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20 АСТАНА

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Студенттер мен жас ғалымдардың
**«ҒЫЛЫМ ЖӘНЕ БІЛІМ - 2018»**
XIII Халықаралық ғылыми конференциясы

# СБОРНИК МАТЕРИАЛОВ

XIII Международная научная конференция
студентов и молодых ученых
**«НАУКА И ОБРАЗОВАНИЕ - 2018»**

The XIII International Scientific Conference
for Students and Young Scientists
**«SCIENCE AND EDUCATION - 2018»**

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В сборник вошли доклады студентов, магистрантов, докторантов и молодых ученых по актуальным вопросам естественно-технических и гуманитарных наук.

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$$u_2 = 1 - \tanh\left(\frac{1}{3}\sqrt{3}\left(x + y + \frac{7}{3}\right)\right) \quad (9)$$

The graphical representation of solution (9) is depicted in Figure 2.

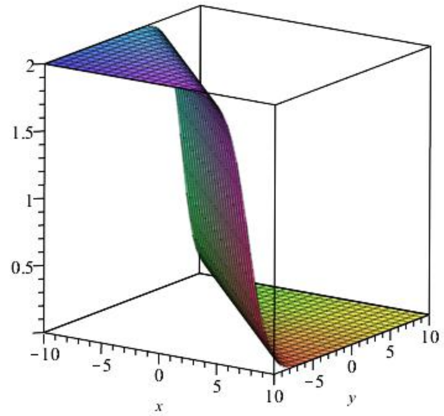


**Figure - 2** The solution $\boldsymbol{u_2(x,t)}$ of equation (1).

**Conclusion.** In this paper, we studied the Gardner equations. Using the extended tanh method, we have constructed various exact wave solutions for this equation. The graphical representation of the obtained solutions is presented in the figures.

**Literature**

1. Ferapontov E.V., Moro A., Novikov V.S. Integrable equations in 2 + 1 dimensions: deformations of dispersionless limits // J. Phys. A: Math. Theor. 42, 2009, P.2-8.
2. Benjamin T.B., Bona J.L., Mahony J.J. Model equations for long waves in nonlinear dispersive systems // Philos. Trans. R. Soc. Lond. Ser.-A 272, 1972, P. 47-78.
3. Wazwaz A. Partial differential equations and solitary waves theory // Springer, 2009,P.746.
4. Gozukızıl O., Akcagıl S. Exact solutions of Benjamin-Bona-Mahony-Burgers-type nonlinear pseudo-parabolic equations // Boundary Value Problems, 2012. P.144.

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## ONE SOLITON SOLUTION OF THE (2+1) – DIMENSIONAL REVERSE TIME COMPLEX MODIFIED KORTEWEG-DE VRIES EQUATIONS

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**Introduction.** The KdV equation

$$q_t + 6qq_x + q_{xxx} = 0, \quad (1)$$

and the mKdV equation

$$q_t + 6q^2 q_x + q_{xxx} = 0, \quad (2)$$

describe the evolution of small amplitude and weakly dispersive waves which occur in the shallow water [1].

In this paper, we will construct Darboux transformation (DT) and will derive one soliton solution for the (2+1)-dimensional reverse time complex modified Korteweg-de Vries equations [2] by next view

$$iq_t(x,y,t)+iq_{xxy}(x,y,t)-\upsilon(x,y,t)q(x,y,t)+(\omega(x,y,t)q(x,y,t))_x=0, \tag{3}$$

$$\upsilon_x(x,y,t)-2i(q^*_{xy}(x,y,-t)q(x,y,t)-q^*(x,y,-t)q_{xy}(x,y,t))=0, \tag{4}$$

$$\omega_x(x,y,t)-2i(q(x,y,t)q^*(x,y,-t))_y=0, \tag{5}$$

where q(x,y,t)-complex function, $\upsilon(x,y,t),\omega(x,y,t)$ - real functions.

Lax representation of the equations (3)-(5) reads as

$$\psi_x=A\psi, \tag{6}$$

$$\psi_t=4\lambda^2\psi_y+B\psi, \tag{7}$$

where

$$A=-i\lambda\sigma_3+A_0, \tag{8}$$

$$B=\lambda B_1+B_0, \tag{9}$$

$$\psi=\begin{pmatrix}\psi_1(\lambda,x,y,t)\\ \psi_2(\lambda,x,y,t)\end{pmatrix}, \tag{10}$$

with

$$B_1=\omega\sigma_3+2i\varepsilon_2\sigma_3A_{0y},$$

$$A_0=\begin{pmatrix}0 & q\\ -r & 0\end{pmatrix},$$

$$B_0=-\frac{i}{2}\upsilon\sigma_3+\begin{pmatrix}0 & -q_{xy}+i\omega q\\ r_{xy}-i\omega r & 0\end{pmatrix},$$

where $r(x,y,t)=\delta q^*(x,y,-t)$, $\delta=\pm1.$ Compatibility condition of equations (6)-(7) is

$$A_t-4\lambda^2A_y-B_x+[A,B]=0. \tag{11}$$

By substituting given matrixes (8)-(9) to (11), we will get (2+1)-dimensional reverse time complex modified Korteweg-de Vries equations (3)-(5).

**Darboux transformation.** Let $\psi$ and $\psi^{[1]}$ are two solutions of the system (6)-(7), and

$$\psi^{[1]}_x=A^{[1]}\psi^{[1]}, \tag{12}$$

$$\psi^{[1]}_t=4\lambda^2A\psi^{[1]}+B^{[1]}\psi^{[1]}, \tag{13}$$

where

$$\psi^{[1]}=T\psi=(\lambda I-P)\psi, \tag{14}$$

with

$$p=\begin{pmatrix}p_{11} & p_{12}\\ p_{21} & p_{22}\end{pmatrix}, I=\begin{pmatrix}1 & 0\\ 0 & 1\end{pmatrix}.$$

From (12)-(13) by (14) we can get

$$T_x + TA = A^{[1]}T, \tag{15}$$

$$T_t + TB = 4\lambda^2 T_y + B^{[1]}T. \tag{16}$$

From the equation (15) by collecting $\lambda^i$ coefficients (i=0, 1, 2), we obtain the next system

$$\lambda^0 : P_x = A_0^{[1]}M - MA_0, \tag{17}$$

$$\lambda^1 : A_0^{[1]} = A_0 + i[P, \sigma_3], \tag{18}$$

$$\lambda^2 : iI\sigma_3 = i\sigma_3 I. \tag{19}$$

The equation (18) gives

$$q^{[1]}(x, y, t) = q - 2ip_{12}. \tag{20}$$

Similarly, the equation (16) gives system

$$\lambda^0 : -P_t = PB_0 - B_0^{[1]}P, \tag{21}$$

$$\lambda^1 : B_0^{[1]} = B_0 - PB_1 + B_1^{[1]}P, \tag{22}$$

$$\lambda^2 : B_1^{[1]} = 4P_y + B_1. \tag{23}$$

From (22)-(23) we obtain

$$B_0^{[1]} = B_0 - PB_1 + (4P_y + B_1)P, \tag{24}$$

$$B_1^{[1]} = 4P_y + B_1. \tag{25}$$

The equations (24)-(25) give DT

$$\upsilon^{[1]} = \upsilon + 4(p_{12}q_y^* + p_{12}^* q_y + 2ip_{11}p_{11y} - 2ip_{12y}p_{12}^*), \tag{26}$$

$$\omega^{[1]} = \omega - 4pi_{11y} = \omega + 4ip_{22y}, \tag{27}$$

where matrix component $p_{22} = p_{11}^*$, and

$$P = \begin{pmatrix} p_{11} & p_{12} \\ -p_{12}^* & p_{11}^* \end{pmatrix}, \qquad P^{-1} = \frac{1}{|p_{11}|^2 + |p_{12}|^2}\begin{pmatrix} p_{11}^* & -p_{12} \\ p_{12}^* & p_{11} \end{pmatrix}. \tag{28}$$

$$P = H\Lambda H^{-1}. \tag{29}$$

Here

$$H = \begin{pmatrix} \psi_1(\lambda_1; t, x, y) & \psi_1(\lambda_2; t, x, y) \\ \psi_2(\lambda_1; t, x, y) & \psi_1(\lambda_2; t, x, y) \end{pmatrix} = \begin{pmatrix} \psi_{1,1} & \psi_{1,2} \\ \psi_{2,1} & \psi_{2,2} \end{pmatrix}, \qquad \Lambda = \begin{pmatrix} \lambda_1 & 0 \\ 0 & \lambda_2 \end{pmatrix}, \tag{30}$$

$\det H \neq 0$, $\lambda_1$ and $\lambda_2$ are constants.

$$P = \frac{1}{\Delta}\begin{pmatrix} \lambda_1\psi_1\psi_1^*(x,y,-t)+\lambda_1^*\psi_2\psi_2^*(x,y,-t) & (\lambda_1+\lambda_1^*)\psi_1\psi_2^*(x,y,-t) \\ (\lambda_1+\lambda_1^*)\psi_1\psi_2^*(x,y,-t) & \lambda_1\psi_2\psi_2^*(x,y,-t)+\lambda_1^*\psi_1\psi_1^*(x,y,-t) \end{pmatrix}, \quad (31)$$

with $\Delta = \psi_1\psi_1^*(x,y,-t)+\psi_2\psi_2^*(x,y,-t).$

Finally we have DT

$$q^{[1]}(x,y,t) = q - 2ip_{12}, \quad (32)$$

$$\upsilon^{[1]} = \upsilon + 4(p_{12}q_y^* + p_{12}^*q_y + 2ip_{11}p_{11y} - 2ip_{12y}p_{12}^*), \quad (33)$$

$$\omega^{[1]} = \omega - 4pi_{11y} = \omega + 4ip_{22y}, \quad (34)$$

Where

$$p_{11} = \frac{\lambda_1\psi_1\psi_1^*(x,y,-t)+\lambda_1^*\psi_2\psi_2^*(x,y,-t)}{\psi_1\psi_1^*(x,y,-t)-\psi_2\psi_2^*(x,y,-t)}, \quad p_{12} = \frac{(\lambda_1+\lambda_1^*)\ \psi_1\ \psi_2^*(x,y,-t)}{\psi_1\ \psi_1^*(x,y,-t)-\psi_2\ \psi_2^*(x,y,-t)}.$$

**Soliton solution.** Having the DT, we can find one soliton solutions of the (2+1)-dimensional reverse time complex modified Korteweg-de Vries equations. To get the one-soliton solution we will take seed solution as

$$q = \upsilon = \omega = 0. \quad (35)$$

From system (6)-(7) with (35) we can obtain

$$\psi_{1x} = -i\lambda\psi_1, \quad \psi_{2x} = i\lambda\psi_2, \quad (36)$$

$$\psi_{1t} = 4\lambda^2\psi_{1y}. \quad \psi_{2t} = 4\lambda^2\psi_{2y}. \quad (37)$$

The systems (36)-(37) give next solutions

$$\psi_1(x,y,-t) = e^{-i\lambda x+i\mu y-i4\lambda^2\mu t+\delta_1+i\delta_2}, \quad (38)$$

$$\psi_2(x,y,-t) = e^{i\lambda x-i\mu y-i4\lambda^2\mu t-\delta_1-i\delta_2+i\delta_0}, \quad (39)$$

where $\mu = \eta + i\upsilon, \lambda = a + ib$ and $\delta_i$ are real constants. We can rewrite equations (38)-(39)

$$\psi_1 = e^{\theta_1+i\chi_1}, \quad \psi_2 = e^{\theta_2+i\chi_2},$$

where

$$\theta_1 = bx - \upsilon y - 4a^2\upsilon t + 4b^2\upsilon t - 8ab\eta t + \delta_1,$$
$$\chi_1 = -ax + \eta y + 4a^2\eta t - 4b^2\eta t - 8ab\upsilon t + \delta_{2,}$$

and $\theta_2 = -\theta_1$, $\chi_2 = -\chi_1 + \delta_0$. Then the one-soliton of the (2+1)-dimensional reverse time complex modified Korteweg-de Vries equations (3)-(5) takes the form

$$q^{[1]} = 2be^{2i\chi_1 - i\delta_0} \sec h[2\theta_1], \tag{40}$$

$$\upsilon^{[1]} = 32((\lambda e^k + \bar{\lambda} e^{-k}) \sec h[k]((\lambda e^k + \bar{\lambda} e^{-k}) \sec h[k])_y)((be^{-n} \sec h[k])_y \frac{be^n}{e^{-k} + e^k}), \tag{41}$$

$$\omega^{[1]} = -2(((a+ib)e^k + (a-ib)e^{-k}) \sec h[k])_y, \tag{42}$$

there $k = 8i\lambda^2 \mu t + 2\delta_1, n = 2i\lambda x - 2i\mu y - 2i\delta_2 + i\delta_0$.

**Conclusion.** In this paper, we constructed Darboux transformation for the (2+1)-dimensional reverse time complex modified Korteweg-de Vries equations. Having the exact form of Darboux transformation, we got the one soliton solutions. The obtained solutions presented in the figures.

## Literature


1. Ablowitz M. J., Kaup D. J., Newell A. C. and Segur H. Solitons and the inverse scattering transform. - SIAM Philadelphia, 1981, P. 125-128.
2. Myrzakulov R., Mamyrbekova G.K., Nugmanova G.N., Lakshmanan M. Integrable (2+1)-dimensional spin models with self-consistent potentials//Symmetry 7(3), 2015, P. 1352-1375.
3. Yesmakanova K.R., Shaikhova G.N., Bekova G.T., Myrzakulov R. Lax representation and soliton solutions for the (2+1) -dimensional two-component complex modified Korteweg-de Vries equations//IOP Conf. Series 804, 2017, P. 012004.
4. Yesmakanova K.R., Shaikhova G.N., Bekova G.T., Myrzakulova Zh.R. Dark and bright solitons for the two-dimensional complex modified Korteweg-de Vries and Maxwell-Bloch system with time-dependent coefficient//IOP Conf. Series:965, 2018, P. 012035.


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# MODEL OF PARTICLES TRANSPORT IN HIGH-TEMPERATURE MAGNETIZED PLASMA OF TOKAMAK

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The presented model simulates transport phenomena in inhomogeneous plasmas, whose temperature can be assumed constant.

Trying to confine highly heated conductive plasma, the strong toroidal magnetic field is applied to plasma cord. Under the influence of the magnetic field, ions and electrons move spirally along its strength lines, and the transition from one field line to another is only possible in case of particles collision, or when a transverse electric field is applied.

**I. Setting basic parameters.** Until nowadays tokamaks have been built with different dimensions. To design this model the most appropriate optimal parameters have been chosen. Thus any subsequent calculations will be based on the J.E.T. (Joint European Torus) parameters, which are tabulated as:

Table 1. J.E.T's operational parameters

| **R, m** | $a$, **m** | $B_T$, **T** | $I_p$, **MA** | $n_e$, $10^{19} m^{-3}$ | $T_e$, **keV** | $T_i$, **keV** | $\tau$, **ms** |
|---|---|---|---|---|---|---|---|
| 3 | 1.25 | 3.5 | 5 | 3.5 | 6 | 8 | 500 |