Abstract

Relativistic solutions of static cold compact objects are obtained in the framework of spherically symmetric isotropic as well as anisotropic geometries. Different stellar models are constructed with and without electromagnetic fields both in the usual four and in higher dimensions. As the equation of state (in short, EoS) for the interior matter composition of compact objects is not clearly known, in this thesis Vaidya-Tikekar approach which is very useful to study dense compact object is adopted. In Vaidya-Tikekar approach geometry is prescribed apriori which is equivalent to law of radial variation of density and pressure. The physical properties of compact objects are investigated by numerical technique as the Einstein feild equations are highly non-linear

- *In Chapter 1*, a brief review on the compact objects with its importance in astrophysics is presented including the objective of the present work and methodology.

- *In Chapter 2*, a class of general relativistic solutions are obtained for compact stars in hydrostatic equilibrium in the framework of isotropic spherical polar coordinates. The geometrical parameters are used to describe the inhomogenity of the matter content of the stars. A number of stellar models which are physically viable for a wide range of values of the parameters are permitted with the relativistic solutions. The physical features of the compact objects are studied numerically for a number of admissible values of the geometrical parameters. Stellar models with observed mass and radius are also probed.

- *In Chapter 3*, a class of new relativistic solutions with anisotropic fluid for compact stars in hydrostatic equilibrium are obtained. The interior space-time geometry considered here for compact objects are described by geometrical parameters namely, Λ, k, A_o, R and n. The values of the geometrical parameters are determined for obtaining physically viable stellar models. The energy-density, radial pressure and tangential pressure are numerically plotted and found finite and positive inside an anisotropic stars for some values of geometrical parameters that are also determined. Considering stars of known mass stellar models are obtained here which can describe compact astrophysical objects with nuclear density.

- *In Chapter 4*, Vaidya-Tikekar metric is used to obtain relativistic solutions of the Einstein-Maxwell equations. It describes a charged static fluid sphere with non-zero electric field. In this case the interior physical 3-space (t=constant) describes a pseudo spheroidal geometry. The solutions obtained here are used to obtain stellar models with or without charge. A qualitative analysis of the physical aspects of the compact object are studied and it is noted that for a large value of the spheroidicity parameter λ, the effect of charge on physical parameters of the compact object is negligible compared to a smaller values of the spheroidicity parameter. In this case, the size of a charged compact star is found more compared to that without charge.

- *In Chapter 5*, a study of the effects of pressure anisotropy on the evolution of a collapsing star dissipating energy in the form of radial heat flux is presented. In this framework, a star begins its collapse from an initial static configuration described by the new metric solution in the presence(or absence) of anisotropic stresses. The form

of the initial static solution, which is generalization of Pant and Sah model, complies with all the requirements of a realistic star and provides a simple method to analyze the impacts of anisotropy onto the collapse.

• *In Chapter 6*, a class of new relativistic solutions for compact cold stars with electromagnetic field in hydrostatic equilibrium is presented in the framework of higher dimensions. The interior geometry of a higher dimensional space-time is visualized with spheroidal geometry. Consequently the stellar models are constructed using the solutions of the Einstein-Maxwell field equations. The Spheroidal geometry considered here is described by Vaidya-Tikekar metric with the geometrical parameters namely, λ , n and R. In order to obtain viable stellar model we consider the phase factor δ of the relativistic solution and the electromagnetic field strength E^2 suitably so as to avoid singularity at the center. It is noted that the central density as well as density profile are dependent on space-time dimensions (D), λ and R. It is also noted that the central density is independent of electromagnetic field strength of the compact object. To obtain viable stellar models we determine the limiting values of the parameters. Considering stars of known mass, we analyzed their physical properties and predict the equation of state (EoS). The stability of the stellar models are also studied.

• *In Chapter 7*, concluding remarks and future work plan are given.

• **List of Publications**

1. "Relativistic models of a class of compact objects", R. Deb, B. C. Paul and R. Tikekar, **Pramana-J. Phys. 79, 211-222 (2012)**.

2. *"Relativistic Solution for a class of static compact charged star in pseudo-spheroidal spacetime",* P.K. Chattopadhyay, B.C. Paul and R. Deb, **Int. J. Mod. Phys. D 21, 1250071 (2012).**

3. *"Relativistic solutions of anisotropic compact objects",* B. C. Paul and R. Deb, **Astrophys. Space Sci.** 354, 421-430 (2014).

4. *"Dissipative gravitational collapse of an (an)isotropic star",* S. Das, R. Sharma, B.C. Paul and R. Deb, **Astrophys. Space Sci. 361, 1-5 (2016)**

5. *"Relativistic charged star solutions in higher dimensions",* P.K. Chattopadhyay, R. Deb and B.C. Paul, *Int. J. Theor. Phy.* **53, 1666-1684 (2014)**.

6. *"Higher dimensional compact object with Electromagnetic Field in Spheroidal geometry",* R. Deb and B. C. Paul. (in preparation).