Open Science Journal of Modern Physics
2015; 2(5): 65-71
Published online August 30, 2015 (http://www.openscienceonline.com/journal/osjmp)

Charged Anisotropic Matter with Modified Tolman IV Potential

Manuel Malaver*

Department of Basic Sciences, Maritime University of the Caribbean, Catia la Mar, Venezuela

Email address
mmf.umc@gmail.com

To cite this article
Manuel Malaver. Charged Anisotropic Matter with Modified Tolman IV Potential. *Open Science Journal of Modern Physics*. Vol. 2, No. 5, 2015, pp. 65-71.

Abstract

In this paper, we studied the behavior of relativistic objects with charged anisotropic matter distribution within the framework of MIT-Bag Model considering modified Tolman IV form for the gravitational potential Zwhich depends on an adjustable parameter n.New exact solutions of the Einstein-Maxwell system are generated. A physical analysis of electromagnetic field indicates that is regular in the origin and well behaved. We show as a variation of the adjustable parameter causes a modification in the charge density, the radial pressure, the tangential pressure and the mass of the stellar object.

Keywords

Relativistic Objects, Anisotropic Matter, MIT–Bag Model, Electromagnetic Field, Tolman IV Potential, Adjustable Parameter, Einstein-Maxwell System

1. Introduction

From the development of Einstein´s theory of general relativity, the modelling of superdense mater configurations is an interesting research area [12]. In the last decades, such models allow explain the behavior of massive objects as neutron stars, quasars, pulsars, black holes and white dwarfs [3,4,5].

In theoretical works of realistic stellar models, is important include the pressure anisotropy [6-8]. Bowers and Liang [6] extensively discuss the effect of pressure anisotropy in general relativity. The existence of anisotropy within a star can be explained by the presence of a solid core, phase transitions, a type III super fluid, a pion condensation [9] or another physical phenomena as the presence of an electrical field [10]. The physics of ultrahigh densities is not well understood and many of the strange stars studies have been performed within the framework of the MIT-Bag model [11]. In this model, the strange matter equation of state has a simple linear form given by $p=\frac{1}{3}(\rho-4B)$ where ρ is the energy density, p is the isotropic pressure and B is the bag constant. Many researchers have used a great variety of mathematical techniques to try to obtain exact solutions for quark stars within the framework of MIT bag model, since it has been demonstrated by Komathiraj and Maharaj [11], Malaver [12,13], Thirukkanesh and Maharaj [14],Maharaj et al. [15], Thirukkanesh and Ragel [16] andSunzu et al. [17].

With then use of Einstein´s field equations, important advances has been made to model the interior of a star.In particular, Feroze and Siddiqui [18,19] and Malaver [20,21] consider a quadratic equation of state for the matter distribution and specify particular forms for the gravitational potential and electric field intensity. MafaTakisa and Maharaj [22] obtained new exact solutions to the Einstein-Maxwell system of equations with a polytropic equation of state. Thirukkanesh and Ragel [23] have obtained particular models of anisotropic fluids with polytropic equation of state which are consistent with the reported experimental observations. Malaver [24,25] generated new exact solutions to the Einstein-Maxwell system considering Van der Waals modified equation of state with and without polytropical exponent and Thirukkanesh and Ragel [26] presented a anisotropic strange quark matter model by imposing a linear barotropic equation of state withTolman IV form for the gravitational potential. Mak and Harko [27] found a relativistic model of strange quark star with the suppositions of spherical symmetry and conformal Killing vector.

The objective of this paper is to obtain new exact solutions to the Maxwell-Einstein systemfor charged anisotropic matter with the barotropic equation of state that presents a linear relation between the energy density and the radial pressure in static spherically symmetric spacetime using modified TolmanIV form for the gravitational potential Zwhich depends on an adjustable parameter n. We have obtained some new classes of static spherically symmetrical models wherethe variation of the parameter n modifies the radial pressure, the tangential pressure, charge density and the mass of the compact objects.This article is organized as follows, in Section 2, we present Einstein´s field equations of anisotropic fluid distribution. In Section 3, we make a particular choice of gravitational potential Z(x) that allows solving the field equations and we have obtained new models for charged anisotropic matter. In Section 4, a physical analysis of the new solutions is performed. Finally in Section 5, we conclude.

2. Einstein Field Equations

We consider a spherically symmetric, static and homogeneousand anisotropic spacetimein Schwarzschild coordinates given by

$$ds^2 = -e^{2\nu(r)}dt^2 + e^{2\lambda(r)}dr^2 + r^2(d\theta^2 + \sin^2\theta d\varphi^2) \quad (1)$$

where $\nu(r)$ and $\lambda(r)$ are two arbitrary functions.

The Einstein field equations for the charged anisotropic matter are given by

$$T_{00} = -\rho - \frac{1}{2}E^2 \quad (2)$$

$$T_{11} = p_r - \frac{1}{2}E^2 \quad (3)$$

$$T_{22} = T_{33} = p_t + \frac{1}{2}E^2 \quad (4)$$

where ρ is the energy density, p_r is the radial pressure, E is electric field intensity and

p_t is the tangential pressure, respectively. Using the transformations, $x = cr^2$, $Z(x) = e^{-2\lambda(r)}$ and $A^2y^2(x) = e^{2\nu(r)}$ with arbitrary constants A and c>0, suggested by Durgapal and Bannerji [28], the metric (1) take the form

$$ds^2 = -A^2y^2(x)dt^2 + \frac{1}{4cxz}dx^2 + \frac{x}{c}(d\theta^2 + \sin^2\theta d\varphi^2) \quad (5)$$

andthe Einstein field equations can be written as

$$\frac{1-Z}{x} - 2\dot{Z} = \frac{\rho}{c} + \frac{E^2}{2c} \quad (6)$$

$$4Z\frac{\dot{y}}{y} - \frac{1-Z}{x} = \frac{p_r}{c} - \frac{E^2}{2c} \quad (7)$$

$$4xZ\frac{\ddot{y}}{y} + (4Z + 2x\dot{Z})\frac{\dot{y}}{y} + \dot{Z} = \frac{p_t}{c} + \frac{E^2}{2c} \quad (8)$$

$$\sigma^2 = \frac{4cZ}{x}\left(x\dot{E} + E\right)^2 \quad (9)$$

σ is the charge density and dots denote differentiation with respect to x. With the transformations of [28], the mass within a radius r of the sphere take the form

$$M(x) = \frac{1}{4c^{3/2}}\int_0^x \sqrt{x}\rho(x)dx \quad (10)$$

In this paper, we assume the following lineal equation of state within the framework of MIT-Bag model

$$p_r = \frac{1}{3}\rho \quad (11)$$

3. The New Models

FollowingTolman [29] andThirukkanesh and Ragel [26], we takethe modified form of the gravitational potential, $Z(x)$ as

$$Z(x) = \frac{(1+ax)^n(1-bx)}{(1+2ax)} \quad (12)$$

The electric field intensity E is continuous, reaches a maximum and then it diminishes in the surface of the sphere and given by

$$E^2 = \frac{nacx}{(1+2ax)^2} \quad (13)$$

where a and b are real constants and n is an adjustable parameter. The potential is regular at the origin and well behaved in the interior of the sphere.

We have considered the particular cases for n=1,2, 3.

For case n=1, using $Z(x)$ in eq.(6) we obtain

$$\rho = c\frac{\left[6(a+b) + \left(14ab + 4a^2 - a\right)x + 12a^2bx^2\right]}{2(1+ax)^2} \quad (14)$$

Substituting (14) in eq.(11), the radial pressure can be written in the form

$$P_r = c\frac{\left[6(a+b) + \left(14ab + 4a^2 - a\right)x + 12a^2bx^2\right]}{6(1+2ax)^2} \quad (15)$$

Using (14) in (10), the expression of the mass function is

$$M(x) = \frac{\left(32a^3x^2 + 32a^3x + 32a^2bx + 8a^2x - 6a\right)\sqrt{ax} + (1+2ax)3a\sqrt{2}\,arctag\sqrt{2ax}}{64a^2\sqrt{ac}(1+2ax)} \quad (16)$$

and for charge density

$$\sigma^2 = \frac{ac^2(1+ax)(1-bx)\left(4a^2x^2+12ax+9\right)}{(1+2ax)^5} \tag{17}$$

The tangential pressure is given for

$$P_t = \frac{4xc(1+ax)(1-bx)}{(1+2ax)}\frac{\ddot{y}}{y} + 2c\left[\frac{2+(5a-3b)x+4a(a-2b)x^2-6a^2bx^3}{(1+2ax)^2}\right]\frac{\dot{y}}{y}$$
$$-c\frac{2(a+b)+(2ab+a)x+2a^2bx^2}{2(1+2ax)^2} \tag{18}$$

Substituting (15),(13) and (12)with n=1 in (7), we have

$$\frac{\dot{y}}{y} = \frac{(a+b+abx)}{4(1+ax)(1-bx)} + \frac{c\left[6(a+b)+\left(14ab+4a^2-a\right)x+12a^2bx^2\right]}{12(1+2ax)(1+ax)(1-bx)} - \frac{ax}{8(1+2ax)(1+ax)(1-bx)} \tag{19}$$

Integrating (19), we obtain

$$y(x) = c_1(1+ax)^A(-1+bx)^B(1+2ax)^C \tag{20}$$

where

$$A = -\frac{18b^2+64ab+56a^2-5a}{24(a+b)(b+2a)},\ B = \frac{2a-8b-5}{24(a+b)} \text{ and } C = \frac{16a+8b+5}{24(2a+b)} \tag{21}$$

The metric functions $e^{2\lambda}$ and $e^{2\nu}$ can be written as

$$e^{2\lambda} = \frac{(1+2ax)}{(1+ax)(1-bx)} \tag{22}$$

$$e^{2\nu} = A^2c_1^{\,2}(1+ax)^{2A}(-1+bx)^{2B}(1+2ax)^{2C} \tag{23}$$

The metric for this model is

$$ds^2 = -A^2c_1^2(1+ax)^{2A}(-1+bx)^{2B}(1+2ax)^{2C}dt^2 + \frac{(1+2ax)}{4xc(1+ax)(1-bx)}dx^2$$
$$+\frac{x}{c}(d\theta^2+\sin^2\theta d\varphi^2) \tag{24}$$

With n=2, the expression for the energy density is

$$\rho = c\frac{\left[10a^3bx^3+\left(15a^2b-4a^3\right)x^2+\left(12ab+4a^2b-2a^3-5a^2-a\right)x+3b\right]}{(1+2ax)^2} \tag{25}$$

replacing (25) in (11), we have for the radial pressure

$$P_r = c\frac{\left[10a^3bx^3+\left(15a^2b-4a^3\right)x^2+\left(12ab+4a^2b-2a^3-5a^2-a\right)x+3b\right]}{3(1+2ax)^2} \tag{26}$$

and the mass function is

$$M(x)=\frac{\left[\begin{pmatrix}48a^4bx^3+96abx+60ab-30a^2-36a^3+128a^2bx-18a+64a^3bx^2\\-40a^3x-48a^4x-24a^2x-32a^4x^2+72a^2b\end{pmatrix}\sqrt{ax}\atop +\left(3-24a^2bx+12a^3x-20abx-12ab-10b+6ax+5a+10a^2x+6a^2\right)3a\sqrt{2}arctag\sqrt{2ax}\right]}{96a^2\sqrt{ac}\left(1+2ax\right)} \tag{27}$$

The expression for the charge density can be written as

$$\sigma^2=\frac{2ac^2\left(1+ax\right)^2\left(1-bx\right)\left(4a^2x^2+12ax+9\right)}{\left(1+2ax\right)^5} \tag{28}$$

The tangential pressure can be obtained from (8) with the help of (12) and (13)

$$P_t=\frac{4xc\left(1+ax\right)^2\left(1-bx\right)}{\left(1+2ax\right)}\frac{\ddot{y}}{y}+c\left[\frac{4+2\left(8a-3b\right)x+24a\left(a-b\right)x^2+2a\left(6a^2-17ab\right)x^3-8a^3bx^4}{\left(1+2ax\right)^2}\right]\frac{\dot{y}}{y}$$
$$+c\frac{\left[-4a^3bx^3+\left(2a^3-7a^2b\right)x^2+\left(2a^2-a-4ab\right)x-b\right]}{\left(1+2ax\right)^2} \tag{29}$$

Substituting (11),(12) and (13) in (7), we have

$$\frac{\dot{y}}{y}=\frac{\left[a^2bx^2+\left(2ab-a^2\right)x+b\right]}{4\left(1+ax\right)^2\left(1-bx\right)}+\frac{\left[3b+\left(12ab+4a^2b-2a^3-5a^2-a\right)x+\left(15a^2b-4a^3\right)x^2+10a^3bx^3\right]}{12\left(1+2ax\right)\left(1+ax\right)^2\left(1-bx\right)}$$
$$-\frac{ax}{4\left(1+2ax\right)\left(1+ax\right)^2\left(1-bx\right)} \tag{30}$$

Integrating (30), we obtain

$$y(x)=c_2\left(1+2ax\right)^D\left(1+ax\right)^E\left(-1+bx\right)^F\exp\left[G(x)\right] \tag{31}$$

Again for convenience we have let

$$D=\frac{2a^2+3a-4ab-b+4}{6\left(b+2a\right)},\quad E=-\frac{a^3+4a^2+5ab+2a-4ab^2+4b}{6\left(a+b\right)^2},$$

$$F=\frac{2ab-2a^2b^2-12ab^2-11a^2b+a^3b-3b^3-3a^3}{\left(a+b\right)^2\left(b+2a\right)}\quad\text{and}\quad G(x)=\frac{a^2-a-2ab-2b+2}{6\left(1+ax\right)\left(a+b\right)} \tag{32}$$

The metric functions $e^{2\lambda}$ and $e^{2\nu}$ can be written as

$$e^{2\lambda}=\frac{\left(1+2ax\right)}{\left(1+ax\right)^2\left(1-bx\right)} \tag{33}$$

$$e^{2\nu}=A^2c_2^2\left(1+2ax\right)^{2D}\left(1+ax\right)^{2E}\left(-1+bx\right)^{2F}\exp\left[2G(x)\right] \tag{34}$$

The metric for this model is

$$ds^2=-A^2c_2^2\left(1+2ax\right)^{2D}\left(1+ax\right)^{2E}\left(-1+bx\right)^{2F}\exp\left[2G(x)\right]dt^2+\frac{\left(1+2ax\right)}{4xc\left(1+ax\right)^2\left(1-bx\right)}dx^2+\frac{x}{c}(d\theta^2+\sin^2\theta d\varphi^2) \tag{35}$$

With n=3, the expressions for ρ , P_r , $M(x)$, σ , P_t , $e^{2\lambda}$ and $e^{2\nu}$ are given for

$$\rho = c\frac{\left[28a^4bx^4 + \left(78a^3b - 20a^4\right)x^3 + \left(78a^2b - 100a^3\right)x^2 + \left(34ab - 50a^2\right)x + 6b - 9a\right]}{2\left(1+2ax\right)^2} \tag{36}$$

$$P_r = c\frac{\left[28a^4bx^4 + \left(78a^3b - 20a^4\right)x^3 + \left(78a^2b - 100a^3\right)x^2 + \left(34ab - 50a^2\right)x + 6b - 9a\right]}{6\left(1+2ax\right)^2} \tag{37}$$

$$M(x) = \frac{\begin{bmatrix}\left(144a^2x^3b + 48a^3x^4b - 344a^2x^2 - 48a^3x^3 + 144abx^2 + 260ax + 48xb + 249\right)2\sqrt{ax} \\ -\left(1+2ax\right)249\sqrt{2}\arctan\left(\sqrt{2ax}\right)\end{bmatrix}}{192\sqrt{ac}\left(1+2ax\right)} \tag{38}$$

$$\sigma^2 = \frac{3ac^2\left(1+ax\right)^3\left(1-bx\right)\left(4a^2x^2 + 12ax + 9\right)}{\left(1+2ax\right)^5} \tag{39}$$

$$\begin{aligned} P_t =& \frac{4xc\left(1+ax\right)^3\left(1-bx\right)}{\left(1+2ax\right)}\frac{\ddot{y}}{y} + c\left[\frac{-20a^4bx^5 + 4\left(4a^4 - 15a^3b\right)x^4 + 2\left(23a^3 - 33a^2b\right)x^3 + 16\left(3a^3 - 2ab\right)x^2 + 2\left(11a - 3b\right) + 4}{\left(1+2ax\right)^2}\right]\frac{\dot{y}}{y} \\ &+ c\frac{\left[-12a^4bx^4 + 8\left(a^4 - 4a^3b\right)x^3 + 6\left(3a^3 - 5a^2b\right)x^2 + 3\left(4a^2 - 4ab - a\right)x + 2a - 2b\right]}{\left(1+2ax\right)^2} \end{aligned} \tag{40}$$

$$e^{2\lambda} = \frac{\left(1+2ax\right)}{\left(1+ax\right)^3\left(1-bx\right)} \tag{41}$$

$$e^{2\nu} = A^2c_3^2\left(1+2ax\right)^{2H}\left(1+ax\right)^{2I}\left(-1+bx\right)^{2J}\exp\left[2K(x)\right] \tag{42}$$

where for convenience we have let $H = \frac{74a + 3ab - 37b + 18}{12\left(b+2a\right)}$

$$I = -\frac{90a^3 + 18a^2 + 6ab^3 + 6a^2b^2 + 260a^2b + 109ab^2 + 36b^2 + 45ab - 66b^3}{24\left(a+b\right)^3}$$

$$J = -\frac{6a^3b^2 + 12b^4 - 76a^2b^2 - 9ab^2 + 6a^4b + 49ab^3 + 8a^4 - 100a^3b}{24\left(b+2a\right)\left(a+b\right)^3}$$

and

$$K(x) = \frac{\begin{bmatrix}\left(136a^3 + 12a^3b + 18a^2 - 10a^2b + 12a^2b^2 - 156ab^2 + 36ab\right)x + 12a^2b \\ +141a^2 + 12ab^2 + 27a - 5ab + 45b - 156b^2\end{bmatrix}}{48\left(1+ax\right)^2\left(a+b\right)^2} \tag{43}$$

The metric for this model is

$$ds^2 = -A^2c_3^2\left(1+2ax\right)^{2H}\left(1+ax\right)^{2I}\left(-1+bx\right)^{2J}\exp\left[2K(x)\right]dt^2 + \frac{\left(1+2ax\right)}{4xc\left(1+ax\right)^3\left(1-bx\right)}dx^2 + \frac{x}{c}(d\theta^2 + \sin^2\theta d\varphi^2) \tag{44}$$

Figures 1, 2, 3 and 4 represent the graphs of P_r , ρ , σ^2 and $M(x)$, respectively for the case n=1. The graphs has been plotted for a particular choice of parameters a = 0.04786, b = 0.00986 with a stellar radius of r=3 km.

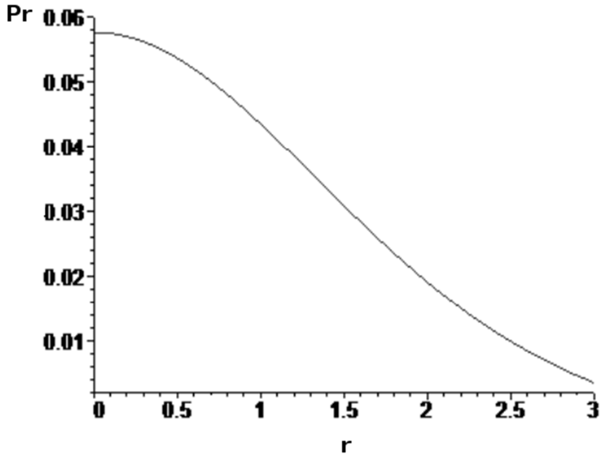

Fig. 1. Radial Pressure.

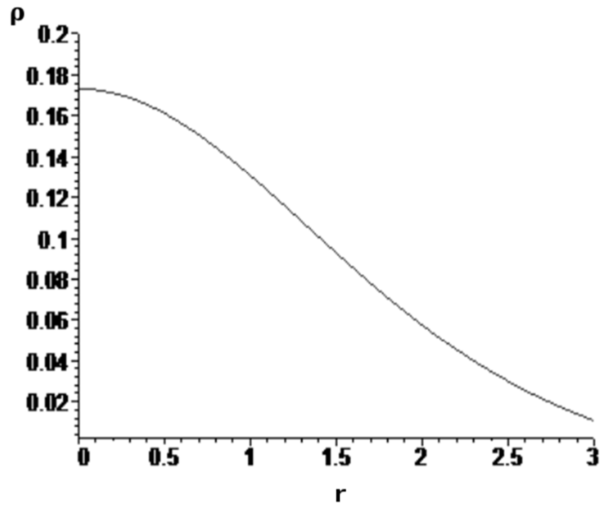

Fig. 2. Charge density.

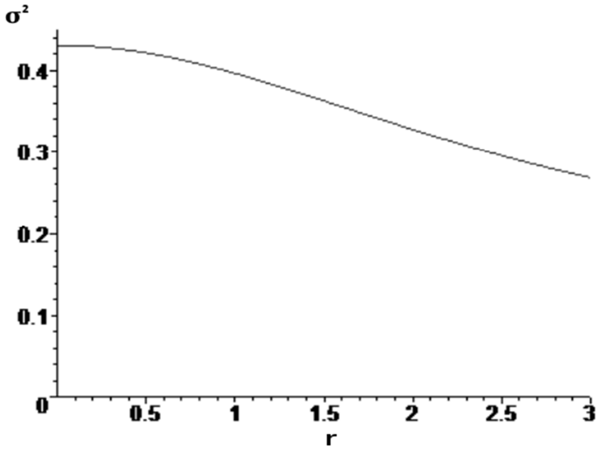

Fig. 3. Charge density.

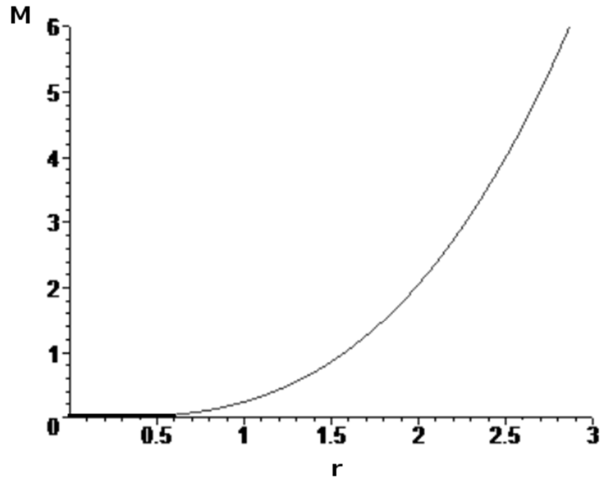

Fig. 4. Mass.

4. Physical Features of the New Models

Any physically acceptable solutions must satisfy the following conditions:

(i) Regularity of the gravitational potentials in the origin.
(ii) Radial pressure must be finite at the centre.
(iii) $P_r > 0$ and ρ >0 in the origin.

With $n=1$, the gravitational potentials are regular at the origin since $e^{2\nu(0)} = A^2 c_1^2 \left(-1\right)^B$ and $e^{2\lambda(0)} = 1$ are constants and $\left(e^{2\lambda(r)}\right)' = \left(e^{2\nu(r)}\right)' = 0$ at r=0. In the centre $\rho(0) = 3c\left(a+b\right)$ and $P_r = c\left(a+b\right)$ both are positive if a > 0 and b > 0. The charge density is continues in the interior and nonsingular in the center.

For the case $n=2$, $e^{2\lambda(0)} = 1$, $e^{2\nu(0)} = A^2 c_2^2 \left(-1\right)^F e^{\frac{a^2-a-2ab-2b+2}{3(a+b)}}$ in the origin $r=0$ and $\left(e^{2\lambda(r)}\right)'_{r=0} = \left(e^{2\nu(r)}\right)'_{r=0} = 0$. This shows that the potential gravitational is regular in the origin. In the centre $\rho(0) = 3cb$ $P_r = bc$.

With $n=3$, $e^{2\lambda(r)} = 1$, $e^{2\nu(0)} = A^2 c_3^2 \left(-1\right)^{2J} e^{\frac{12a^2b+141a^2+12ab^2+27a-5ab+45b-156b^2}{48(a+b)^2}}$ in the origin and $\left(e^{2\lambda(r)}\right)'_{r=0} = \left(e^{2\nu(r)}\right)'_{r=0} = 0$. Again the gravitational potential is regular in $r=0$. The energy density is $\rho = \dfrac{c\left(6b-9a\right)}{2}$ and the radial pressure $P_r = \dfrac{c\left(6b-9a\right)}{6}$ atr=0. In all the cases, the mass function is strictly increasing function, continuous and finite and the charge density is continues and behaves well inside of the star.

In figure 1, the radial pressure is finite and decreasing with the radial coordinate. In fig. 2, that represent energy density for the case n=1,we observe that is continuous, finite and monotonically decreasing function. In fig.3, the charge density σ is nonsingular at the origin, non-negative and decreases. In fig.4, the mass function is strictly increasing function, continuos and $M(x)$= 0 at r=0.

5. Conclusion

In this paper, we have generated new exact solutions to the Einstein-Maxwell system considering modified Tolman IV form for the gravitational potential Z what depends on an adjustable parameter n and a linear equation of state which is relevant in the description of charged anisotropic matter. The new obtained models may be used to model relativistic stars in different astrophysical scenes. The relativistic solutions to the Einstein-Maxwell system presented are physically reasonable. The charge density σ is nonsingular at the origin and the mass function is an increasing function, continuous and finite in the stellar interior. The gravitational potentials are regular at the centre and well behaved.

We show as a modification of the parameter n of the gravitational potential affects the electrical field, charge density and the mass of the stellar object. The models presented in this article may be useful in the description of relativistic compact objects with charge, strange quark stars and configurations with anisotropic matter.

References

[1] Kuhfitting, P.K .(2011). Some remarks on exact wormhole solutions, Adv. Stud. Theor. Phys., 5, 365- 367 .

[2] Bicak, J.(2006). Einstein equations: exact solutions, Encyclopedia of Mathematical Physics, 2, 165-173.

[3] Malaver, M. (2013). Black Holes, Wormholes and Dark Energy Stars in General Relativity. Lambert Academic Publishing, Berlin. ISBN: 978-3-659-34784-9.

[4] Komathiraj, K., and Maharaj,S.D. (2008). Classes of exact Einstein-Maxwellsolutions, Gen. Rel. Grav., 39, 2079-2093.

[5] Sharma, R., Mukherjee, S and Maharaj, S.D.(2001). General solution for a class ofstatic charged stars, Gen. Rel. Grav., 33, 999-110.

[6] Bowers, R. L., Liang, E. P. T.: Astrophys. J., 188, 657 (1974).

[7] Cosenza, M., Herrera, L., Esculpi, M.and Witten, L.(1981), J.Math. Phys., 22(1),118.

[8] Gokhroo, M.K., and Mehra. A.L. (1994). Anisotropic spheres with variable energy density in general relativity, Gen.Relat.Grav., 26(1), 75-84.

[9] Sokolov. A.I. (1980), Sov. Phys. JETP., 52, 575

[10] Usov, V. V.: Phys. Rev. D, 70, 067301 (2004).

[11] Komathiraj, K., and Maharaj, S.D.(2007). Analytical models for quark stars, Int.J.Mod. Phys., D16, pp. 1803-1811.

[12] Malaver, M. (2009). Análisis comparativo de algunos modelos analíticos paraestrellas de quarks, Revista Integración, 27, 125-133.

[13] Malaver, M. AASCIT Communications, 1,48-51 (2014).

[14] Thirukkanesh, S., and Maharaj, S.D. (2008). Charged anisotropic matter with linearequation of state, Class. Quantum Gravity, 25, 235001.

[15] Maharaj, S.D., Sunzu, J.M. and Ray, S. (2014). Eur. Phys. J.Plus., 129, 3.

[16] Thirukkanesh, S., and Ragel, F.C. (2013).A class of exact strange quark star model, PRAMANA-Journal of physics, 81(2), 275-286.

[17] Sunzu, J.M, Maharaj, S.D and Ray, S.(2014). Astrophysics. Space. Sci. 354,517-524

[18] Feroze, T..and Siddiqui, A. (2011). Charged anisotropic matter with quadraticequation of state, Gen. Rel. Grav., 43, 1025-1035.

[19] Feroze, T,.and Siddiqui, A. (2014). Some exact solutions of the Einstein-Maxwellequations with a quadratic equation of state, Journal of the Korean Physical Society, 65(6), 944-947.

[20] Malaver, M. (2014). Strange Quark Star Model with Quadratic Equation of State, Frontiers of Mathematics and Its Applications., 1(1), 9-15.

[21] Malaver, M.(2015). Relativistic Modeling of Quark Stars with Tolman IV Type Potential, International Journal of Modern Physics and Application.,2(1), 1-6.

[22] Takisa, P.M., and Maharaj, S.D. (2013). Some charged polytropic models, Gen.Rel.Grav., 45, 1951-1969.

[23] Thirukkanesh, S., and Ragel, F. C. (2012). Exact anisotropic sphere with polytropic equation of state, PRAMANA-Journal of physics, 78(5), 687-696.

[24] Malaver, M. (2013). Analytical model for charged polytropic stars with Van der Waals Modified Equation of State, American Journal of Astronomy and Astrophysics, 1(4), 41-46.

[25] Malaver, M. (2013). Regular model for a quark star with Van der Waals modified equation of state, World Applied Programming., 3, 309-313.

[26] Thirukkanesh, S., and Ragel, F.C. (2014).Strange star model with Tolmann IV type potential, Astrophysics and Space Science, 352(2), 743-749.

[27] Mak, M.K., and Harko, T. (2004). Quark stars admitting a one-parameter group of conformal motions, Int.J.Mod.Phys, D13, 149-156.

[28] Durgapal, M.C., and Bannerji, R. (1983). New analytical stellar model in general relativity, Phys.Rev. D27, 328-331.

[29] Tolman, R.C. (1939). Static Solutions of Einstein's Field Equations for Spheres of Fluid, Phys. Rev., 55, 364-373.