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NUMERICAL CALCULATIONS IN THE GENERAL DYNAMICAL THEORY OF GRAVITIONAL TIME DIALATION

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ABSTRACT
It is well known that, Einsten's Geometrical Principles and Laws of Gravitation may be used to construct a corresponding theory of Gravitational Time Dilation. In (Howusu, 1991) paper, it was shown how to extend Newton's Dynamical Principles and Laws based upon the experimental facts of inertia, active and passive masses available today. In this paper, we apply this extended Dynamical Principles and Laws and compare to construct a corresponding theory of Gravitational Time Dilation and compute the ratio of the coordinate time to proper time for both general and dynamical theory of gravitation.

Key words: Dynamic, Gravitational Time Dilation, Einstein, Numerical, Theory

INTRODUCTION

In the paper (Howusu 1991) entitled, "On Gravitation of Moving Bodies", the following postulates were introduced:-

The Instantaneous inertial mass m_i and passive and mass m_p and active mass m_A of a photon of frequency v is given by

$$m_A = m_r = m_1 = \frac{hv}{c^2}$$

In all inertial frames and proper times, where c is the speed of light in vacuum and h is plank's constant.

This postulate was based upon the experimental physical facts available today, such as phenomena of Compton Scattering (Roser 1954; Hoffman 1989) and radiation pressure (Jackson 1975; Joos 1950).

This forms the basis of the General Dynamical Theory of Gravitation for photons. It was shown immediately how the general dynamical theory of gravitation resolves the phenomena of (i) gravitational spectral shift and (ii) gravitational deflection (lensing) (Howusu, 1991) in solar system in excellent agreement with experiment, (Howusu 1991; Reasenberg 1976; Richard 1975; Eddington 1923). Now in this papar we construct the general dynamical law of gravitational time dilation for comparison with experimental measurements.

MATERIALS AND METHODS

Calculations

Consider a photon with instantaneous frequency v in a gravitational field of scalar potential . Then as is well known, its instantaneous kinetic energy T is given by

$$T = hv \qquad (1)$$

where v is a quantity and vanishes when the photon is at rest. Also by definition and postulate in section (1) the instantaneous gravitational potential energy v_g of photon is given by

$$V_g = \frac{hv}{c^2}\Phi_g \qquad (2)$$

It therefore follows by definition that the instantaneous mechanical energy E of the photon is given by

$$E = hv\left[1 + \frac{1}{c^2}\Phi_g\right] \qquad (3)$$

Therefore, it follows from the principle of Conservation of mechanical Energy in gravitational fields that the instantaneous frequency of the photon is given by

$$\upsilon[r_1 t] = \left\{1 + \frac{1}{c^2}\Phi_g\left[r_, t\right]\right\}\left\{1 + \frac{1}{c^2}\Phi_{g[r,t]}\right\}^{-1} \upsilon_o\left[r_{o,} t\right]$$

where v is the frequency at the particular position r_o at time t_o. This is the General Dynamical Law of Gravitational Spectral Shift for photons, (Howusu, 2001).

Now it is well known that the frequency of a clock is directly proportional to its successive ticks. It therefore follows from the General Dynamical Law of Gravitational Spectral Shift that the coordinate time (t) measured by the photon and all other in a gravitational field satisfied the relation,

$$dt(r)=\left\{1+\frac{1}{c^2}\Phi_g(r)\right\}\left\{1+\frac{1}{c^2}\Phi_g(r)\right\}^{-1} dt_o(r_o) \qquad (5)$$

This is the General Dynamical Law of Gravitational Time Dilation (Aatwater, 1974).

It may be noted that for a clock located in the gravitational field of stationary homogenous spherical body of radius r and rest mass M_o

$$\Phi_o(r)=\frac{GM_o}{r}; r \geq R$$

Consequently the General Dynamical Law of Gravitational Time Dilation, equation (5), become:-

$$dt(r)=\left[1-\frac{GM}{c^2 r_o}\right]\left[1-\frac{GM}{c^2 r}\right]^{-1} dt_o(r_o) \qquad (7)$$

and choosing the particular point at infinite distance from the body:

$$r = \infty \qquad (8)$$

This time is the proper time;

$$dt_o(t_o) = dt \qquad (9)$$

Thus (7) become

$$dt(r) = \left[1-\frac{GM}{c^2 r}\right]^{-1} dr \qquad (10)$$

This is the relation between coordinate and proper time in the gravitational field exterior to a stationary homogenous spherical body according to the General Dynamical Law of Gravitational Time Dilation. It is now obvious from the relation to the proper clock.

RESULTS AND DISCUSSION

In this paper we derived the general dynamical law of gravitational time dilation (5) and specialized it to the field of a stationary homogenous spherical body such as the sun in (7) and (10).

It may be noted that the expression for Einstein's graviotational time violation in the field of a stationary homogenous body according to the geometrical theory of general relatively is given by (Atwater, 1974; Foster, 1979),

$$dt\{r\} = \left[1-\frac{2GM}{c^2 r}\right]^{-\frac{1}{2}} dt \qquad (11)$$

Hence to the order of c^{-2}, the general dynamical law of gravitational time dilation is identically equivalent to Einstein's expression in general relativity. Consequently, to the order of c^{-2}, the general dynamical theory of gravitation resolves the phenomenon of gravitational time dilation as excellently as Einstein's theory of general relativity (*GR).

This agreement between the gravitational time dilation according to Einstein's general relativity and the general dynamical theory in this paper is illustrated in Table 1.

It may be noted further that to order finer c^{-2} the expression for the gravitational time dilation of a clock in the field of a Centro symmetric spherical massive body due to the general dynamical theory of gravitation in this paper is different for the corresponding Einstein's expression due to his geometrical theory of classical gravitation (GR). This difference is most welcome as a means of distinguishing ultimately between the general dynamical theory of gravitation and Einstein's geometrical theory of gravitation, as the accuracy of experimental measurement increases in the future.

It may be immediately seen that, within the General Dynamical Theory of Gravitation the phenomenon of Gravitational Time Dilation is a consequence of the electrical mean field. Therefore, within the General Dynamical Theory of Gravitation the phenomenon of Gravitational Time Dilation becomes understandable in the most natural and physical way that if the total mechanical energy of the clock remains constant and the Gravitational Potential Energy changes then the state of motion of the clock must change accordingly. And this can be seen and appreciated in the cases of all real clocks such as mechanical and pendulum and atomic clocks. Now the dynamical concept of Gravitational Time Dilation may be compared with the corresponding Einstein theory to which Gravitational Time Dilation is due to the so-called "curvature" or "bending" of space – time around a massive body. it is also most interesting and instructive to note immediately the great mathematical simplicity of the Dynamical Theory of classical gravitation in this paper which is formulated in terms of the natural three- dimensional space vectors and proper times.

Table1: calculated values of the ratio of coordinate time to proper time for both general relativity and dynamical theory of gravitation.

Body	Mass (M) Kg	Orbital Radius ® M	General Relativity $\left[\frac{dT}{dt}-1\right]=\left[1\frac{2GM}{c^2R}\right]^{-\frac{1}{2}}-1$	Dynamical Theory of Gravitation $\left[\frac{dT}{dt}-1\right]=\left[1\frac{2GM}{c^2R}\right]^{-\frac{1}{2}}-1$
Sun	1.960×10^{30}	6.96×10^{8}	2.105×10^{-6}	2.105×2710^{-6}
Mercury	3.360×10^{20}	5.79×10^{10}	4.300×10^{-15}	4.305×10^{-15}
Venus	4.920×10^{24}	1.08×10^{11}	3.376×10^{-14}	3.376×10^{-14}
Earth	6.000×10^{24}	1.49×10^{11}	2.984×10^{-14}	2.984×10^{-14}
Mars	6.600×10^{23}	2.28×10^{11}	2.145×10^{-15}	$2.145 \times 10\text{-}^{15}$
Jupiter	1.920×10^{27}	7.78×10^{11}	1.829×10^{-12}	1.829×10^{-12}
Saturn	5.700×10^{26}	1.43×10^{12}	2.954×10^{-13}	$2.954 \times 10\text{-}^{13}$
Uranus	9.000×10^{25}	2.87×10^{12}	2.324×10^{-14}	2.324×10^{-14}
Neptune	1.020×10^{26}	4.50×10^{12}	1.680×10^{-14}	1.680×10^{-14}
Pluto	4.800×10^{24}	4.80×10^{12}	6.050×10^{-16}	6.050×10^{-16}

This simplicity may be compared with the mathematically more rigorous formulation [Phipps 1926] of Einstein's Geometrical Theory of Gravitation (GR) in terms of tensors of several ranks and types in the abstract four-dimensional space – time.

CONCLUSION

It is obvious that to the order of c^{-2}, the general theory of dynamical gravitation is in perfect agreement with the Einstein's general relativity theory of Gravitation.

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