover, capturing the dynamics of real problems often requires preserving qualitative properties such as conservation laws, positivity, and monotonicity.

In this talk, we focus on the numerical solution of time-fractional partial differential problems. We propose a mixed spectral method, which is able to preserve the conservation laws of the analytical solution. Secondly, to obtain positivity preserving methods, we develop and analyse two classes of non-standard spatial discretization schemes, combined with L1 or Grünwald-Letnikov approaches in time. As a meaningful application, we consider a fractional model for charge carriers, applicable in batteries based on disordered semiconductors, such as P3HT used in lithium batteries, where anomalous diffusion arises.

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References

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