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ORIGINAL ARTICLE

Well behaved parametric class of relativistic charged fluid ball in general relativity

Neeraj Pant

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Abstract The paper presents a class of interior solutions of Einstein–Maxwell field equations of general relativity for a static, spherically symmetric distribution of the charged fluid. This class of solutions describes well behaved charged fluid balls. The class of solutions gives us wide range of parameter K $(0 \le K \le 42)$ for which the solution is well behaved hence, suitable for modeling of super dense star. For this solution the mass of a star is maximized with all degree of suitability and by assuming the surface density $\rho_b = 2 \times 10^{14}$ g/cm^3. Corresponding to $K = 2$ and $X = 0.30$, the maximum mass of the star comes out to be $4.96\ M_\Theta$ with linear dimension 34.16 km and central redshift and surface redshift 2.1033 and 0.683 respectively. In absence of the charge we are left behind with the well behaved fourth model of Durgapal (J. Phys., A, Math. Gen. 15:2637, 1982).

Keywords Charge fluid · Reissner–Nordstrom · General relativity · Exact solution

1 Introduction

Bonnor (1965), pointed out that a dust distribution of arbitrarily large mass and small radius can remain in equilibrium against the pull of gravity by a repulsive force produced by a small amount of charge. Thus it is desirable to study the implications of Einstein–Maxwell field equations with reference to the general relativistic prediction of gravitational collapse. For this purpose charged fluid ball models are required. The external field of such ball is to be matched with *Reissner–Nordstrom* solution.

N. Pant (✉)
Department of Mathematics, National Defence Academy, Khadakwasla, Pune 411023, India
e-mail: neeraj.pant@yahoo.com

Many of the authors obtained the parametric class of exact solutions of Einstein–Maxwell field equations with their counterpart neutral solutions e.g. Kuchowicz solutions (1968) by Nduka (1977), Tolman solution (1939) by Cataldo and Mitskievic (1992) and Durgapal and Fuloria solution (1985) by Gupta and Maurya (2010a), Heintzmann's (1969) solution by Pant et al. (2010), Durgapal (1982) by Gupta and Maurya (2010b) etc. These coupled solutions are well behaved with some values of parameter and completely describe interior of the super-dense astrophysical objects with charge matter. Further, The mass of the such modeled super dense object can be maximized by assuming surface density is equal to typical nuclear density i.e. $\rho_b = 2 \times 10^{14}$ g/cm^3.

In the present paper we have obtained a new parametric class of exact solutions of Einstein–Maxwell field equations which is well behaved and the most interesting feature is that in the absence of charge the solution is also well behaved. In the absence of charge we rediscovered *Durgapal's well behaved solution IV* Durgapal (1982).

For well behaved nature of the solution implies in curvature coordinates, the following conditions should be satisfied (Pant et al. 2010):

(i) The solution should be free from physical and geometrical singularities i.e. finite and positive values of central pressure, central density and non zero positive values of e^{λ} and e^{υ}, mathematically it is expressed as

(a) $e^{\upsilon} > 0$ and $(e^{-\lambda})_{r=0} = 1$;

(b) $p_0 > 0$ and $\rho_0 > 0$.

(ii) The solution should have positive and monotonically decreasing expressions for fluid parameters (p and ρ) with the increase of r i.e.

(a) $\left(\frac{dp}{dx}\right)_{x=0} < 0$ (b) $\left(\frac{d\rho}{dx}\right)_{x=0} < 0$.

(iii) The solution should have positive and monotonically decreasing expression for fluid parameter $\frac{p}{\rho c^2}$ with the increase of r i.e.

$$\frac{1}{c^2}\left[\frac{d}{dx}\left(\frac{p}{\rho}\right)\right]_{x=0} < 0.$$

(iv) The solution should have positive and monotonically decreasing expressions for fluid parameter $(\frac{dp}{d\rho})$ with the increase of r

$$\left(\frac{d}{dx}\left(\frac{dp}{d\rho}\right)\right)_{x=0} < 0.$$

(v) The solution should have causality condition at centre of the ball i.e. $0 < \frac{1}{c^2}(\frac{dp}{d\rho})_{r=0} \leq 1$.

(vi) The solution should have positive value of ratio of pressure-density and less than 1 at the centre of the ball i.e. $0 < \frac{p_0}{\rho_0 c^2} \leq 1$.

(vii) The central red shift Z_0 and surface red shift Z_b should be positive and finite i.e.

$$Z_0 = (e^{-\upsilon/2} - 1)_{r=0} > 0 \quad \text{and}$$

$$Z_b = [e^{\lambda_b/2} - 1] > 0;$$

both should be bounded and red shift should be monotonically decreasing with the increase of r i.e.

$$\left[\frac{dz}{dx}\right]_{x=0} < 0.$$

(viii) Electric intensity is positive and monotonically increasing from centre to boundary and at the centre the Electric intensity is zero i.e.

$$\left[\frac{d}{dx}\left(\frac{E^2}{c_1}\right)\right]_{x=0} > 0.$$

2 Einstein–Maxwell equation for charged fluid distribution

Let us consider a spherical symmetric metric in curvature coordinates

$$ds^2 = -e^{\lambda}dr^2 - r^2(d\theta^2 + \sin^2\theta d\phi^2) + e^{\upsilon}dt^2 \tag{1}$$

where the functions $\lambda(r)$ and $\upsilon(r)$ satisfy the Einstein–Maxwell equations

$$\begin{aligned} -\frac{8\pi G}{c^4}T^i_j &= R^i_j - \frac{1}{2}R\delta^i_j \\ &= -\frac{8\pi G}{c^4}\Big[(c^2\rho + p)v^i v_j - p\delta^i_j \\ &\quad + \frac{1}{4\pi}\Big(-F^{im}F_{jm} + \frac{1}{4}\delta^i_j F_{mn}F^{mn}\Big)\Big] \end{aligned} \tag{2}$$

where ρ, p, v^i, F_{ij} denote energy density, fluid pressure, velocity vector and skew-symmetric electromagnetic field tensor respectively.

In view of the metric (1), the field equation (2) gives (Dionysiou 1982)

$$\frac{\upsilon'}{r}e^{-\lambda} - \frac{(1-e^{-\lambda})}{r^2} = \frac{8\pi G}{c^4}p - \frac{q^2}{r^4}, \tag{3}$$

$$\left(\frac{\upsilon''}{2} - \frac{\lambda'\upsilon'}{4} + \frac{\upsilon'^2}{4} + \frac{\upsilon' - \lambda'}{2r}\right)e^{-\lambda} = \frac{8\pi G}{c^4}p + \frac{q^2}{r^4}, \tag{4}$$

$$\frac{\lambda'}{r}e^{-\lambda} + \frac{(1-e^{-\lambda})}{r^2} = \frac{8\pi G}{c^2}\rho + \frac{q^2}{r^4} \tag{5}$$

where, prime ($\prime$) denotes the differentiation with respect to r and $q(r)$ represents the total charge contained within the sphere of radius r.

Now let us assume

$$e^{\upsilon} = B(1 + c_1 r^2)^4 \tag{6}$$

Putting (6) into (3)–(5), we have

$$\frac{8Y}{1+x} - \frac{(1-Y)}{x} + \frac{c_1 q^2}{x^2} = \frac{1}{c_1}\frac{8\pi G}{c^4}p, \tag{7}$$

$$\frac{(1-Y)}{x} - 2\frac{dY}{dx} - \frac{c_1 q^2}{x^2} = \frac{1}{c_1}\frac{8\pi G}{c^2}\rho \tag{8}$$

and Y satisfying the equation

$$\frac{dY}{dx} + \frac{7x^2 - 2x - 1}{x(1+x)(1+5x)}Y = \frac{(1+x)}{x(1+5x)}\left(\frac{2c_1 q^2}{x} - 1\right) \tag{9}$$

$$\text{where } x = c_1 r^2, e^{-\lambda} = Y. \tag{9a}$$

Our task is to explore the solutions of (9) and obtain the fluid parameters p and ρ from (7) and (8).

3 New class of solutions

In order to solve the differential equation (9), we consider the electric intensity E of the following form

$$\frac{E^2}{c_1} = \frac{c_1 q^2}{x^2} = \frac{K}{2}x(1+5x)^{\frac{3}{5}} \tag{10}$$

where K is a positive constant. The electric intensity is so assumed that the model is physically significant and well behaved i.e. E remains regular and positive throughout the sphere. In addition, E vanishes at the centre of the star. Thus we have,

$$K \geq 0, \qquad c_1 > 0 \tag{10a}$$

In view of (10) differential equation (9) yields the following solution

$$Y = e^{-\lambda} = \frac{K}{4} \cdot \frac{x(1+x)^2}{(1+5x)^{\frac{2}{5}}} + \frac{7-10x-x^2}{7(1+x)^2} + \frac{Ax}{(1+5x)^{\frac{2}{5}}(1+x)^2} \tag{11a}$$

where A is an arbitrary constant of integration.

Using (6), (9a), (11a) into (7) and (8), we get the following expressions for pressure and energy density

$$\frac{1}{c_1}\frac{8\pi G}{c^4} p = \frac{K}{4} \cdot \frac{(19x^2+12x+1)}{(1+5x)^{\frac{2}{5}}} + \frac{A(1+9x)}{(1+x)^3(1+5x)^{\frac{2}{5}}} + \frac{32-112x-16x^2}{7(1+x)^3}, \tag{12}$$

$$\frac{1}{c_1}\frac{8\pi G}{c^2}\rho = -\frac{K}{4} \cdot \frac{(81x^3+69x^2+23x+3)}{(1+5x)^{\frac{7}{5}}} + \frac{A(9x^2-10x-3)}{(1+5x)^{\frac{7}{5}}(1+x)^3} + \frac{72+16x+8x^2}{7(1+x)^3} \tag{13}$$

4 Properties of the new class of solutions

The central values of pressure and density are given by

$$\frac{1}{c_1}\frac{8\pi G}{c^4} p_0 = \frac{K}{4} + A + \frac{32}{7}, \tag{14}$$

$$\frac{1}{c_1}\frac{8\pi G}{c^2}\rho_0 = -\frac{3}{4}K - 3A + \frac{72}{7} \tag{15}$$

For p_0 and ρ_0 must be positive and $\frac{p_0}{\rho_0} \le 1$, we have

$$-\frac{K}{4} - \frac{32}{7} < A \le -\frac{K}{4} + \frac{10}{7}, \quad \text{and} \quad K \ge 0,\ A < 0 \tag{16}$$

Differentiating (12) and (13) w.r.t. x, we get;

$$\frac{1}{c_1} \cdot \frac{8\pi G}{c^4}\frac{dp}{dx} = \frac{K}{2}\frac{(76x^2+47x+5)}{(1+5x)^{\frac{7}{5}}} + 4A\frac{(1-2x-27x^2)}{(1+x)^4(1+5x)^{\frac{7}{5}}} + \frac{16}{7}\frac{(x^2+12x-13)}{(1+x)^4}, \tag{17}$$

$$\frac{1}{c_1} \cdot \frac{8\pi G}{c^2}\frac{d\rho}{dx} = -\frac{K}{2} \cdot \frac{(324x^3+225x^2+46x+1)}{(1+5x)^{\frac{12}{5}}} + 4A\frac{(-27x^3+49x^2+31x+5)}{(1+5x)^{\frac{12}{5}}(1+x)^4} - \frac{8}{7}\frac{(x^2+2x+25)}{(1+x)^4}, \tag{18}$$

$$\left(\frac{1}{c_1} \cdot \frac{8\pi G}{c^4}\frac{dp}{dx}\right)_{x=0} = \frac{5K}{2} + 4A - \frac{208}{7}, \tag{19}$$

$$\left(\frac{1}{c_1} \cdot \frac{8\pi G}{c^4}\frac{dp}{dx}\right)_{x=0} < 0$$

The expression of right hand side of (19) is negative, thus the pressure p is maximum at the centre and monotonically decreasing.

$$\left(\frac{1}{c_1}\frac{8\pi G}{c^2} \cdot \frac{d\rho}{dx}\right)_{x=0} = -\frac{K}{2} + 20A - \frac{200}{7}, \tag{20}$$

$$\left(\frac{1}{c_1} \cdot \frac{8\pi G}{c^2}\frac{d\rho}{dx}\right)_{x=0} < 0 \tag{21}$$

The expression of right hand side of (20) is negative, thus the density ρ is maximum at the centre and monotonically decreasing and hence the velocity of sound v is given by the following expression

$$v^2 = \frac{dp}{d\rho}$$

$$\frac{1}{c^2}\frac{dp}{d\rho} = \frac{7K(76x^2+47x+5)(1+x)^4(1+5x) + 56A(1-2x-27x^2)(1+5x) + 32(x^2+12x-13)(1+5x)^{\frac{12}{5}}}{-7K(324x^3+225x^2+46x+1)(1+x)^4 + 56A(-27x^3+49x^2+31x+5) - 16(x^2+2x+25)(1+5x)^{\frac{12}{5}}}, \tag{22}$$

$$\left(\frac{1}{c^2}\frac{dp}{d\rho}\right)_{r=0} = \frac{35K+56A-416}{-7K+280A-400} \le 1,$$

for all values of K and A satisfied by (16).

Using (12) and (13)

$$\frac{1}{c^2}\frac{p}{\rho} = \frac{\alpha}{\beta}, \tag{23}$$

where

$$\alpha = \frac{K}{4} \cdot \frac{(19x^2+12x+1)}{(1+5x)^{\frac{2}{5}}} + \frac{A(1+9x)}{(1+x)^3(1+5x)^{\frac{2}{5}}} + \frac{32-112x-16x^2}{7(1+x)^3},$$

$$\beta = -\frac{K}{4}\cdot\frac{(81x^3+69x^2+23x+3)}{(1+5x)^{\frac{7}{5}}} + \frac{A(9x^2-10x-3)}{(1+5x)^{\frac{7}{5}}(1+x)^3} + \frac{72+16x+8x^2}{7(1+x)^3}$$

Differentiating (22) w.r.t. x

$$\frac{1}{c^2}\frac{d}{dx}\left(\frac{p}{\rho}\right) = \frac{\beta\frac{d\alpha}{dx} - \alpha\frac{d\beta}{dx}}{\beta^2}, \tag{24}$$

$$\frac{1}{c^2}\left[\frac{d}{dx}\left(\frac{p}{\rho}\right)\right]_{x=0} = \frac{(-1372K^2 - 11770AK + 45024K + 52864A + 25088A^2 - 137216)}{(-21K - 84A + 288)^2} \tag{25}$$

The expression of right hand side of (25) is negative, thus the pressure density ratio $\frac{p}{\rho c^2}$ is maximum at the centre and monotonically decreasing for all values of K and A satisfied by (16).

Differentiating equation (22) w.r.t. x, we get,

$$\frac{1}{c^2}\left(\frac{d}{dx}\left(\frac{dp}{d\rho}\right)\right) = \frac{d}{dx}\left(\frac{\psi}{\xi}\right) = \frac{\xi\frac{d\psi}{dx} - \psi\frac{d\xi}{dx}}{\xi^2}, \tag{26}$$

$$\begin{aligned}\psi &= 7K(76x^2+47x+5)(1+x)^4(1+5x)\\ &\quad + 56A(1-2x-27x^2)(1+5x)\\ &\quad + 32(x^2+12x-13)(1+5x)^{\frac{12}{5}},\end{aligned}$$

$$\begin{aligned}\xi &= -7K(324x^3+225x^2+46x+1)(1+x)^4\\ &\quad + 56A(-27x^3+49x^2+31x+5)\\ &\quad - 16(x^2+2x+25)(1+5x)^{\frac{12}{5}},\end{aligned}$$

$$\frac{1}{c^2}\left(\frac{d}{dx}\left(\frac{dp}{d\rho}\right)\right)_{x=0} = 2\frac{3871K^2 + 68992AK - 100912K - 182336A - 25088A^2 - 83456}{(-7K - 400 + 280A)^2} \tag{27}$$

The expression of right hand side of (27) is to be negative, thus the square of adiabatic speed of sound $\frac{dp}{d\rho}$ is maximum at the centre and monotonically decreasing.

The expression for gravitational red-shift (z) is given by

$$z = \frac{(1+x)^{-2}}{\sqrt{B}} - 1 \tag{28}$$

The central value of gravitational red shift to be non zero positive finite, we have

$$1 > \sqrt{B} > 0 \tag{28a}$$

Differentiating equation (28) w.r.t. x, we get,

$$\left[\frac{dz}{dx}\right]_{x=0} = \frac{-2}{\sqrt{B}} < 0 \tag{28b}$$

The expression of right hand side of (28b) is negative, thus the gravitational red-shift is maximum at the centre and monotonically decreasing.

Differentiating equation (10) w.r.t. x, we get,

$$\frac{d}{dx}\left(\frac{E^2}{c_1}\right) = \frac{K}{2}\left[\frac{(1+8x)}{(1+5x)^{2/5}}\right], \tag{29}$$

$$\left[\frac{d}{dx}\left(\frac{E^2}{c_1}\right)\right]_{x=0} = \frac{K}{2}(+ve) \tag{29a}$$

The expression of right hand side of (29a) is positive, thus the electric intensity is minimum at the centre and monotonically increasing for all values of $K > 0$. Also at the centre it is zero.

5 Boundary conditions

The solutions so obtained are to be matched over the boundary with Reissner–Nordstrom metric.

$$\begin{aligned}ds^2 &= -\left(1 - \frac{2GM}{r} + \frac{e^2}{r^2}\right)^{-1} dr^2 - r^2(d\theta^2 + \sin^2\theta\, d\phi^2)\\ &\quad + \left(1 - \frac{2GM}{r} + \frac{e^2}{r^2}\right) dt^2\end{aligned} \tag{30}$$

which requires the continuity of e^λ, e^ν and q across the boundary $r = r_b$

$$e^{-\lambda(r_b)} = 1 - \frac{2GM}{c^2 r_b} + \frac{e^2}{r_b^2}, \tag{31}$$

$$e^{\nu(r_b)} = 1 - \frac{2GM}{c^2 r_b} + \frac{e^2}{r_b^2}, \tag{32}$$

$$q(r_b) = e, \tag{33}$$

$$p(r_b) = 0 \tag{34}$$

The condition (34) can be utilized to compute the values of arbitrary constants A as follows.

On setting $x_{r=r_b} = X = c_1 r_b^2$, ($r_b$ being the radius of the charged sphere) pressure at $p_{(r=r_b)} = 0$ gives

$$A = -\frac{K}{4}\frac{(1+X)^3(19X^2+12X+1)}{(1+9X)} + \frac{(16X^2+112X-32)(1+5X)^{2/5}}{7(1+9X)} \tag{35}$$

The expression for mass can be written as

$$\frac{GM}{c^2}=\frac{r_b}{2}\left[KX^2\frac{(1+5X)^{\frac{8}{5}}}{(1+9X)}+\frac{8X}{(1+9X)}\right] \tag{36}$$

In view of (31) and (32) we get,

$$B=\frac{2-KX^2(1+5X)^{\frac{3}{5}}}{2(1+9X)(1+X)^3} \tag{37}$$

The surface density is given by

$$\frac{8\pi G}{c^2}\rho_b r_b^2=X\left[-\frac{K}{4}.\frac{(81X^3+69X^2+23X+3)}{(1+5X)^{\frac{7}{5}}}\right.$$
$$\left.+\frac{A(9X^2-10X-3)}{(1+5X)^{\frac{7}{5}}(1+X)^3}+\frac{72+16X+8X^2}{7(1+X)^3}\right] \tag{38}$$

Centre red shift is given by

$$z_0=B^{-1/2}-1 \tag{39}$$

6 Discussion

In view of and Table 1, it has been observed that all the physical parameters (p, $\rho\frac{p}{\rho c^2}$, $\frac{dp}{d\rho}$ and z) are positive at the centre and within the limit of realistic equation of state. From Table 2, the first derivative of all the parameters is negative at the centre. Thus, by virtue of the theorem by Pant et al. (2010) "*If* $f(r)=g(x)$; $(\frac{dg}{dx})_{x=0}$ *and* $(\frac{d^2g}{dx^2})_{x=0}$, *are non zero finite; where* $x=r^2$, *then* (i) *maxima of* $f(r)$ *will exist at* $r=0$ *if* $(\frac{dg}{dx})_{x=0}$ *is finitely negative.* (ii) *Minima of* $f(r)$ *will exist at* $r=0$ *if* $(\frac{dg}{dx})_{x=0}$ *is finitely nonzero positive*", all the parameters are monotonically decreasing in nature for ($0\le K\le 42$). In view of (29a), the electric intensity is minimum at the centre and monotonically increasing. for all values of $K>0$. Therefore, the solution is well behaved for ($0\le K\le 42$). Corresponding to any value of $K>42$, there exists no value of X for which adiabatic sound speed is real. For this solution the mass of a star is maximized with all degree of suitability and by assuming the surface density $\rho_b=2\times 10^{14}$ g/cm^3. Corresponding to $K=2$ and $X=0.3$ the maximum mass of the star comes out to be 4.96 M_Θ with

Table 1 The variation of various physical parameters at the centre, surface density, electric field intensity on the boundary, mass and linear dimension of stars with different values of K and X

K	$X=c_1r_b^2$	$\frac{1}{c_1}\frac{8\pi G}{c^4}p_0$	$\frac{1}{c_1}\frac{8\pi G}{c^2}\rho_0$	$\frac{1}{c^2}\frac{p_0}{\rho_0}$	$\frac{1}{c^2}(\frac{dp}{d\rho})_{x=0}$	z_0	$(\frac{E^2}{c_1})_{r_b}$	$\frac{8\pi G}{c^2}\rho_b r_b^2$	$\frac{M}{M_\Theta}$	$\approx 2r_b$ in km
0	0.24	4.311252	11.06624	0.38958	0.91058	1.45457	0	1.425	4.02	39.13
0	0.26	4.464096	10.60771	0.42083	0.98129	1.58481	0	1.445	4.15	39.42
2	0.1	2.4091	15.2725	0.15774	0.427	0.6004	0.1275	1.062	2.52	33.76
2	**0.3**	**3.36733**	**12.3978**	**0.2716**	**0.4953**	**2.1033**	**0.5198**	**1.086**	**4.96**	**34.16**
2	0.52	2.5273	14.915	0.1695	0.4337	5.9175	1.1214	0.15884	3.26	13.06
5	0.1	1.90347	14.539	0.1309	0.30052	0.61622	0.318	1.013	2.63	32.99
5	0.25	1.74217	15.02348	0.11596	0.29764	1.91734	1.016	0.788	4.81	29.09
5	0.35	0.71556	18.1033	0.03952	0.28259	3.82779	1.605	0.109	2.6	10.82
10	0.1	1.060	13.31	0.07964	0.18699	0.64351	0.637	0.931	2.79	31.62
10	0.2	0.0499	16.35	0.00305	0.18850	1.63499	1.515	0.591	4.29	25.20

Table 2 The derivatives of various physical parameters at the centre with different values of K and X

K	$X=c_1r_b^2$	$(\frac{1}{c_1}\cdot\frac{8\pi G}{c^4}\frac{dp}{dx})_{x=0}$	$(\frac{1}{c_1}\frac{8\pi G}{c^2}\cdot\frac{d\rho}{dx})_{x=0}$	$\frac{1}{c^2}[\frac{d}{dx}(\frac{p}{\rho})]_{x=0}$	$\frac{1}{c^2}(\frac{d}{dx}(\frac{dp}{d\rho}))_{x=0}$	$[\frac{dz}{dx}]_{x=0}$
0	0.24	**−30.755**	**−33.775**	**−1.59013**	**−0.33736**	**−4.90915**
0	0.26	**−30.1436**	**−30.7181**	**−1.62301**	**−0.69398**	**−5.16963**
2	0.1	−35.3633	−82.8167	−1.3989	−0.49027	−3.20098
2	0.3	−31.5305	−63.6525	−1.15879	−0.67261	−6.20674
5	0.52	−34.8867	−80.4337	−1.37033	−0.50355	−13.8352
5	0.1	**−32.8861**	**−109.431**	**−1.17463**	**−1.28968**	**−3.23245**
5	**0.25**	**−33.5313**	**−112.657**	**−1.22849**	**−1.26398**	**−5.83469**
10	0.35	**−37.6378**	**−133.189**	**−1.52205**	**−1.13643**	**−9.65559**
10	0.1	−28.7574	−153.787	−1.00323	−2.01181	−3.28704
10	**0.2**	**−32.8002**	**−174.001**	**−1.35841**	**−1.85581**	**−5.26998**

Table 3 The variation of various physical parameters at the centre, surface density, electric field intensity on the boundary, mass and linear dimension of stars with different values of K and for $X = 0.25$, where the class of solution is well behaved

K	$\frac{1}{c_1}\frac{8\pi G}{c^4}p_0$	$\frac{1}{c_1}\frac{8\pi G}{c^2}\rho_0$	$\frac{1}{c^2}\frac{p_0}{\rho_0}$	$\frac{1}{c^2}(\frac{dp}{d\rho})_{x=0}$	z_0	z_b	$(\frac{E^2}{c_1})_{r_b}$	$\frac{8\pi G}{c^2}\rho_b r_b^2$	$\frac{M}{M_\Theta}$	$\approx 2r_b$ in km
0	4.389034	10.8329	0.40515	0.94489	1.51945	0.612	0	1.435	4.09	39.26
1	3.859662	11.67102	0.33070	0.64300	1.58604	0.655	0.203	1.306	4.35	37.46
2	3.33029	12.50913	0.26622	0.49195	1.65820	0.701	0.406	1.176	4.55	35.54
3	**2.800918**	**13.34725**	**0.20985**	**0.40128**	**1.73676**	**0.751**	**0.610**	**1.047**	4.69	33.54
4	**2.271546**	**14.18536**	**0.16013**	**0.34083**	**1.82273**	**0.806**	**0.813**	**0.917**	4.76	31.39
5	**1.74217**	**15.02348**	**0.11596**	**0.29764**	**1.91734**	**0.867**	**1.016**	**0.788**	**4.81**	**29.09**
6	1.212802	15.8616	0.07646	0.26524	2.02215	0.934	1.220	0.659	**4.68**	**26.61**
7	**0.68343**	**16.69971**	**0.04092**	**0.24004**	**2.13913**	**1.009**	**1.423**	**0.529**	4.44	23.84
8	**0.154058**	**17.53783**	**0.00878**	**0.21988**	**2.27085**	**1.093**	**1.626**	**0.400**	4.13	20.73

linear dimension 34.16 km, central red shift 2.1033 and surface redshift 0.683.

It has been observed that for higher values of K approaching to 42, though the solution is well behaved but the mass of the star is very less than the Chandrasekhar limit.

In view of Table 3, it has been observed that all the physical parameters at the centre (p, $\frac{p}{\rho c^2}$, $\frac{dp}{d\rho}$ and $2r_b$) have well behaved nature and these parameters have monotonically decreasing trend with the increase of charge parameter K. The trend of surface redshift, central redshift, central density and electric field intensity are increasing with the increase of K. However the trend of Mass of the star first increasing then after some value of K it goes on decreasing.

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