

# Contents

|                                                                  |            |
|------------------------------------------------------------------|------------|
| <b>Contents</b>                                                  | <b>I</b>   |
| <b>List of Figures</b>                                           | <b>IV</b>  |
| <b>List of Tables</b>                                            | <b>VII</b> |
| <b>1 Introduction</b>                                            | <b>1</b>   |
| 1.1 Tensor Calculus . . . . .                                    | 1          |
| 1.2 Energy Momentum Tensor . . . . .                             | 3          |
| 1.2.1 Dust Fluid . . . . .                                       | 4          |
| 1.2.2 Perfect Fluid . . . . .                                    | 4          |
| 1.2.3 Electromagnetic Field . . . . .                            | 4          |
| 1.2.4 Anisotropic Fluid Distribution . . . . .                   | 5          |
| 1.3 Field Equations . . . . .                                    | 6          |
| 1.4 Geometrically Significance Spacetime Metric . . . . .        | 9          |
| 1.5 Compact Stars . . . . .                                      | 14         |
| 1.5.1 White Dwarfs . . . . .                                     | 14         |
| 1.5.2 Neutron Star . . . . .                                     | 15         |
| 1.5.3 Black Holes . . . . .                                      | 15         |
| 1.6 Layout of the thesis . . . . .                               | 17         |
| <b>2 Compact Relativistic Stars under Karmarkar Condition</b>    | <b>21</b>  |
| 2.1 Introduction . . . . .                                       | 21         |
| 2.2 Einstein's Field Equations and Karmarkar Condition . . . . . | 24         |
| 2.3 Anisotropic Solution under Karmarkar Condition . . . . .     | 27         |
| 2.4 Physical Plausibility Conditions . . . . .                   | 29         |
| 2.4.1 Positive Definiteness of Density and Pressure . . . . .    | 30         |
| 2.4.2 Subluminal Sound Speed and Energy Conditions . . . . .     | 30         |
| 2.4.3 Stability Criteria . . . . .                               | 31         |

|          |                                                                   |           |
|----------|-------------------------------------------------------------------|-----------|
| 2.5      | Discussion . . . . .                                              | 32        |
| <b>3</b> | <b>Anisotropic Approach: Compact Star as Generalized Model</b>    | <b>37</b> |
| 3.1      | Introduction . . . . .                                            | 37        |
| 3.2      | Einstein field equations . . . . .                                | 39        |
| 3.3      | Generating Model . . . . .                                        | 41        |
| 3.4      | Exterior Spacetime and Boundary Conditions . . . . .              | 43        |
| 3.5      | Physical Analysis . . . . .                                       | 45        |
| 3.5.1    | Energy Conditions . . . . .                                       | 46        |
| 3.5.2    | Causality and Stability Conditions . . . . .                      | 46        |
| 3.5.3    | Gravitational Redshift . . . . .                                  | 47        |
| 3.5.4    | Stability under Three Forces . . . . .                            | 48        |
| 3.6      | Discussion . . . . .                                              | 49        |
| <b>4</b> | <b>New Charged Anisotropic Solution on Paraboloidal Spacetime</b> | <b>56</b> |
| 4.1      | Introduction . . . . .                                            | 56        |
| 4.2      | The Spacetime Metric . . . . .                                    | 59        |
| 4.3      | Linear Equation of State . . . . .                                | 61        |
| 4.4      | Matching Condition . . . . .                                      | 62        |
| 4.5      | Physical Plausibility Condition and Bound on $\alpha$ . . . . .   | 64        |
| 4.5.1    | Energy Condition . . . . .                                        | 65        |
| 4.5.2    | Causality and Stability Conditions . . . . .                      | 65        |
| 4.5.3    | Gravitational Redshift . . . . .                                  | 67        |
| 4.5.4    | Mass-Radius Relation . . . . .                                    | 67        |
| 4.5.5    | Stability under Three Forces Acting on the System . . . . .       | 67        |
| 4.6      | Discussion . . . . .                                              | 69        |
| <b>5</b> | <b>Anisotropic star with Linear equation of state</b>             | <b>76</b> |
| 5.1      | Introduction . . . . .                                            | 76        |
| 5.2      | Field Equation . . . . .                                          | 78        |
| 5.3      | Technique to Generate New Stellar Solutions . . . . .             | 79        |
| 5.4      | Exterior Spacetime and Boundary Conditions . . . . .              | 81        |
| 5.5      | Physical Conditions . . . . .                                     | 82        |
| 5.5.1    | Energy Conditions . . . . .                                       | 85        |
| 5.5.2    | Stability . . . . .                                               | 85        |
| 5.5.3    | Gravitational Redshift . . . . .                                  | 87        |
| 5.5.4    | Stability under Three Different Forces . . . . .                  | 87        |
| 5.6      | Discussion . . . . .                                              | 89        |

|          |                                                                          |            |
|----------|--------------------------------------------------------------------------|------------|
| <b>6</b> | <b>A Various Equation of State for Anisotropic Model of Compact Star</b> | <b>96</b>  |
| 6.1      | Introduction . . . . .                                                   | 96         |
| 6.2      | The Field Equations . . . . .                                            | 100        |
| 6.3      | Equation of State for Various Models . . . . .                           | 101        |
| 6.3.1    | Quadratic Equation of State . . . . .                                    | 103        |
| 6.3.2    | Linear Equation of State . . . . .                                       | 105        |
| 6.3.3    | Polytropic Equation of State . . . . .                                   | 105        |
| 6.3.4    | Chaplygin Equation of State . . . . .                                    | 107        |
| 6.3.5    | CFL Equation of State . . . . .                                          | 108        |
| 6.4      | Matching conditions . . . . .                                            | 109        |
| 6.5      | Conditions for Physical Acceptability . . . . .                          | 110        |
| 6.5.1    | Energy Condition . . . . .                                               | 112        |
| 6.5.2    | Causality and Stability Conditions . . . . .                             | 112        |
| 6.5.3    | Gravitational Redshift . . . . .                                         | 114        |
| 6.5.4    | Stability under Three Forces . . . . .                                   | 115        |
| 6.6      | Discussion . . . . .                                                     | 116        |
|          | <b>Appendix</b>                                                          | <b>124</b> |
|          | <b>Publications</b>                                                      | <b>126</b> |
|          | <b>Bibliography</b>                                                      | <b>128</b> |