Accepted Manuscript

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Feng Liao, Luming Zhang, Shanshan Wang

 PII:
 S0168-9274(17)30103-4

 DOI:
 http://dx.doi.org/10.1016/j.apnum.2017.04.007

 Reference:
 APNUM 3201

To appear in: Applied Numerical Mathematics

Received date:17 June 2016Revised date:7 December 2016Accepted date:19 April 2017



Please cite this article in press as: F. Liao et al., Numerical analysis of cubic orthogonal spline collocation methods for the coupled Schrödinger–Boussinesq equations, *Appl. Numer. Math.* (2017), http://dx.doi.org/10.1016/j.apnum.2017.04.007

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Numerical analysis of cubic orthogonal spline collocation methods for the coupled Schrödinger-Boussinesq equations

Feng Liao, Luming Zhang, Shanshan Wang ¹ College of Science, Nanjing University of Aeronautics and Astronautics, Nanjing 211106, PR China

5 Abstract In this article, we formulate two orthogonal spline collocation schemes, which

⁶ consist of a nonlinear and a linear scheme for solving the coupled Schrödinger-Boussinesq
⁷ equations numerically. Firstly, the conservation laws of our schemes are derived. Secondly,
⁸ the existence solutions of our schemes are investigated. Thirdly, the convergence and
⁹ stability of the nonlinear scheme are analyzed by means of discrete energy methods, while
¹⁰ the convergence of the linear scheme is proved by cut-off function technique. Finally,
¹¹ numerical results are reported to verify our theoretical analysis for the numerical methods.
¹² Keywords Orthogonal spline collocation; Schrödinger-Boussinesq equations; Conserva-

13 tion law; Convergence; Stability

14 1. Introduction

In this paper, we examine the use of the cubic orthogonal spline collocation (OSC) method for approximate solution of the coupled Schrödinger-Boussinesq (SBq) equations

$$iu_t + \gamma u_{xx} - \xi uv = 0, (t, x) \in \Omega_T, \tag{1}$$

$$v_t = \phi_{xx}, (t, x) \in \Omega_T, \tag{2}$$

$$\phi_t = v - \alpha v_{xx} + f(v) + \omega |u|^2, (t, x) \in \Omega_T,$$
(3)

¹⁷ with the initial-boundary conditions

$$u(x,0) = u_0(x), v(x,0) = v_0(x), \phi(x,0) = \phi_0(x), x \in \Omega,$$
(4)

$$u(x,t) = v(x,t) = \phi(x,t) = 0, x \in \partial\Omega, t \in [0,T],$$
(5)

¹This work is supported by Jiangsu Innovation Program for Graduate Education under Grant No.KYZZ160161 and the National Science Foundation of China under Grant No.11571181. Corresponding author. E-mail: zhanglm@nuaa.edu.cn (L.Zhang), wawjd3kwcom@163.com (F.Liao), wangss@nuaa.edu.cn (S.Wang).

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