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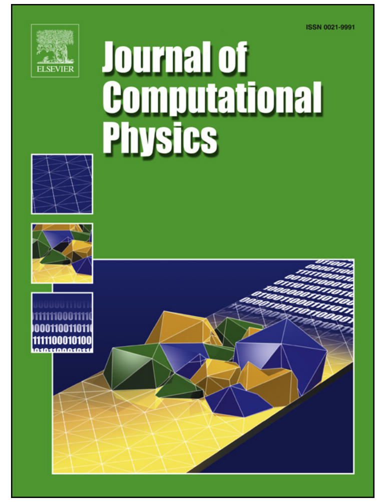

A higher order numerical method for time fractional partial differential equations with nonsmooth data

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Highlights

- We introduced a higher order scheme with order $O(k^{3-\alpha})$, $0 < \alpha < 1$ to approximate the Riemann-Liouville fractional derivative by approximating the Hadamard finite-part integral, where k denotes the time step size.
- We introduced a time discretization scheme for approximating fractional diffusion equation based on the new approximation scheme to the Riemann-Liouville fractional derivative.
- We proved the error estimates of this time discretization scheme with nonsmooth data by using Laplace transform. The convergence order is $O(k^{3-\alpha})$ in both nonsmooth and smooth data. To the best of our knowledge, the best error estimates proved in the literature for the time discretization scheme (L1 scheme and discontinuous Galerkin method) of time fractional partial differential equation with nonsmooth data is $O(k)$, see Jin et al., [16] and McLean and Mustapha [24].
- The idea for the approximation of the fractional Riemann-Liouville derivative in this paper with $0 < \alpha < 1$ can be easily extended to the case with $1 < \alpha < 2$. Therefore one may consider the time discretization for fractional wave diffusion equation with $\alpha \in (1, 2)$ by using the similar idea.
- It is very easy to program the numerical method. The weights in the numerical scheme are very simple.