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Numerical solutions for space fractional dispersion equations with nonlinear source terms
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Keywords: fractional differential dispersion equation; nonlinear forcing term; finite difference scheme; one dimensional spatial domain; Euler approximation; right shifted Grünwald formula: stability; consistency; convergence order

Review text:

The aim of the article is to provide a finite difference scheme for the fractional differential dispersion equation with a nonlinear forcing term. Thanks to a right shifted Grünwald formula (Note that unshifted Grünwald formula for the fractional derivative of Riemann-Liouville type is unstable regardless a finite difference scheme is either explicit or implicit.) , the authors present an implicit Euler approximation for the problem under consideration. Existence of the finite difference approximate solution is proved thanks to the use of the Leray-Schauder fixed point theorem. To prove the convergence of the approximate solution, the authors first justified the stability of the finite difference scheme and then they combined this stability together with a consistency for the finite difference scheme. As usual, the stated stability result can be used to prove the uniqueness of the approximate finite difference solution. It is proved that the convergence order is $h + k$ in a discrete L^2-norm, where h (resp. k) is the mesh size of space (resp. time) discretization. Some numerical experiments are presented.

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