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ORIGINAL ARTICLE

Exact solutions: neutral and charged static perfect fluids with pressure

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Abstract We show in this article that charged fluid with pressure derived by Bijalwan (Astrophys. Space. Sci. doi:10.1007/s10509-011-0691-0, 2011a) can be used to model classical electron, quark, neutron stars and pulsar with charge matter, quasi black hole, white dwarf, super-dense star etc. Recent analysis by Bijalwan (Astrophys. Space. Sci., 2011d) that all charged fluid solutions in terms of pressure mimic the classical electron model are partially correct because solutions by Bijalwan (Astrophys. Space. Sci. doi:10.1007/s10509-011-0691-0, 2011a) may possess a neutral counterpart. In this paper we characterized solutions in terms of pressure for charged fluids that have and do not have a well behaved neutral counter part considering same spatial component of metric e^{λ} for neutral and charged fluids. We discussed solution by Gupta and Maurya (Astrophys. Space Sci. 331(1):135–144, 2010a) and solutions by Bijalwan (Astrophys. Space Sci. doi:10.1007/s10509-011-0735-5, 2011b; Astrophys. Space Sci. doi:10.1007/s10509-011-0780-0, 2011c; Astrophys. Space Sci., 2011d) such that charged fluids possess and do not possess a neutral counterpart as special cases, respectively. For brevity, we only present some analytical results in this paper.

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

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1 Introduction

The presence of charge and pressure in charged solutions are important, since it tends to stabilize the system. The most important tool for such modeling is static, spherically symmetric exact solution with perfect fluid matter and finite central parameters. The applications of such solutions are as follows:

Category 1 If the solutions are well behaved (Delgaty and Lake 1998; Pant et al. 2010a). These solutions their self completely describe interior of the Neutron star or analogous super dense astrophysical objects with uncharged matter. Delgaty and Lake (1998) studied most of the exact solutions so far obtained and pointed out those only nine solutions are regular and well behaved. Out of which only six of them are well behaved in curvature coordinates and rest three solutions are in isotropic coordinates. Pant et al. (2010a) obtained a new well behaved solution in isotropic coordinates.

Category 2 If the solutions are not regular and well behaved but with finite central parameters, such solutions are taken as seed solutions of Neutron star or pulsar with charge matter since at centre the charge distribution is zero. Many of the authors electrified the well known exact solutions as seed solutions e.g Kuchowicz solutions (1968) by Nduka (1977), Tolman solution (1939) by Cataldo and Mitskievic (1992), Durgapal and Fuloria solution (1985) by Gupta and Maurya (2010a), Heintzmann's (1969) solution by Pant et al. (2010b), Durgapal (1982) by Gupta and Maurya (2010b, 2011), Kuchowicz solutions (1967) by Gupta and Maurya (2010c), Buchdahl (1959) by Gupta and Kumar (2005), Bijalwan and Gupta (2008), Bijalwan (2011b, 2011c) etc. These coupled solutions completely describe interior of the Neutron star or pulsar with charge matter. Also, the charge generalization of the incompressible Schwarzschild interior