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# D Non Empty Charged Perfect Fluid in General Relativity

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**ORIGINAL ARTICLE**

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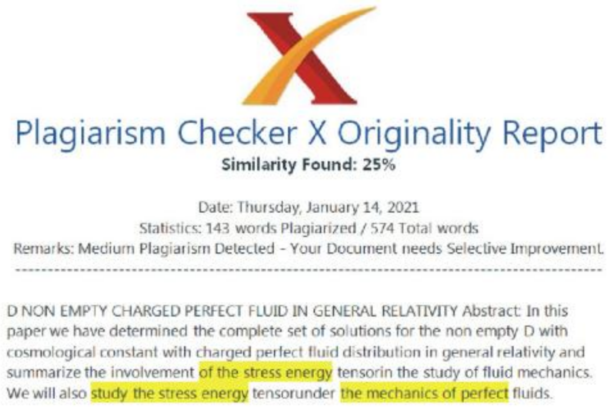

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D NON EMPTY CHARGED PERFECT FLUID IN GENERAL RELATIVITY Abstract: In this paper we have determined the complete set of solutions for the non empty D with cosmological constant with charged perfect fluid distribution in general relativity and summarize the involvement of the stress energy tensorin the study of fluid mechanics. We will also study the stress energy tensorunder the mechanics of perfect fluids.

## Abstract

*In this paper we have determined the complete set of solutions for the non empty D with cosmological constant with charged perfect fluid distribution in general relativity and summarize the involvement of the stress energy tensorin the study of fluid mechanics. We will also study the stress energy tensorunder the mechanics of perfect fluids.*

## Key Words

**Perfect fluid, Cosmological constant, Metric Tensor.**

## Introduction

This paper deals about rotating matter in general relativity. Authors have solved Einstein-Maxwell equation by giving the form of the metric given by Dubey (1995). The metric has four arbitrary functions P, $P_1$, Q, $Q_1$. In this the first two function depend on $x$ and other two on $y$. Starting from single canonical metric element, authors have presented by integrating field equations all the null or non-null arbitrary D solutions. The coordinates $(x, \sigma, y, \tau)$ are arbitrary and have freedom of being interpreted time like or space-like. For $H(x, y) = 1$, we recover the metric discover by Mishra (1983). The metric for $P_1 = Q_1 = 1$ goes over to the metric founded by Diaz (1983)

The Equation of metric is

$$ds^2 = H^{-2}[-\frac{\Delta}{PP_1}dx^2 - \frac{P}{\Delta}(d\tau + pd\sigma)^2 - \frac{\Delta}{QQ_1}dy^2 + \frac{Q}{\Delta}(d\tau + md\sigma)] \qquad \text{....... (1.1)}$$

Where

$$P = P(x), \quad Q = Q(y), \quad \Delta = m - P, \quad p = p(y) \qquad \text{....... (1.2)}$$
$$P_1 = P_1(x), \quad Q_1 = Q_1(y), \quad m = m - x, \quad H = H(x, y)$$

The metric (1.1) may alternatively be expressed as:

$$ds^2 = H^{-2}[-\frac{\Delta}{PP_1}dx^2 - (\frac{Pp^2-Qm^2}{\Delta})d\sigma^2 - \frac{\Delta}{QQ_1}dy^2 - 2\left(\frac{pP-mQ}{\Delta}\right)d\tau d\sigma + \frac{Q-P}{\Delta}d\tau^2] \quad \text{……. (1.3)}$$

We note that,

$$\frac{Pp^2-Qm^2}{\Delta} = \frac{1}{Q-P}\left[\frac{PQ(m-p)^2-(Pp-mQ)^2}{\Delta}\right] \quad \text{……. (1.4)}$$

Hence the equation (1.3) takes the form,

$$ds^2 = H^{-2}[-\Delta\{\frac{dx^2}{PP_1} + \frac{dy^2}{QQ_1} + \frac{PQ}{Q-P}d\sigma^2\} + \frac{Q-P}{\Delta}\left\{d\tau - \frac{pP-mQ}{Q-P}d\sigma\right\}^2] \quad \text{……. (1.5)}$$

It is obvious from the above that if all the structural functions (1.2) are positive $Q > P$, then τ may be interpreted as time coordinate. However if $P > Q$, τ no more can be taken as time, instead σ should be interpreted to represent time coordinate. In this manner different assumptions regarding the sign and relative magnitude of the structural functions would lead to different interpretations of the coordinates $(x, \sigma, y, \tau)$. However, for the sake of convenience we designate the coordinates as :

$$x^n = (x, \sigma, y, \tau)$$

The non vanishing components of metric tensor are:

$$g_{\mu\nu} = \begin{vmatrix} -H^{-2}\frac{\Delta}{PP_1} & 0 & 0 & 0 \\ 0 & -\frac{(Pp^2-Qm^2)H^{-2}}{\Delta} & 0 & \frac{-(pP-mQ)H^{-2}}{\Delta} \\ 0 & 0 & H^{-2}\frac{\Delta}{QQ_1} & 0 \\ 0 & \frac{-(Pp-mQ)H^{-2}}{\Delta} & 0 & \frac{(Q-P)H^{-2}}{\Delta} \end{vmatrix} \quad \text{……. (1.6)}$$

From equation (1.6), we further have:

$$g = \|g_{\mu\nu}\| = -H^{-8}\frac{(m-p)^2}{P_1Q_1} \quad \text{……. (1.7)}$$

Since we know that the cosmological constant $\Lambda$ appears in Einstein's field equation in the form

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = KT_{\mu\nu} - \Lambda g_{\mu\nu} \quad \text{……. (1.8)}$$

Where the Ricci tensor/ scalar R and the metric tensor $g$ describe the structure of spacetime, the stress-energy tensor $T$ describes the energy and momentum density and flux of the matter in that point in spacetime.

When $\Lambda$ is zero, this reduces to the field equation of general relativity. When $T$ is zero, the field equation describes empty space.

We see that, from equation (1.8), $T_{\mu\nu}$ is given by,

(i) For perfect fluid

$$T_{\mu\nu} = (\Pi + \varepsilon)U_\mu U_\nu + \Pi g_{\mu\nu} \quad \text{……. (1.9)}$$

Where $\Pi$ and $\varepsilon$ are respectively the pressure and matter density and $U_\mu U_\nu$ is the four-velocity vector held satisfying

$$U_\mu U^\nu = 1$$

and $g_{\mu\nu}$ s the metric written with a space-positive signature.

(ii) For electromagnetic fields

$$T_{\mu\nu} = \frac{1}{4\pi}\left[-g^{\lambda\sigma}(F_{\mu\lambda}F_{\nu\sigma}) + \frac{1}{4}g_{\mu\nu}(F_{\lambda\sigma}F^{\lambda\sigma})\right] \qquad \ldots\ldots (1.10)$$

Where $F_{\mu\nu}$ is the electromagnetic field tensor.

## Conclusion

We saw the stress energy tensor ($T_{\mu\nu}$), in general relativity, is that as the sole function of defining the energy density of the corpsethat causes the curvature of space-time. However, we noticed that the stress energy tensorused in general relativity was other than a generalization of the stress tensor used in fluid mechanics.

So, without giving details of calculations, we can give some useful findings which are as follows:

1. Charged perfect solution of type D metric.
2. Dubey's solution may be recovered by applying the limit of vanishing electromagnetic fields which is particular case goes over to the Wahlquist solution.
3. For H=1, we get Mishra's (1983) solution.
4. For $P_1Q_1=1$ , we obtain the solution of Diaz (1983).

Thus, in this way a large number of solutions are obtained by authors.

## References

1. Diaz, A.G. (1983), J. Math, Physics, 25(6).
2. Dubey, G. S. (1984), Ph. D. Thesis, Department of Physics , D. D. U. Gorakhpur University, Gorakhpur (U.P.)
3. Dubey, G. S. (1995), Reprint, Department of Physics, G. S. D. College, Samodhpur, Jaunpur.
4. Mishra, R. M. (1983), Reprint, Department of Physics, D. D. U. Gorakhpur University, Gorakhpur (U.P.).
5. Pathak, Ramesh (2001), Ph. D. Thesis , V. B. S. Purvanchal University, Jaunpur.
6. Srivastava, J. (1998), Ph. D. Thesis, V. B. S. Purvanchal University, Jaunpur.
7. Sciences.ch (2017), 50. Relativite generale, Cosmologie.

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