

Closed form charged fluid with $t = \text{constant}$ hypersurfaces as spheroids and hyperboloids

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Abstract In the present article models of well behaved charged superdense stars with surface density $2 \times 10^{14} \text{ gm/cm}^3$ are constructed by considering a static spherically symmetric metric with $t = \text{const}$ hypersurfaces as spheroids and hyperboloids. Maximum mass of the star is found to be $7.66300M_{\odot}$ with radius 19.35409 km for spheroids case while $1.51360M_{\odot}$ with radius 13.72109 km for hyperboloid case satisfying ultra-relativistic conditions. The solutions thus found satisfy all the reality and causality conditions. For brevity we don't present a detailed analysis of the derived solutions in this paper.

Keywords Charge fluids · Reissner-Nordstrom · General relativity · Exact solution

1 Introduction

It is well known that static, spherically symmetric, uncharged perfect fluids cannot be held in equilibrium below a certain radius without developing singularities inside. Since the inception of Reissner-Nordstrom metric, research workers have been busy in deriving interior regular charged perfect fluid solutions. A good account of the same can be had from the work of Ivanov (2002). The relevance of the study

of charged fluid distributions is connected with the following interesting facts such as: (i) Charge dust (CD) (pressure free distribution) may be realized in the slight ionization of neutral hydrogen. (ii) CD may possess arbitrary mass and radius, can attain very large redshifts, their exteriors can be made arbitrarily near to the exterior of an extreme charged black hole. (iii) A classical model of an electron is likely to be represented by CD if many of its characteristics remain finite and non-trivial while the junction radius shrinks to zero. (iv) Besides many other speciality, the charge in the fluid distribution helps in countering the gravitational collapse by means of the Colombian repulsion together with the pressure gradient. Although one can reach this goal with non-perfect fluids, a perfect fluid solution of the type mentioned was recently found (Gupta and Kumar 2005a) but with the presence of an electric charge. Electric charges inhibit the growth of space-time curvature and therefore they are an efficient means of avoiding singularities inside matter and enhance stability.

Recently, Gupta and Kumar (2005b) has obtained most general class of charged fluid spheres described by space-time with hypersurfaces ' $t = \text{const}$ ' as spheroids or hyperboloids considering the electric field intensity that has positive gradient. Recently, Gupta et al. (2010), Bijalwan (2011) and Gupta and Kumar (2011) discussed new closed form solutions for spheroid and hyperboloid, respectively considering a special form of charge profile satisfying ultra-relativistic and non-relativistic conditions. We present new closed form solutions for charged fluid with $t = \text{constant}$ hyper-surfaces as spheroids and hyperboloids considering new electric field intensity. The solutions thus found satisfy all the reality and causality conditions.

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