Chapter 0

INTRODUCTION

0.0 Aim of the Thesis

The thesis aims at removing all the deficiencies of the Newtonian theory and transforming it into a theory, equivalent to electro dynamics. The GTR is mostly concerned with a static theory of gravitation. On the other hand, the basic weakness of Newtonian theory is the static nature of the law of gravitation and absence of vector potential of AMPERE (1775-1836). In the following sections, we examine the non-relativistic theory and relativistic theory of motion and briefly describe the steps in Chapters 1 to 3, in order to remove the deficiencies of the Newtonian dynamics.

0.1 A Survey of Pre-relativistic Theory of Gravitation

In his book, 'Philosophia Naturalis Principia Mathematica', SIR ISAAC NEWTON (1642-1727) introduced the inverse square law of gravitation. This law played an important role in the development of mechanics. Newtonian mechanics assumed the existence of absolute space and inertial frame. This concept was severely criticised by LEIBNITZ (1646-1716) who argued that there is no philosophical need for any conception of space, apart from the relations of matter and object. None of the high-minded metaphysics had led to any idea about how to develop a dynamical theory that might challenge the Newtonian theory, until the advent of electromagnetic theory. Before J.C. MAXWELL (1831-1879), it was supposed that all laws of physics are invariant under the Galilean transformations. Nevertheless, the electromagnetic theory is in apparent
disagreement with the principle of Galilean relativity and Galilean transformation. To remove this apparent disagreement, H.A. LORENTZ (1853-1928) introduced a new transformation. The formulae of Lorentz transformation were discoveries \[7\] made by Lorentz when he was studying the equations of electricity and magnetism. In a lecture to the Congress of Arts and Science at St. Louis, USA, on 24\(^{th}\) September 1904, HENRY POINCARE (1854-1912) gave a generalized form of a new principle: ‘the principle of relativity’. According to the principle of relativity, he said that the laws of physical phenomena must be the same for a fixed observer as for an observer who has a uniform motion of translation relative to him. The apparent failure of the Michelson-Morley experiment in 1887 to determine the velocity of earth relative to the ether led EINSTEIN (1879-1955) to postulate the constancy of speed of light as an axiom in his 1905 paper ‘On the Electrodynamics of Moving Bodies’ \[12\]. The apparent failure of the Newtonian theory is its inability to explain

(i) the perihelion shift of the planet Mercury

(ii) the gravitational red-shift

(iii) deflection of light by the Sun

0.2 Relativistic Theory of Gravitation

Newton was aware that the inertial mass entering in his discussion of motion might not be precisely the same as the gravitational mass appearing in his law of gravitation. Later in 1889, Roland von Eötvös concluded from his experiments that the difference between the ratio of inertial mass and gravitational mass, \( \frac{m_i}{m_g} \) for wood and platinum was less than \( 10^{-9} \).
Einstein was impressed with this experimental conclusion [6]. It served him to postulate the principle of equivalence $m_e = m_g$ in his theory of gravitation. He formulated the relativistic theory of gravitation in his paper ‘The Foundations of General Relativity’ in 1916. The GTR is dependent on the Riemannian geometry and requires a study of metrics, affine connections and curvature of space-time. [19, 20]

Einstein used the principle of equivalence to derive his field equations. The field equations for empty space are $R_{\mu\nu} = 0$ [12, 14, 19, and 20]. Schwarzschild applied these field equations to derive the static metric:

$$d\tau^2 = \left(1 - \frac{2MG}{r}\right) dt^2 - \left[1 - \frac{2MG}{r}\right]^{-1} dr^2 - r^2 d\theta^2 - r^2 \sin^2 \theta d\phi^2$$  \hspace{1cm} (1)

By making the substitution $\rho = \frac{1}{2} \left[r - M\delta + (r^2 - 2MGr)^{\frac{3}{2}}\right]$ or $r = \rho \left(1 + \frac{MG}{2\rho}\right)^2$, the above Schwarzschild metric has the isotropic form

$$d\tau^2 = \left(1 - \frac{MG}{2\rho}\right)^2 \left(1 + \frac{MG}{2\rho}\right)^2 dt^2 - \left(1 + \frac{MG}{2\rho}\right) \left(dp^2 + \rho^2 d\theta^2 + \rho^2 \sin^2 \theta d\phi^2\right)$$  \hspace{1cm} (2)

Eddington and Robertson suggested another possible metric

$$d\tau^2 = \left(1 - \frac{2\alpha MG}{\rho} + \frac{2\beta M^2 G^2}{\rho^2}\right) dt^2$$

$$- \left(1 + \frac{\gamma MG}{\rho} + \ldots\right) \left(dp^2 + \rho^2 d\theta^2 + \rho^2 \sin^2 \theta d\phi^2\right)$$  \hspace{1cm} (3)

where $\alpha, \beta,$ and $\gamma$ are unknown dimensionless parameters [20] comparing this with the isotropic form (2), the expected values of $\alpha, \beta,$ and $\gamma$ must be equal to 1, subject to experimental verification. Einstein suggested the following tests of general relativity [20]
(A) The gravitational red shift of spectral lines

(B) The deflection of light by the Sun

(C) The precession of the perihelia of the orbits of the inner planets

(D) The time delay of radar echoes passing the Sun

Confirmation of (A) is just equivalent to the principle of equivalence. This implies \( \alpha \approx 1 \). The statements (B) and (D) can test whether \( \gamma \approx 1 \) whereas (C) verifies that \( 2\gamma \approx \beta \approx 1 \). Thus (A) to (D) can be verified, if it is found experimentally that \( \alpha = \beta = \gamma = 1 \). In the book \(^{20}\) we read that these values are experimentally verified. In Chapter 3, we shall show that the metric according to the modified Newton-Lorentz theory must be

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\begin{align*}
\text{If the exponential is expanded up to terms of the second order, we get} \\
\alpha = \beta = \gamma = 1 \quad \text{and the metric (3) of Eddington and Robertson. Thus, a verification of the tests of general relativity suggested by Einstein is also a verification of the Newton-Lorentz theory of Chapter 2 and 3.}
\end{align*}
\]

0.3 Summary

In the first chapter, we examine the various concepts of time, such as classical time, local time, retarded/advanced time and arrive at the conclusion that the proper time interval \( d\tau \), serves the purpose of the absolute time or invariant time, suitable for the Lagrangian formulation of Newtonian dynamics. Since the local time interval \( dt \) is a good approximation for \( d\tau \), the former can be used in place of the latter. It is proved that the postulate of retarded time/advanced time leads to the
correct proof of Lorentz Transformation (LT) whereas the postulates of special relativity lead to a nonlinear transformation. The main results of Chapter 1 are taken from the researcher’s published paper ‘Truth of Lorentz Time Concept & Transformation Vs Logical Falsity of SRT’. [*2]

The second chapter deals with Maxwell-Lorentz theory, applicable to mass body moving in the gravitational fields of other mass bodies. Some of the equations derived are, Gauss laws, Ampere’s law, Faraday’s law, Poynting’s theorem, Lorentz Force Law and gravitational wave equations. The proper Lagrangian $L_p$ is obtained by multiplying the classical Lagrangian $L$ with $(dt/d\tau)^2$ and then $L_p = g_{ij}(dx^i/d\tau)(dx^j/d\tau)$ is a quadratic function of the generalized velocities $(dx^i/d\tau)$. The equation of planetary motion in the form: $(d^2u/d\theta^2) + u = a + bu^2$ is obtained as a direct consequence of the modified Newton’s theory. The modified theory is sufficient for the explanation of perihelion motion of planets, bending of light rays, gravitational red shift etc. The main results of this Chapter 2 are taken from the researcher’s published paper ‘On Maxwell-Lorentz Equations’. [*3]

The third chapter contains a discussion of criticisms on Newtonian dynamics, the many-body problem by using centre of mass co-ordinates system and the principle of least time/stationary time. This solution coincides with the planetary orbit of second chapter. In addition, the Chapter contains the applications and conclusions of Newton-Lorentz theory, which were not covered in Chapter 2. By examining the Compton-shift analysis, it is shown that the momentum consists of a mechanical part
$m\nu$ and a quantum mechanical part/electromagnetic part $\hbar k$, so that $p = m\nu \pm i\hbar k$. Further, an interpretation of the Schrödinger’s wave function $\psi$ as the quantum mechanical energy density is examined.

From the whole analysis, it can be concluded that the concepts of centre of mass frame, the proper time interval $d\tau$ and the theory of retarded/advanced potentials can remove the deficiencies of the classical Newtonian dynamics. Besides, the modified theory is sufficient to explain the tests (A) to (D) of page 4 more elegantly without the troubles of singularities/black holes.