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A dissipation preserving method to solve a fractional generalization of a nonlinear combustion equation

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Abstract

In this work, we investigate a fractional generalization of a nonlinear parabolic system and propose a numerical model to solve it. More precisely, we study a generalization of the multidimensional heat equation with nonlinear reaction and fractional derivatives in space, considering the fractional derivatives in the Riesz sense. Initial data and homogeneous Dirichlet boundary conditions are considered. The mathematical system possesses a free energy function and we prove that it is a decreasing function over time. Motivated by these facts, we propose as finite difference discretization of the continuous model based on the use of fractional-order centered differences. We discuss the existence of a discrete free energy function and its decrease over time, the existence of solutions, the quadratic consistency of the model, the stability and the convergence. Finally, from the computational point of view, simulations confirm the capability of the numerical model to dissipate the free energy of the continuous fractional system.

References

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