

ADAPTED NUMERICAL METHODS FOR REACTION-DIFFUSION PROBLEMS IN SUSTAINABILITY

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Abstract

Reaction-diffusion models play a central role in sustainability-related phenomena, from ecological dynamics to battery modeling. After space discretization, they lead to large and highly stiff ODE systems, whose solution is particularly demanding especially when long-time integrations and repeated simulations are required, for instance in parameter calibration. We discuss adapted numerical methods for their efficient and reliable time integration. In particular, starting from the TASE-RK framework [3], we consider related modifications and generalizations [1,4], including linearly implicit formulations connected with W-methods [2]. These approaches rely on problem-adapted operators to improve stability and efficiency while retaining accuracy. We also discuss their combination with splitting techniques, such as Approximate Matrix Factorization [2], and matrix-oriented formulations for multidimensional problems, in order to further reduce computational costs. Numerical experiments illustrate the effectiveness of the proposed strategies.

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Keywords: reaction-diffusion problems, sustainability, TASE-RK methods, W-methods

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