List of Publications :

P-1) Solutions of Yang's Euclidean R-Gauge Equations and Self-Duality, International Journal of Theoretical Physics, volume **34**, no. **11**, November, 1995 (page: 2223 – 2244).

P-2) Exact solutions of the field equations for Charap's chiral invariant model of the pion dynamics, Pramana-journal of physics, volume 52, no.3, March 1999 (page: 245 – 256).

P-3) A combination of Yang's equation for SU (2) gauge fields and Charap's equations for pion dynamics with exact solutions, Pramana-journal of physics, volume 52, no. **6**, June, 1999 (page: 579 – 591).

P-4) Some physical solutions of Yang's equations for SU(2) gauge fields, Charap's equations for pion dynamics and their combination, Pramana-journal of physics, volume 63, no.5, November, 2004 (page: 1039 – 1045).

P-5) On a revisit to the Painleve' test for integrability and exact solutions for Yang's self-dual equations for SU(2) gauge fields, Pramana-journal of physics, 2006. (in press).

P-6) Painleve' test for integrability and exact solutions for the field equations for Charap's chiral invariant model of the pion dynamics, Pramana -journal of physics, 2006 (in press).

P-7) Painleve' test for integrability and exact solutions for the field equations for the combined equations of Yang's SU (2) gauge equations, and Charap's chiral invariant model of the pion dynamics,

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International Journal of Theoretical Physics, Vol. 34, No. 11, 1995

Solutions of Yang's Euclidean R-Gauge Equations and Self-Duality

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Received February 7, 1995

Under some assumptions and transformations of variables, Yang's equations for R-gauge fields on Euclidean space lead to conformally invariant equations permitting one to obtain infinitely many other solutions from any solution of these conformally invariant equations. These conformally invariant equations closely resemble the mathematically interesting generalized Lund–Regge equations. Some exact solutions of these conformally in variant equations are obtained. Except for some singular situations, these solutions are self-dual.

1. INTRODUCTION

While discussing the self-dual $SU(2)$ gauge-fields on Euclidean space Yang arrived at the following equations:

$$\phi(\phi_{y\bar{y}} + \phi_{z\bar{z}}) - \phi_y\phi_{\bar{y}} - \phi_z\phi_{\bar{z}} + \rho_y\bar{\rho}_{\bar{y}} + \rho_z\bar{\rho}_{\bar{z}} = 0 \qquad (1.1a)$$

$$\phi(\rho_{y\bar{y}} + \rho_{z\bar{z}}) - 2\rho_y\phi_{\bar{y}} - 2\rho_z\phi_{\bar{z}} = 0 \qquad (1.1b)$$

where an overbar denotes the complex conjugate, ϕ and ρ are functions of y, $\bar{y}$, z, and $\bar{z}$, ϕ is real, ρ is complex, and

$$\sqrt{2}y = x^1 + ix^2 \qquad (1.1c)$$

$$\sqrt{2}z = x^3 - ix^4 \qquad (1.1d)$$

x^1, x^2, x^3, x^4 are real.

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FRONT PAGE OF PUBLICATION NUMBER (P- 2) :

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Exact solutions of the field equations for Charap's chiral invariant model of the pion dynamics

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MS received 10 March 1998; revised 3 November 1998

Abstract. The field equations for the chiral invariant model of pion dynamics developed by Charap have been revisited. Two new types of solutions of these equations have been obtained. Each type allows infinite number of solutions. It has also been shown that the chiral invariant field equations admit invariance for a transformation of the dependent variables.

Keywords. Exact solutions; chiral invariance; pion dynamics; tangential parametrization; Charap.

PACS Nos **11.30; 11.10**

1. Introduction

Under tangential parametrization [1] the field equations for the chiral invariant model of the pion dynamics take the form [2]

$$\Box\phi = \eta^{\mu\gamma}\frac{\partial\phi}{\partial x^{\mu}}\cdot\frac{\partial\beta}{\partial x^{\gamma}} \tag{1.1a}$$

$$\Box\psi = \eta^{\mu\gamma}\frac{\partial\psi}{\partial x^{\mu}}\cdot\frac{\partial\beta}{\partial x^{\gamma}} \tag{1.1b}$$

$$\Box\chi = \eta^{\mu\gamma}\frac{\partial\chi}{\partial x^{\mu}}\cdot\frac{\partial\beta}{\partial x^{\gamma}} \tag{1.1c}$$

where,

$$\begin{aligned}\eta^{\mu\gamma} &= 0 \ \text{for} \ \mu \neq \gamma \\ &= 1 \ \text{for} \ \mu = \gamma \neq 4 \\ &= -1 \ \text{for} \ \mu = \gamma = 4\end{aligned} \tag{1.1d}$$

$$\beta = \ln(f_\pi^2 + \phi^2 + \psi^2 + \chi^2) \tag{1.1e}$$

$$f_\pi = \text{constant.} \tag{1.1f}$$

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A combination of Yang's equations for $SU(2)$ gauge fields and Charap's equations for pion dynamics with exact solutions

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MS received 3 March 1998; revised 13 May 1999

Abstract. Two sets of nonlinear partial differential equations originating from two different physical situations have been combined and a new set of nonlinear partial differential equations has been formed wherefrom the previous two sets can be obtained as particular cases. One of the two sets of equations was obtained by Yang [1] while discussing the condition of self-duality of $SU(2)$ gauge fields on Euclidean four-dimensional space. The second one was reported by Charap [2] for the chiral invariant model of pion dynamics under tangential parametrization. Using the same type of ansatz in each case De and Ray [16] and Ray [7] obtained physical solutions of the two sets of equations. Here exact solutions of the combined set of equations with particular values of the coupling constants have been obtained for a similar ansatz. These solutions too are physical in nature.

Keywords. Exact solutions; combined field equations; $SU(2)$ gauge field; self duality; pion dynamics; chiral invariance.

PACS Nos 11.30; 11.10

1. Introduction

In this paper we have combined the equations originating from two physical situations. We also present exact solutions to the combined equations for some of the particular values of the coupling constants. The solutions are physical in nature. In the following the two sets of equations leading to the combination are given. Then the motivation for such a combination is presented.

Equations leading to the combination

(i) *The equations due to Yang* [1]: These were obtained by Yang [1] while discussing the condition of self-duality of $SU(2)$ gauge fields on Euclidean four-dimensional space. The equations are given by,

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Some physical solutions of Yang's equations for $SU(2)$ gauge fields, Charap's equations for pion dynamics and their combination

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Abstract. Some previously obtained physical solutions [1–3] of Yang's equations for $SU(2)$ gauge fields [4], Charap's equations for pion dynamics [5,6] and their combination as proposed by Chakraborty and Chanda [1] have been presented. They represent different physical characteristics, e.g. spreading wave with solitary profile which tends to zero as time tends to infinity, spreading wave packets, solitary wave with oscillatory profile, localised wave with solitary profile which becomes plane wave periodically, and, wave packets which are oscillatory in nature.

Keywords. Exact solution; combined field equations; $SU(2)$ gauge field; self-duality; chiral invariance; soliton.

PACS Nos 05.45.Yv; 11.10.Lm; 11.30.Na; 11.30.Rd

1. Introduction

This communication reports the graphical representations of some exact physical solutions for Yang's equations for $SU(2)$ gauge fields [1,2,4], Charap's equations for pion dynamics [1,3,5,6] and a combination of these two sets of equations [1]. The combination was proposed by Chakraborty and Chanda [1]. It is given by

$$\begin{aligned}\phi_{11} + \phi_{22} + \phi_{33} + \varepsilon\phi_{44} = {} & k'[(1/\phi)(\phi_1^2 + \phi_2^2 + \phi_3^2 + \varepsilon\phi_4^2) \\ & -(1/\phi)(\psi_1^2 + \psi_2^2 + \psi_3^2 + \varepsilon\psi_4^2) \\ & -(1/\phi)(\chi_1^2 + \chi_2^2 + \chi_3^2 + \varepsilon\chi_4^2) \\ & -(2/\phi)(\psi_1\chi_2 - \psi_2\chi_1 + \psi_4\chi_3 - \psi_3\chi_4)] \\ & +k''\{2\phi[\exp(-\beta)](\phi_1^2 + \phi_2^2 + \phi_3^2 + \varepsilon\phi_4^2) \\ & +2\psi[\exp(-\beta)](\phi_1\psi_1 + \phi_2\psi_2 + \phi_3\psi_3 + \varepsilon\phi_4\psi_4) \\ & +2\chi[\exp(-\beta)](\phi_1\chi_1 + \phi_2\chi_2 + \phi_3\chi_3 + \varepsilon\phi_4\chi_4)\}, \end{aligned} \quad (1.1a)$$

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On a revisit to the Painlevé test for integrability and exact solutions for Yang's self-dual equations for $SU(2)$ gauge fields

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Abstract. Painlevé test (Jimbo *et al* [1]) for integrability for the Yang's self-dual equations for SU(2) gauge fields has been revisited. Jimbo *et al* analysed the complex form of the equations with a rather restricted form of singularity manifold. They did not discuss exact solutions in that context. Here the analysis has been done starting from the real form of the same equations and keeping the singularity manifold completely general in nature. It has been found that the equations, in real form, pass the Painlevé test for integrability. The truncation procedure of the same analysis leads to non-trivial exact solutions obtained previously and auto-Backlund transformation between two pairs of those solutions.

Keywords. Painlevé analysis; integrability; auto-Backlund transformation; exact solutions; $SU(2)$ gauge field; self-duality.

PACS Nos 02.30; 42.65; 43.25; 47.20; 52.35

1. Introduction

This communication revisits some observations regarding a set of well-known equations, namely Yang's self-dual equations for $SU(2)$ gauge fields [1–3]. Jimbo *et al* [1] adopted the algorithm of Weiss *et al* [4] and showed that the equations [2] pass the Painlevé test for integrability in the sense of Weiss *et al* [4]. Ward used a completely different approach, complicated indeed, and arrived at the same conclusion [5]. Both the investigations [4,5] used the complex form of the equations [2] and neither of them reported any solution from the analysis.

Recently, Chakraborty and Chanda [6] have shown that the equations admit spreading wave with solitary profile, which tends to zero as time tends to infinity and spreading wave packets. Chakraborty and Chanda [6] found another interesting thing about the equations. They observed that the self-dual equations reported by Yang [2] and the equations reported by Charap [7] for the chiral invariant model of

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Painlevé test for integrability and exact solutions for the field equations for Charap's chiral invariant model of the pion dynamics

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Abstract. It has been shown that the field equations for Charap's chiral invariant model of the pion dynamics pass the Painlevé test for complete integrability in the sense of Weiss et al. The truncation procedure of the same analysis leads to auto-Backlund transformation between two pairs of solutions. With the help of this transformation non-trivial exact solutions have been rediscovered.

Keywords. Painlevé analysis; integrability; auto-Backlund transformations; exact solutions; pion dynamics, chiral invariance.

PACS Nos 02.30.Jr; 11.30.Rd; 11.10.Lm

1. Introduction

In this paper we have observed that the field equations [1,2] for Charap's chiral invariant model of the pion dynamics pass the test for integrability in the sense of Painlevé analysis due to Weiss *et al* [3–5]. The formalism of the truncation of a series solution as advocated by Weiss *et al* [3,5] leads to auto-Backlund transformation between two pairs of solutions. From the transformation, the nontrivial exact solutions have been rediscovered.

According to Weiss *et al*, the Painlevé test is as follows: If the singularity manifold is determined by

$$u(z_1, z_2, z_2, \ldots, z_n) = 0 \tag{1.1}$$

and $\phi = \phi(z_1, z_1, z_1, \ldots, z_1)$ is a solution of the partial differential equation, then we require that

$$\phi = u^{\alpha} \sum_{j=0}^{\infty} \phi_j u^j, \tag{1.2}$$

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Painleve' test for integrability for a combination of Yang's self-dual equations for SU(2) gauge fields and Charap's equations for chiral invariant model of pion dynamics and a comparative discussion among the three.

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Abstract : *Painleve' test for integrability for the Combined equations generated from Yang's equations for SU(2) gauge fields and Charap equations for pion dynamics faces some peculiar situations that allow none of the stages (leading order analysis, resonance calculation and checking of the existence of the requisite number of arbitrary functions) to be conclusive. It is also revealed from a comparative study with the previous results that the existence of abnormal behaviour at any of the stated stages may have a correlation with the existence of Chaotic property or some other properties that do not correspond to solitonic behaviour.*

Key words : ***Painleve' analysis, integrability, , SU(2) gauge field, chaotic property, solitonic behaviour.***

PACS no. : 02.30 Jr, 11.30 Rd, 11.10 Lm