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On optimal high-order in time approximations for the Korteweg-de Vries equation. (English)

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Math. Comput. 55, No. 192, 473-496 (1990).

This paper discusses the computation of periodic solutions to the Korteweg-de Vries equation $u_t + uu_x + \epsilon u_{xxx} = 0$, $x \in (0, 1)$, $t \in (0, \infty)$ with initial value $u(x, 0) = u^0(x)$, using a finite element process for the space discretization and an implicit Runge-Kutta method for the time integration. In spite of their excellent stability properties and the high orders of accuracy of which they are capable, implicit Runge-Kutta methods exhibit an order reduction phenomenon when applied to stiff problems. This applies both to Gauss and Radau IIA methods and to diagonally implicit methods, where the stage order may be significantly lower than the method order. A detailed analysis of truncation error in the case of the special problem considered here, leads to the conclusion that, for this application, order reduction is avoided.

Reviewer: J.C.Butcher (Auckland)

MSC:

- 65Z05 Applications to the sciences
- 65M12 Stability and convergence of numerical methods for initial value and initial-boundary value problems involving PDEs
- 65M20 Method of lines for initial value and initial-boundary value problems involving PDEs
- 65L20 Stability and convergence of numerical methods for ordinary differential equations
- 65M60 Finite element, Rayleigh-Ritz and Galerkin methods for initial value and initial-boundary value problems involving PDEs
- 35Q53 KdV equations (Korteweg-de Vries equations)

Cited in 11 Documents

Keywords:

periodic solutions; Korteweg-de Vries equation; finite element; implicit Runge-Kutta method; order reduction; stiff problems; Gauss and Radau IIA methods; truncation error

Full Text: DOI