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Numerical Evolution Methods of Rational Form for Reaction Diffusion Equations

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Abstract

The purpose of this study was to investigate select numerical methods that demonstrate good performance in solving PDEs that couple diffusion and reaction terms. These types of equations have numerous fields of application such as environmental studies, biology, chemistry, medicine, and ecology. Our aim was to investigate and develop accurate and efficient approaches which compare favourably to other applicable methods. In particular, we investigated and adapted a relatively new class of methods based on rational polynomials. Namely, Padé time stepping (PTS), which is highly stable for the purposes of the present application and is associated with lower computational costs. Furthermore, PTS was optimized for our study to focus on reaction diffusion equations. Due to the rational form of PTS method, a local error control threshold (LECT) was proposed. Numerical runs were conducted to obtain the optimal LECT. In addition, new schemes based on both PTS and splitting methods were established.

Based on the results, we found PTS alone and combined via splitting with other approaches provided favourable performance in certain and wide ranging parameter regimes.