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Numerical solution of coupled nonlinear Schrödinger equation by Galerkin method. (English)

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Summary: The coupled nonlinear Schrödinger equation models several interesting physical phenomena and presents a model equation for optical fiber with linear birefringence. In this paper we derive a finite element scheme to solve this equation, we test this method for stability and accuracy, many numerical tests have been conducted. The scheme is quite accurate and describe the interaction picture clearly.

MSC:

- 65M60 Finite element, Rayleigh-Ritz and Galerkin methods for initial value and initial-boundary value problems involving PDEs
- 35Q55 NLS equations (nonlinear Schrödinger equations)
- 65M12 Stability and convergence of numerical methods for initial value and initial-boundary value problems involving PDEs
- 35Q51 Soliton equations

Cited in **32** Documents

Keywords:

Galerkin method; coupled nonlinear Schrödinger equation; soliton interaction; numerical examples; optical fiber; finite element scheme; stability

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References:

- [1] A. Aydin, B. Karasozen, Multi-symplectic integration of coupled nonlinear Schrödinger system with soliton solutions, Int. J. Comput. Math., in press. · Zbl 1165.65084
- [2] A. Aydin, B. Karasozen, Symplectic and multisymplectic methods for the coupled nonlinear Schrödinger equations with periodic solutions, Comput. Phys. Commun. 177 (7) (2007) 566-583. · Zbl 1196.65139
- [3] J. de Frutos, J.M. Sanz-Serna, An easily implementable fourth order method for the time integration of waves problems, Report 1991/2, Universidad De Valladolid, Spain, 1991. · Zbl 0761.65074
- [4] D.F. Griffiths, A.R. Mitchell, J. Li Morris, A numerical study of the nonlinear Schrödinger equation, NA/52, University of Dundee, 1982.
- [5] Ismail, M.S.; Taha, T.R., A linearly implicit conservative scheme for the coupled nonlinear Schrödinger equation, Math. comp. simul., 74, 302-311, (2007) · Zbl 1112.65079
- [6] Ismail, M.S.; Alamri, S.Z., 'highly accurate finite difference method for coupled nonlinear Schrödinger equation, Int. J. comput. math., 81, 3, 333-351, (2004) · Zbl 1058.65090
- [7] Ismail, M.S.; Taha, T.R., Numerical simulation of coupled nonlinear Schrödinger equation, Math. comput. simul., 56, 547-562, (2001) · Zbl 0972.78022
- [8] Ismail, M.S.; Taha, T., A finite element solution for the coupled Schrödinger equation, ()
- [9] Ismail, M.S., Finite difference method with cubic spline for solving nonlinear Schrödinger equation, Int. J. comput. math., 62, 101-112, (1996) · Zbl 1001.65501
- [10] Menyuk, C.R., Stability of solitons in birefringent optical fibers, J. opt. soc. am. B, 5, 392-402, (1998)
- [11] Muslu, G.M.; Erbay, H.A., Higher-order split-step Fourier schemes for the generalized nonlinear Schrödinger equation, Math. comput. simul., 67, 581-595, (2005) · Zbl 1064.65117
- [12] Sanz-Serna, J.M.; Verwer, J.G., Conservative and nonconservative Schrödinger equation, IMA J. numer. anal., 6, 25-42, (1986) · Zbl 0593.65087
- [13] Shamerdan, A.B., The numerical treatment of the nonlinear Schrödinger equation, Comput. math. appl., 19, 67-73, (1990) · Zbl 0702.65096
- [14] Sheng, Q.; Khaliq, A.Q.M.; Al-Said, E.A., Solving the generalized nonlinear Schrödinger equation via quartic spline approximation, J. comput. phys., 166, 400-417, (2001) · Zbl 0979.65082
- [15] Somnner, W.J.; Christov, C.I., Strong coupling of Schrödinger equations conservative scheme approach, Math. comput. simul., 69, 314-325, (2005)

- [16] N.H. Sweilam, R.F. Al-Bar, Variational iteration method for coupled nonlinear Schrödinger equations, *Comput. Math. Appl.*, in press.
- [17] Sun, J.Q.; Gu, X.Y.; Ma, Z.Q., Numerical study of the soliton waves of the coupled nonlinear Schrödinger system, *Physica D*, 196, 311-328, (2004) · [Zbl 1056.65083](#)
- [18] Sun, J.Q.; Qin, M.Z., Multi-symplectic methods for the coupled 1D nonlinear Schrödinger system, *Comput. phys. commun.*, 155, 221-235, (2003) · [Zbl 1196.65195](#)
- [19] Wadati, M.; Izuka, T.; Hisakado, M., A coupled nonlinear schrödinger equation and optical solitons, *J. phys. soc. jpn.*, 61, 7, 2241-2245, (1992)
- [20] Wang, H., Numerical studies on the split step finite difference method for the nonlinear Schrödinger equations, *Appl. math. comput.*, 170, 17-35, (2005) · [Zbl 1082.65570](#)
- [21] A.M. Wazwaz, The variational method for rational solutions for KdV, K(2,2), Burger, and Cubic Boussinesq equation, *J. Comput. Appl. Math.* 207 (2007) 18-23. · [Zbl 1119.65102](#)
- [22] A.M. Wazwaz, A study on linear and nonlinear Schrödinger equations by the variational iteration method, *Chaos, Solitons & Fractals*, in press.
- [23] Xu, Y.; Shu, C., Local discontinuous Galerkin method for nonlinear Schrödinger equations, *J. comput. phys.*, 205, 72-97, (2005) · [Zbl 1072.65130](#)
- [24] Yang, J., Multisoliton perturbation theory for the Manakov equations and its applications to nonlinear optics, *Phys. rev. E*, 59, 2, 2393-2405, (1999)

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