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ORIGINAL ARTICLE

Some static relativistic compact charged fluid spheres in general relativity

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Abstract In this work a new family of relativistic models of electrically charged compact star has been obtained by solving Einstein–Maxwell field equations with preferred form of one of the metric potentials and a suitable form of electric charge distribution function. The resulting equation of state (EOS) has been calculated. The relativistic stellar structure for matter distribution obtained in this work may reasonably models an electrically charged compact star whose energy density associated with the electric fields is on the same order of magnitude as the energy density of fluid matter itself (e.g. electrically charged *bare* strange stars). Based on the analytic model developed in the present work, the values of the relevant physical quantities have been calculated by assuming the estimated masses and radii of some well known strange star candidates like X-ray pulsar Her X-1, millisecond X-ray pulsar SAX J 1808.4-3658, and 4U 1820-30.

Keywords General relativity · Einstein–Maxwell · Reissner–Nordström · Relativistic Astrophysics · Schwarzschild coordinates · Charged fluid sphere · Compact star · Relativistic star · Equation of state

1 Introduction

The possibility cannot be discarded that the collapse of spherical distribution of matter to a point singularity may be avoided if the matter acquires large amounts of electric charge during the gravitational collapse or during an accretion process onto a compact object. The gravitational attraction is then balanced by electrostatic repulsion due to the same charge and by the pressure gradient (Bekenstein 1971). Hence the study of the gravitational behavior of stellar charged object has been remaining as one of the main interests to the researchers (de Felice et al. 1995; Ghezzi 2005).

The analysis and the determination of maximum mass of very compact astrophysical objects has been a key issue in relativistic astrophysics for the last few decades. There are several astrophysical objects as well as cosmological phases where one needs to consider equation of state (EOS) of matter involving energy densities of the order of 10^{15} g cm^{-3} or higher, exceeding the normal nuclear matter density. Recent observations show that the estimated mass and radius of several compact objects associated with X-ray pulsar Her X-1, X-ray burster 4U 1820-30, millisecond pulsar SAX J 1808.4-3658, X-ray sources 4U 1728-34 are not compatible with the standard neutron star models (Dey et al. 1998; Li et al. 1999, for a recent review see Weber 2005).

The maximum mass of strange star is almost the same but the radius is less than as that of neutron stars, with higher compactness parameter (Weber et al. 2012). Compact objects like neutron stars or strange stars may be classified on the basis of mass–radius (M–R) relation. The approximate (M–R) relations of strange stars follow $M \propto R^3$ are in surprising contrast to that of neutron stars ($M \propto R^{-3}$), and strange stars can have much small radii.

The EOS of compact objects such as neutron/strange stars are not well understood at least near the core region. Apart from the differences in the EOS, an important distinction between quark stars and conventional neutron stars is that the quark stars are self-bound by the strong interaction,

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