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New generalized Jacobi elliptic function rational expansion method

Ahmad T. Ali*

King Abdul Aziz University, Faculty of Science, Department of Mathematics, PO Box 80203, Jeddah, 21589, Saudi Arabia
 Al-Azhar University, Faculty of Science, Mathematics Department, Nasr City, 11448, Cairo, Egypt

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ABSTRACT

In this work, a new generalized Jacobi elliptic function rational expansion method is based upon twenty-four Jacobi elliptic functions and eight double periodic Weierstrass elliptic functions, which solve the elliptic equation $\phi'^2 = r + p\phi^2 + q\phi^4$, is described. As a consequence abundant new Jacobi–Weierstrass double periodic elliptic functions solutions for (3 + 1)-dimensional Kadomtsev–Petviashvili (KP) equation are obtained by using this method. We show that the new method can be also used to solve other nonlinear partial differential equations (NPDEs) in mathematical physics.

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1. Introduction

The investigation of the exact solutions of NPDEs plays an important role in the study of nonlinear physical phenomena. In the past decades, there has been significant progress in the development of methods such as the inverse scattering method [1], Hirota's bilinear method [2], the similarity transformation method [3–6], the non-local symmetries method [7,8], the homogeneous balance method [9], the exp-function method [10–12], the sine-cosine method [13], the tanh function method [14,15], the mapping method [16,17], the F-expansion method [18], the Riccati equation rational expansion method [19], the Jacobi and Weierstrass elliptic function method [20,21] and the new generalized Jacobi elliptic function expansion method [22–27]. In [28–32] Wang and Chen et al. presented a new elliptic function rational expansion method that is more powerful than the existing Jacobi elliptic function method to uniformly construct more new doubly-periodic solutions in terms of a rational formal Jacobi elliptic function of nonlinear evolution equations.

The main objective in this work is to extend the Jacobi elliptic function expansion method by adding rational expansion to the original form. This leads to obtain several new families of exact solutions for the (3 + 1)-dimensional KP equation. The paper is arranged as follows: In Section 2, we briefly describe the generalized Jacobi elliptic function rational expansion method. In Section 3, Several families of solutions to the elliptic equation $\phi'^2 = r + p\phi^2 + q\phi^4$ are obtained. In Section 4, taking to advantage of the solutions developed in Section 3, a great variety of exact solutions for (3 + 1)-dimensional KP equation are obtained. The conclusion is then given in Section 5.

2. Method description

The main idea of our method is to take full advantage of the elliptic equation. This equation is

$$\phi'^2 = r + p\phi^2 + q\phi^4, \quad (2.1)$$

* Corresponding address: King Abdul Aziz University, Faculty of Science, Department of Mathematics, PO Box 80203, Jeddah, 21589, Saudi Arabia.
 E-mail address: atali71@yahoo.com.