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Lump and interaction solutions to the (2+1)-dimensional Burgers equation

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Abstract

Based on the Hirota bilinear method, the lump solution of a (2+1)-dimensional Burgers equations is presented through symbolic computation with Maple, which is rationally localized in all directions in the space. Then the interaction solution between lump solution and one stripe solution is obtained and the result shows that the lump soliton will be drowned or swallowed by the stripe soliton, which can also be called the fission or fusion phenomenon. Furthermore, by the interaction between lump solution and a pair of resonance stripe solitons, a rogue wave phenomenon is revealed.

Keywords: Lump solution, Rogue solution, Interaction solutions, (2+1)-dimensional Burgers equation.
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1. Introduction

In soliton theory, it is always a hot topic to find the exact solutions of nonlinear evolution equations (NLEEs). Over the past decades, many systematic methods have been developed to find the exact solutions of NLEEs, such as the inverse scattering method [1], Darboux transformation method [2], Hirota bilinear method [3] and Painlevé analysis method [4]. Recently, based on the Hirota bilinear method, the lump solutions [5–10] and interaction solutions [11–25] of some integrable and nonintegrable NLEEs are obtained.

This paper focus on the following (2+1)-dimensional Burgers equations [26–28]

$$u_t - uu_y - avu_x - bu_{yy} - abu_{xx} = 0, u_x = v_y, \tag{1.1}$$

when $x = y$ and $u = v$, equations (1.1) can be reduced to the well-known (1+1)-dimensional Burgers equation

$$u_t + auu_x + bu_{xx} = 0. \tag{1.2}$$

Based on the Hirota bilinear method, Ref. [26] gave the multiple kink solutions and multiple singular kink solutions of equations (1.1). In Refs. [27–29], the rational triangular periodic wave solutions, rational solitary wave solutions, rational wave solutions and non-travelling wave solutions of equations (1.1) are obtained by using the auxiliary equation expansion method. The variable separation solutions and Y-shaped soliton fusion phenomenon are presented in Ref. [30]. The interaction solutions are discussed in Ref. [31] by using the Hirota bilinear method.

The aim of this paper is to study the lump solution, the lump-one stripe soliton solution and lump-twin stripe solitons solution of equations (1.1). In Sec. 2, the lump solution of equations (1.1) is obtained. The interaction solutions which including the lump-one stripe soliton solution and lump-twin stripe solitons solution will be proposed in Sec. 3 and 4, respectively. Some conclusions are given in Sec. 5.

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