Open Access Journal of Physics
Volume-4, Issue-1, 2020, PP 13-22
ISSN 2637-5826

An Alternative to the General Theory of Relativity

Dr. Donald C. Aucamp

Professor, Southern Illinois University at Edwardsville (Emeritus)

***Corresponding Author:** Dr. Donald C. Aucamp, Professor, Southern Illinois University at Edwardsville (Emeritus)*

ABSTRACT

This is the third of three related works on dark matter (DM), dark energy (DE), and the General Theory of Relativity (GTR). In the first two papers laws L_1 and L_2 are given which resolve the DM and DE problems, respectively, without the invention of mysterious dark forces. While L_1 deals with the gravitational force that one moving body of mass M exerts on another moving body of mass m, in this third work it is extended to L_3 to include the effects of gravity on photons and bodies moving with unusually high speeds. From L_3 many of the well-known triumphs of GTR are given alternate explanations. Based on the inability of GTR to explain DM and DE, and also from other arguments provided herein, it is concluded that GTR is either incomplete or in error.

PART 1 - INTRODUCTION

In Aucamp[5] a gravitational law L_1 is proposed which deals with the force that one moving body of rest mass *M* exerts on another moving body of rest mass *m*. From L_1 the dark matter (DM) problem is resolved without the invention of mysterious forces. This law differs only in a miniscule way from Newton's Law of Gravity (NLG), and it predicts that bodies will move imperceptibly faster in gravitational fields than they would if only NLG were applicable. The extra force is so small it only becomes apparent over travel distances involving extremely long periods of time. In Aucamp[6] a law L_2 is postulated which, in combination with L_1, resolves the dark energy (DE) problem. Since L_1 is a gravitational law which deals with moving bodies with small values of *v/c*(explained below), it does not apply to the effect of gravity on photons, where *v/c=1*.Accordingly, the primary purpose of this work will be the extension ofL_1 to a more general law $L_3$to handle a broader range of cases, especially photons. This law will then be applied to various situations which the General Theory of Relativity (GTR) also explains.

PART 2–HIGHLIGHTS OF LAW L1

In Aucamp[5] a law $L_1$is proposed which determines the gravitational force that one moving body of rest mass *M* exerts on another moving body of rest mass *m*, where it is assumed that relative velocities are small as compared to *c*. Also, a corollary C_1 is derived from L_1 which explains why *m* moves imperceptibly faster in a gravitational field, over and above the speed dictated by Newton's Law of Gravity (NLG).From L_1/C_1 the DM problem is resolved, which GTR fails to do. A brief review of L_1 will now be covered.

When masses *M* and *m* are permanently stationary in a fixed IFR (inertial frame of reference), say IFR *(t)* = IFR_0, then the gravitational force exerted by *M* on *m* is given by $f=f_0$, wheref_0 obeys NLG for stationary bodies, as follows:

$$(2.1) f_0 = -GMmu / r^2$$

In this formula *r* is the constant vector running from *M* to *m* as measured in IFR_0, and *u* is a unit vector given by *u* = *r*/*r*. The force is attractive in the direction of -*u*.

Now consider a more general situation in which a gravitational ray is sent at time *t* from a moving body *M* to a moving body *m*, and the inertial frame of reference of *M* at the instant of the emission is IFR*(t)*. A ray in this case is defined as the gravitational field emitted over an infinitesimal period of time. It is postulated the ray travels at velocity *c* in IFR*(t)*.Now suppose it hits *m* at a future time, $t+\Delta t$, which has moved from *r(t)* to$r(t+\Delta t)$, where all quantities are measured inIFR*(t)*. It is assumed the exerted force *f* at the instant of impact is in the direction of $-r(t+\Delta t)$and that at this instant *m* is traveling at velocity $v(t+\Delta t)$, which is at an angle φ to $r(t+\Delta t)$. Then the general law of gravity, L_1, in Aucamp[5] is postulated as follows:

LAW L_1

(2.2) $f = f_0(1- \alpha v \cos(\varphi) /c)$

In the above equation α is a dimensionless constant which is assumed to be positive. Based on (2.2) it is convenient to define Vas the relative velocity of $m$in the direction of $r(t+\Delta t)$, as follows:

(2.3) $V= v \cos(\varphi)$

Then (2.2) can be restated as follows:

LAW L_1

(2.4) $f = f_0(1- \alpha V/c)$

It is reiterated that V is the scalar component of the velocity of m in the direction of the gravitational ray at the instant of impact, and that all quantities are evaluated in IFR(t). In (2.3)φ is the angle between $r(t+\Delta t)$and $v(t+\Delta t)$. If at the instant of impact v is precisely in the direction of r, then φ=0 and V=v. If v is in the-r direction, then $\varphi=\pi$ and V=-v. If v is orthogonal to the ray, then V=0 and the exerted force is f_0. It is assumed in L_1that v/c is small, as it usually is for bodies with rest masses, so that $f$is a linear perturbation in v/c of f_0. In the event that v/c happens to be large, as would be the case if m were a photon instead of a stationary mass, then it is desirable to amend (2.2) by adding one or more nonlinear terms. This is accomplished by law L_3(discussed later).

From (2.2) it is clear that the restraining force is less than it is in NLG when m is moving from M (with the direction of the gravitational field), and vice-versa when it is moving toward M (against the direction of the field).Thus corollary $C_1$is evident, and is as follows:

Corollary C1

Masses move faster in gravitational fields than they would if only NLG were in effect. From L_1/C_1 and analysis the DM problem is resolved in Aucamp[5].It is reiterated that GTR is not of any help in this regard.

Part 3 – Highlights of Law L2

The second postulate (P_2) of Einstein[8] in his Special Theory of Relativity (STR) assumes that the measured velocity of light is c, independent of the source. While the Michelson and Michelson-Morely experiments in 1880's found no effect on this velocity due to the motion of the Earth, and thereby opened up the question concerning the existence of light moving in ether, it is reputed that Einstein was instead mainly concerned that Maxwell's electromagnetic (EM) equations were independent of any given IFR. This problem was seemingly resolved with his P_2. As necessary conditions for this postulate to be valid Einstein derived certain length and time transformations which were based on a thought experiment that was essentially the mathematical equivalent of calculating the round-trip length and time for the passage of a pulse sent down the x axis and reflecting it back to the starting point. Unfortunately, if Einstein had checked to see if these transformations would also be valid if just a one-way trip were involved, he would have seen they wouldn't work. It is interesting his round-trip approach was similar to the thought experiment sdone previously by H. Lorentz and G. FitzGerald in connection with explaining the null results of the Michelson-Morely experiments on the ether.

Due to Einstein's concern with Maxwell's equations, he attempted to explain how these laws were valid in spite of their being a function of an arbitrarily defined velocity. In this regard it is argued he offered a meandering analysis which did not lead to the desired conclusion. It is further argued the dependence of velocity on an arbitrarily defined IFR makes this is a hopelessly difficult problem to resolve. Making matters worse for P_2, it is shown in Aucamp[2] that Einstein's equation for mass, which is based on the untenable STR and an arbitrarily set IFR, has additional mathematical difficulties stemming from the shape of the curve of mass versus velocity.

This IFR problem is resolved in Aucamp[1], where it is shown electric fields travel at c with respect to the instantaneous IFR(t) of the source, so that the c calculation is independent of the observer's fixed IFR_0.Interestingly, magnetic forces are shown to be electric field forces which act on charges in a manner similar to gravitational law L_1. It is argued the similarity between the two L_1laws speaks strongly for both.

Based on these conclusions, an alternate STR is postulated and analyzed in Aucamp[3], where one of the conclusions is law L_2, as given below. Along with L_1 these two laws are employed in Aucamp[6] to resolve the DE problem.L_2 is explained as follows: Consider an emission (herein called light) at time t from a source, where the instantaneous IFR at this instant is IFR(t). Then:

LAW L_2

The measured velocity of light in IFR(t)atany future time is c.

While experimental results seemingly contradict L_2 and confirm P_2, it is argued in Aucamp[3] that the conclusions drawn from them are in error. By way of note, it is clear that L_2 explains the Mickelson-Morely experimental results, since the signals used by them all moved at c in a fixed apparatus.

Law L_2 is the primary one which is used to resolve the dark energy (DE) problem in Aucamp[6], where DE is a term used in connection with astronomical observations that conclude the farthest galaxies/stars are accelerating outward into space (inflationary universe theory, or IUT). This theory was announced in separate studies in 1998 by Nobelists Saul Perlmutter[11], Adam Riess, and Brian Schmidt, which were all based on type Ia supernovae that explode with the same luminosity. Thus, by observing the brightness of an emission one can determine the travel distance D, which in turn leads to the travel time T as given by $T=D/c$. The results of these studies indicated that the more distant stars were fainter than expected, and this was viewed as evidence of IUT. Since then, in spite of more data and intense scientific effort, no explanation has been offered for these findings. As GTR has not been helpful in resolving this problem, it can be argued this theory is either in error or it is incomplete.

The DE problem is resolved as follows: Suppose that an observer is moving away from the source at velocity v. Then in the IFR of the observer the measured velocity of light, c^*, is given as:

$$(3.1)\quad c^* = c - v$$

In particular, assume a photon is emitted at $t=0$by a star with an inertial frame of reference IFR_0 at that instant, and that the distance to the earth as measured in $IFR_0$is D. While It is convenient to assume the Earth moves away from the star at a constant velocity v, the analysis can be generalized by interpreting v as the average velocity of the Earth from $t=0$ to the instant of impact. According to L_2 the velocity of the photon is c, as measured in IFR_0. During the travel time, T, the earth moves further away by a distance of vT, so the measured travel distance $D^*$is determined from:

$$(3.2)\quad D^* = cT = D + vT$$

From (3.2)T is determined as :

$$(3.3)\quad T = D/(c-v)$$

Inserting (3.3) into (3.2) yields:

$$(3.4)\quad D^* = D + v\,D/(c-v) = D/(1-v/c)$$

Thus, the true separation distance, D, is given as:

$$(3.5)\quad D = D^*(1 - v/c)$$

Assuming that $v>0$, which from the Big Bang Theory and the observations of Hubble for distant stars is generally the case, it is seen from (3.5) that the actual distance D tends to be less than the measured distance D^*. From this result, it is conjectured in Aucamp[6] that the inflationary universe problem will be resolved when the calculations are corrected according to law L_2.While this argument is the primary one used in Aucamp[6] to treat the DEproblem, it is shown that there are several other factors based on L_1which may also strengthen this case.

PART4-GRAVITATIONAL LAW L3

It is argued that law L_1 as given by (2.2)is valid in the general situation when v/c is small. However, the small v/c assumption is not valid when photons are moving in a gravitational field, where $v/c=1$. In order to handle this situation, L_1 is extended here to law L_3. First, it is noted that (2.2) has the following form:

$$(4.1)\quad f = f_0(1 - \alpha Z)$$

Where

$$(4.2)\quad Z = (v/c)\cos(\varphi)$$

It is assumed in the case when v/c is large that law L_1 should be extended to law L_3 by adding on a quadratic term, as follows:

$$(4.3)\quad f = f_0(1 - \alpha Z + \gamma Z^2)$$

It is noted in (4.3) that $f=f_0$ when $Z=0$, as required. Also, if v/c is small, as is generally the case when m is a body with a rest mass, then$Z^2 << Z$ and L_3very closely reduces to L_1.

A further necessity of (4.3) is that it should yield $f=0$when $Z=1$. This is based on the following argument: If $Z=1$, then $v/c=1$and $\cos(\varphi)=1$. This can only happen if m is a photon moving directly away from M. In this case the photon and the gravitational field created by M are both moving together at the same speed, and it is argued there should be no gravitational force exerted on the photon. Therefore, γ in (4.3) should be set so that $1-\alpha Z+\gamma Z^2=0$ when $Z=1$. This is accomplished by setting $\gamma=\alpha-1$, and law L_3 becomes, with the inclusion of a function $S(Z)$ which will be defined below:

GRAVITATIONAL LAW L_3

(4.4) $f=f_0\,[1-\alpha Z+(\alpha-1)\,Z^2 S(Z)]=K(Z)f_0$

The non-dimensional $S(Z)$ function is defined as:

(4.5) $S(Z)=sign(Z)$

As L_3 as given by (4.4) is independent of $S(Z)$ when $Z=0$, then arbitrarily define $S(0)=0$. From (4.4) it is seen that $K(Z)$ is given as follows:

(4.6) $K(Z)=1-\alpha Z+(\alpha-1)\,Z^2\,S(Z)$

A plot of the proposed $K(Z)$ function is shown below in Figure 1:

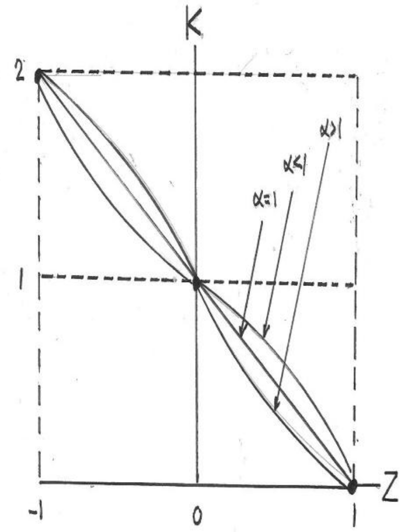

Figure1. *K (Z) for VARIOUS α*

From Figure 1 the reason for the sign function, $S(Z)$, in (4.4) can be seen. When Z increases from $Z=0$ to $Z=1$, the gravitational force deceases from $f=f_0$ to $f=0$. This decrease is desirable when $Z=1$ because m is this case is a photon moving at the same velocity as the gravitational field. Conversely, this decrease in force should become an increase in force when Z goes the other way from $Z=0$ to $Z=-1$. The argument here is that the curve should be asymmetric in the sense that the change in force from f_0 when the gravity field is moving with m is the opposite of the change when it is moving against m. More succinctly, if $Z>0$, then

(4.7) $1-K(Z)=K(-Z)-1$

PART 5 – SIMILARITY OF GRAVITY AND ELECTRIC FIELDS

It is noted that the electric field force law L_1 for moving charges in Aucamp[1] is the same in form as the gravitational force law L_1 in this work. In particular, the linear electric force law is:

(5.1) $f=f_0(1-\alpha\, V/c)$

In this case L_1 examines the electric field force exerted by one moving charge q_1 on moving charge q_2, where f_0 is given by Coulomb's law. It is shown from both theoretical and experimental arguments that $\alpha=3/2$. A key finding is that magnetic forces do not exist. They are instead electric field forces as given by (5.1) which travel at c in IFR*(t)*. it is also shown that Maxwell's equations concerning forces and his formula for the velocity of light can be derived from L_1 as example problems. As velocities depend on the user's arbitrary definition of IFR, it is not surprising that Maxwell's laws of electromagnetic theory (EMT), though useful, must be in error. It is reiterated that Einstein[9] worried about this, but it is argued his analysis is meandering, unconvincing, and leads nowhere. Moreover, since it is shown that electric fields travel at velocity c and exert forces on other charges, based on IFR(t), then this conclusion further refutes STR.

It is important to note from Aucamp[1] that electric fields are very similar to gravitational fields in that (a) both travel at c with respect to the IFR of the source at the time of emission, (b) both are inverse r^2 laws, and (c) both have the same L_1 properties. It is argued these similarities lend a degree of weight to gravitational law L_1 (and therefore to L_3). It is further argued that the rejection of STR ipso facto implies the rejection of GTR if GTR in any way depends on the correctness of STR.

Though the problem of creating a special gravitational law $L_3$for high *v/c* was not considered in the charge movements in the EMT paper in Aucamp[1], it is noted that the special situation which deals with the relativistic effects in high *v/c* linear accelerators is resolved from energy considerations.

PART 6 – DISCUSSION OF A

Section 6.1 – Introduction

Though the value of α is not determined here or in Aucamp[1-6],nevertheless several candidates are discussed below, and one of them is conjectured. However, it may eventually be shown by experiment that α is totally different from any of the possibilities listed below:

a) $\alpha=1$

b) $\alpha = 3/2$

c) $\alpha<<1$

Section 6.2 – Possibility That α=1

It is stated in Aucamp[6] that one can conjecture that $\alpha=1$. Briefly, the argument runs as follows: First, assume a body of mass *m* is moving at velocity *V* relative to the gravitational ray from mass *M*, and assume that the gravitational force on *m* is *f*. It can be conjectured this force differs from the Newtonian force f_0, as follows:

(6.2.1)$f = f_0$ x (gravity flow past *m*) / (gravity flow when $V=0$)

In time *dt*, the actual flow by *m* is proportional to $(c-V)dt$, and the flow when $V=0$it is proportional to *cdt*. Thus, (6.1) implies that:

(6.2.2)$f / f_0 = (c-V)\,dt / cdt = 1 – V/c$

From (6.2.2) and L_1 it might be conjectured that α=1.

Section 6.3 – PossibilityThat α = 3/2

In Aucamp[1] the following conclusions are theoretically and experimentally shown: (a) magnetic forces are in reality electric field forces, (b) Maxwell's force laws and his equation for *c* can be derived from an electric field law L_1 which is similar to the gravitational field law L_1. As it is shown in Aucamp[1] both mathematically and experimentally that $\alpha=3/2$, perhaps this value also applies to the value of α in the gravitational law L_1. However, it is noted that electric fields differ from gravitational fields.

Section 6.4 – Possibility that α<<1

In Aucamp[5] it is shown that the precession of the planet Mercury is mathematically predicted to be 35.9437α (arcsec/orbit), based on L_1. This value may be deemed to be too great if $\alpha=1$. As the derivation of the formula involves a very complicated analysis and a complicated computer program, it may be that there is an error somewhere in the proceedings.

Section 6.5 – Conjecture that α=1

It is conjectured that that $\alpha=1$ for several reasons: (a) there is a logical argument for it, based Section 6.2, (b) the conjecture is simple, (c) there is a somewhat similar value applicable to electromagnetic fields, and the result is simple. With this conjecture law L_3becomesL_3*, as follows:

GRAVITATIONAL LAW L_3* BASED ON THE α=1 CONJECTURE

(6.5.1)$f^* = f_0(1 – v\cos(\varphi)/c) = f_0 [1 + Z]$

In (6.5.1) Z is defined by (4.2) as $Z = (v/c) \cos(\varphi)$.

PART 7 – SEVERAL PROPERTIES OF PHOTONS

Section 7.1 – Background Comments on Photons

The effect of gravity on photons will be analyzed in this paper by law L_3. Interestingly, perhaps the biggest selling point of Einstein's[9]GTR was the 1919 experiment of Arthur Eddington in Africa that showed photon paths moving past the sun were bent, reportedly according to the theory. However, some astrophysicists have subsequently cast doubt on these results. Some doubters say the measurements were not sufficiently accurate and that Eddington was biased. Also, they charge Eddington threw out non-supporting data, and the experiment required additional measurements at a much later time. Very important, Frank Watson Dyson in South America also did the same experiment and got significantly different results which were more in agreement with the Newtonian method (covered below) than with GTR, but he then ignored them. In a 1979 analysis it was concluded the Eddington experiments were not sufficiently accurate to overthrow the Newtonian method.

Section 7.2 – Assumed Properties of Photons

While a detailed theory of photons will be forthcoming in this author's upcoming work on quantum theory (referred to herein as QT), several properties are needed and discussed below. In Einstein[7,10] concerning the photoelectric effect he theorized that photons have the following energy:

$$(7.2.1) E = h\,\Omega = h\,c\,/\,\lambda$$

In (7.2.1) the photon frequency is written as Ω rather than by v or f in order to avoid confusion with velocity and force. It is noted that $\Omega = 1/T$, where T is the period. Since the wavelength λ is given by $\lambda = cT$, then $\Omega = 1/T = c/\lambda$ and (7.2.1) follows from Einstein's $E = h\Omega$. In practice, wavelengths are currently measured and not frequencies. In QT this practice is shown to be no accident. However, as it is more convenient to use frequencies in formulas than wavelengths, they will be used here with the understanding that $\Omega = c$. By way of note, (7.2.1) will be derived from other considerations in QT, where it is also shown that electromagnetic waves are not photons.

Now consider the situation where a photon is emitted with a frequency of Ω from a given source, and assume IRF_0 is the inertial frame of reference of the source at the instant of emission. From L_2, $|v| = c$, as measured in IRF_0. It is reiterated that experiments concluding otherwise are shown in Aucamp[2] to be inconclusive. Based on L_2 it is convenient to evaluate all measurements in this discussion with respect to IRF_0. If the photon is travelling in a gravitational field, it will be assumed there will be a differential energy change, dE, as follows:

$$(7.2.2) dE = f_r dr$$

In (7.2.2) dr is the differential movement in IRF_0 of the photon position vector, r, and f_r is the gravitational force component at the of arrival of the ray in the r direction. During a move of dr, it is postulated from (7.2.1) that:

$$(7.2.3) dE = h\,d\Omega$$

From L_2 it is assumed that f does not affect the photon speed of c, but the perpendicular component f_p of f will change the direction of motion. These assumptions are more specifically analyzed as follows: First, assume the angle between f and v at any instant of impact is φ, where $f = |f|$. The radial force component, f_r, and the perpendicular component, f_p, are given as:

$$(7.2.4) f_r = f\cos(\varphi)$$

$$(7.2.5) f_p = f\sin(\varphi)$$

Based on the above arguments concerning the movement of a photon under a force f, it is assumed that the total velocity remains at $|v| = c$. However, if v_p is the velocity component perpendicular to f, then the change dv_p in this component is found from:

$$(7.2.6) f_p dt = m dv_p$$

In(7.2.6) m is taken as the photon mass, which is assumed to obey:

$$(3.2.7) E = m\,c^2$$

Thus, from (7.2.7) and (7.2.1) :

$$(7.2.8) m = h\,\Omega\,/\,c^2$$

Then, from (7.2.2) and (7.2.4) :

$$(7.2.9) dE = f\cos(\varphi)\,dr$$

From (7.2.9) and (7.2.3) the differential change in frequency Ω is given as:

$$(7.2.10) d\Omega = dE\,/\,h = f\cos(\varphi)\,dr\,/\,h$$

This result will later on be useful in determining the frequency change in a photon when it passes by a large body (i.e., a star).

Part 8 – Application: Precession

In the upcoming analyses several of the experimental strengths of GTR are shown to have somewhat similar explanations as derived from L_2 and L_3. These strengths are: (a) the prediction of the precession of orbiting bodies in general and the planet Mercury in particular, (b) the bending of photon paths in gravitational fields created by large masses, and (c) photon frequency shifts in gravitational fields. The problem concerning photon emission frequency changes in the presence of gravitational fields, such as in atomic clocks, is postponed to an upcoming paper (QT).

Concerning (a) it is noted that precession has already been covered in Aucamp[5]. In that study it was shown that gravitational law L_1 explains the orbital precession of bodies of mass m around a virtually stationary body of much larger mass M in the usual situation when v/c is small. From L_1 this result is obvious because m

gets an added acceleration in a gravitational field when it is moving in the direction of the ray, whereas the deceleration is decreased when it is moving away from the ray. Since L_1 is virtually identical to L_3 when v/c is small, then L_3 also successfully explains gravitational precession.

Part 9 – Application: Bending of Photon Paths

Section 9.1 - Introduction

The situation examined here assumes a photon with initial frequency Ω is emitted from an infinitely distant star at $(x,y)=(\infty,D)$ and travels to the left, parallel to the x axis. Suppose IFR_0 is the IFR of the source at the instant of emission. The photon ultimately passes by a star of mass M and radius R which is centered at $(x,y)=(0,0)$, all as measured in IFR_0. While the velocity component V_M of M as measured along the x axis may be non-zero at the time of impact, it is assumed that V_M/c is very small, so that there little error in assuming M is virtually stationary during the short time it takes for the photon to pass by. It is noted the amount of photon bending as it moves by M is so small that the path remains essentially on a straight line. As shown in Figure 2the photon bends toward Min such a way that the final velocity is at a very small angle ψ to the original path line. The position at a given x is shown as point (x,y), which is at an angle θ to the horizontal axis. It is noted that the final bend angle, ψ, in the figure is highly exaggerated.

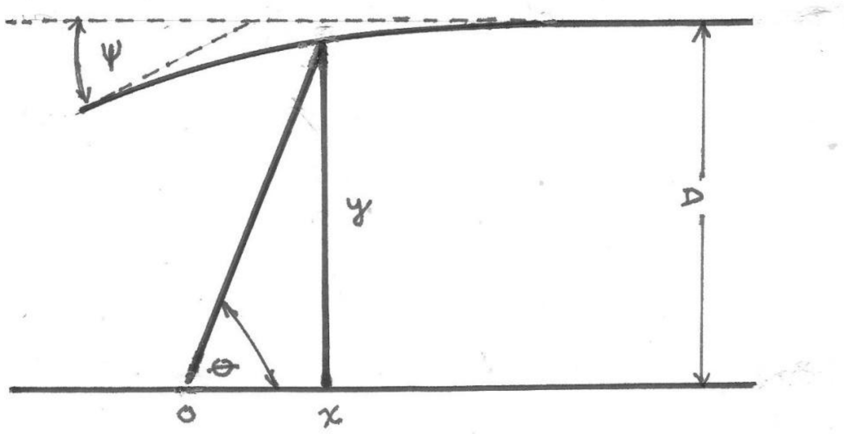

Figure2. *Photon Path (Exagerated Bend)*

Section 9.2 - Analysis

From (7.2.6) $f_y dt=mdv_y$. Thus, if m is the mass of the photon and f_y is the orthogonal force component, then the following obtains for the final velocity v_y in the y direction is, very closely, given as:

$$(9.2.1)\quad v_y = \int (f_y/m)\, dt = \int_{\infty}^{-\infty} (f_y/m)\,(-dx)/c = \int_{-\infty}^{\infty} f_y\, dx/(mc)$$

In the above integral x initially runs from $x=+\infty$ to $x=-\infty$, where dt is replaced by $dt=-dx/c$. From this equation it is seen that the difference between it and the standard Newton's method is in the calculation of the force, f_y, where in the Newtonian analysis $\alpha=0$. Assuming the bend angle at any given point is φ, then $dy/dx=tan(\varphi)$. Since this angle is minute, an inspection of the figure reveals that φ in (4.2) is very nearly given by $\varphi=\pi-\theta$. Thus:

$$(9.2.2)\quad cos(\varphi) = -cos(\theta)$$

Since $v/c=1$ in IFR_0, then from (4.2):

$$(9.2.3)\quad Z = (v/c)\, cos(\varphi) = cos(\varphi) = -cos(\theta)$$

From (4.4) and f_0 =$-GMmu/r^2$,the following obtains:

$$(9.2.4)\quad f_y = -\,(GMm/r^2)\,[\,1-\alpha Z+(\alpha-1)Z^2 S(Z)]\, sin(\theta)$$

In (9.2.4) the $sin(\theta)$ term enters in the equation since the component of u in the y direction is $sin(\theta)$.Substituting Z from(9.2.3) into (9.2.4) yields:

$$(9.2.5)\quad f_y = -\,(GMm/r^2)\,[\,1+\alpha\, cos(\theta)+(\alpha-1)cos(\theta)^2\, S(Z)]\, sin(\theta)$$

Thus, from (9.2.1) and (9.2.5):

$$(9.2.6)\quad v_y = -(GM/c)\int_{-\infty}^{\infty} dx\ [1+\alpha\, cos(\theta)+(\alpha-1)cos^2(\theta)\, S(Z)]\, sin(\theta)/r^2$$

It is noted that $S(Z)=sign[cos(\varphi)]=-sign[cos(\theta)]$. Thus, $S(Z)=-1$when $x>0$ and

$S[Z]=1$ when $x<0$. An inspection of (9.2.6) reveals that the integral consists of three terms, where the first is the component of v_y due to NLG. The second term involves $\alpha[\cos(\theta)\sin(\theta)/r^2]$, which is an odd function and integrates to zero. The third term involves an even function, $\cos^2(\theta)\sin(\theta)$, multiplied by an odd function, $S(Z)$. Thus, the contribution of this term to the integral is also zero. From these arguments the following obtains:

$$(9.2.7)\quad v_y = -(GM/c) \int_{-\infty}^{\infty} dx \;\; \sin(\theta)/r^2$$

From Figure 2 it is seen that, very closely, $\sin(\theta)=D/r$ and $r^2=x^2+D^2$. Therefore, $\sin(\theta)/r^2=D/r^3=D/(x^2+D^2)^{3/2}$. From this result:

$$(9.2.8)\quad v_y = -(GM/c) \int_{-\infty}^{\infty} D \; dx \; / (x^2+D^2)^{3/2}$$

Setting $X=x/D$, then $dx=DdX$ and (9.2.8) reduces to:

$$(9.2.9)\quad v_y = -(GM/c) \int_{-\infty}^{\infty} dX \; D^2 \; / (D^2X^2+D^2)^{3/2}$$

Thus:

$$(9.2.10)\quad v_y = -[GM/(cD)] \int_{-\infty}^{\infty} dX \; / (X^2+1)^{3/2}$$

As the above integral has the value of 2, then:

$$(9.2.11)\quad v_y = -2GM/(cD)$$

Very closely, $\psi = v_y/c$. Thus, it is concluded that the angle ψ between the arriving and departing paths is given as:

$$(9.2.12)\quad \psi = -2GM \; / \; (c^2D)$$

It is noted that (9.2.12) is identical to the well-known Newtonian result, but ψ is only half of the value that is sometimes attributed to the prediction by GTR. It is interesting that ψ is independent of α. This is due the fact that the gravitational force is increased when the photon is moving toward M and is decreased by the same amount when it is moving away from M. It is also noted that the angle ψ is measured in IFR_0 and not in the IFR_M of an observer at M. However, very closely, the values are virtually the same.

Part 10 – Application: Affect of Gravity on Frequencies

It is known that photons experience frequency shifts in the presence of gravitational fields. The three situations studied here are: (a) when photons move directly away from masses, (b) when they move directly toward masses, and (c) when they pass by masses. The case concerning frequency shifts at emission due to gravitational fields at the source is covered in a future work on quantum theory, where the details of the emission process are analyzed. In the analysis herein it is noted that L_3 will be used to explain, at least to an order of magnitude, the above frequency cases without the aid of GTR.

Section 10.1 – Application: When a Photon Moves Away from a Mass

Consider a photon which has been emitted from a mass M, and assume law L_3 applies as given by (4.4). In this case $v/c=1$ and $\varphi=0$. Therefore, $Z=(v/c)\cos(\varphi)=1$, and f in L_3 is given as:

$$(10.1.1)\quad f = f_0[\, 1-\alpha + (\alpha -1)] = 0$$

Accordingly, no gravitational force acts on the photon after it has been emitted. There is consequently no subsequent change in energy or frequency due to M. It would appear that this result cannot be valid since it is known that photons emitted by stars experience red shift. In this regard it will be shown in an upcoming work (QT) that the red shift is due to the gravitational field at emission.

Section 10.2 – Application: When a Photon Moves Toward a Mass

Consider the situation when a photon with initial frequency Ω moves to the left along the x axis. It eventually hits a body of mass M and radius R_M which is moving at velocity v_M at the instant of collision, where all measurements are with respect to the inertial frame of reference IFR_0 of the source at the emission time. Assuming $|v_M/c|$ is small, the gravitational force that M exerts on the photon when it is nearby is, very closely, found by assuming $v_M=0$. Noting that $|v|=c$ for photons as measured in IFR_0 and $\cos(\varphi)=-1$, then $Z=(v/c)\cos(\varphi)= -1$ and $S(Z)=-1$. Thus, from (4.4):

$$(10.2.1)\quad f = f_0[1-\alpha(-1) + (\alpha-1)(-1)^2(-1)) = 2\, f_0$$

Plugging f_0 as given by (2.1) into (10.2.1) yields:

$$(10.2.2)\quad f= -2\, G\, Mmu/r^{\,2}$$

From (7.2.8) $m=h\Omega/c^2$. Then from (10.2.2):

$$(10.2.3)\quad f = -2\, G\, Mh\, \Omega u/\, (c^2\, r^{\,2})$$

From (10.2.3) the gain δE in energy during the photon passage from $x=+\infty$ to the outside radius R_M of mass M is found as follows:

$$(10.2.4)\quad \delta E = \int_{\infty}^{R} f_x dx$$

From (10.2.3) and (10.2.4):

(10.2.5) $\delta E = \int_{\infty}^{R} - 2\,GMh\,\Omega dr / (c^2 r^2) = 2GMh\,\Omega / (c^2 R)$

As $\delta E = h\delta\Omega$, then from (10.2.5), the positive frequency shift is given as:

(10.2.6) $\delta\Omega = 2G M\Omega / (c^2 R)$

Section10.3 – Application: Photon Movement by a Mass

The assumptions in this section are the same as in Part 9 concerning photon bending. It is again assumed a photon travels to the left on a virtually straight line according to the equation, $y=D$, and it initially has a frequency Ω. However, rather than calculating the orthogonal force f_y which contributes to the bending, in this case attention is focused on f_x, which is the force that changes the photon energy and frequency. The differential change in energy, dE, is found from:

(10.3.1) $d E = h\, d\Omega = f_x\, dx$

Thus, $\delta\Omega$ can be found from δE and the following integral:

(10.3.2) $\delta E = \int_{\infty}^{-\infty} f_x\, dx$

From (2.1), (4.4), and Figure 2 the following obtains:

(10.3.3) $f_x = - GMm\cos(\theta)[1 - \alpha Z + (\alpha-1) Z^2 S(Z)] / r^2$

Thus, (10.3.2) becomes, on reversing the integration limits:

(10.3.4) $\delta E = GMm \int_{-\infty}^{\infty} \cos(\theta)[(1 - \alpha Z + (\alpha-1) Z^2 S(Z)]\, dx / r^2$

Sincethe first term in the above equation integrates to zero, then:

(10.3.5) $\delta E = GMm \int_{-\infty}^{\infty} \cos(\theta)[(-\alpha Z + (\alpha-1) Z^2 S(Z)]\, dx / r^2$

From (9.2.3), $Z = -\cos(\theta)$. Inserting this into (10.3.5) yields:

(10.3.6) $\delta E = GMm \int_{-\infty}^{\infty} \cos^2(\theta)[\alpha + (\alpha-1)\cos(\theta) S(Z)]\, dx / r^2$

As $\cos(\theta) = x/r$, then (10.3.6) is rewritten as:

(10.3.7) $\delta E = GMm \int_{-\infty}^{\infty} x^2 [\alpha + (\alpha-1)(x/r) S(Z)]\, dx / r^4$

This integral is evaluated as

(10.3.8) $\delta E = I_1 + I_2$

where

(10.3.9) $I_1 = GMm\alpha \int_{-\infty}^{\infty} x^2 dx / r^4$

(10.3.10) $I_2 = GMm(\alpha-1) \int_{-\infty}^{\infty} x^3 S(Z)\, dx / r^5$

Setting dimensionless variables $X=x/D$, $Y=y/D$, and $R=r/D$ into the above equations becomes, on noting the integrand is an even function in I_1:

(10.3.11) $I_1 = [GMm\alpha/D] \int_{-\infty}^{\infty} X^2 dX / (X^2+1)^2 = GMm\alpha\pi/(2D)$

Next, I_2 is re-written using the above dimensionless variables as follows:

(10.3.12) $I_2 = [GMm(\alpha 1)/ \int_{-\infty}^{\infty} X^3 S(Z) dX / (X^2+1)^{5/2}$

Since $S(Z) = sign[-\cos(\theta)]$, then $S(Z) = -1$ for $x>0$, $S(Z)=1$ for $x<0$, and

$S(Z) = 0$ for $x=0$. I_2 can therefore be written as $I_2 = I_3 + I_4$, where:

(10.3.13) $I_3 = [GMm(\alpha-1)/D] \int_{-\infty}^{0} X^3 dX / (X^2+1)^{5/2}$

(10.3.14) $I_4 = - [GMm(\alpha-1)/D] \int_{0}^{\infty} X^3 dX / (X^2+1)^{5/2}$

From (10.3.13) and (10.3.14) and standard integral calculus:

(10.3.15) $I_3 = I_4 = - (4/3)\, [GMm(\alpha-1)/D]$

Thus: $I_2 = I_3 + I_4 = - (8/3)\ [GMm(\alpha-1)/D]$. Inserting these results into (10.3.8):

(10.3.16) $\delta E = I_1 + I_2 = [GMm/D][(\alpha\pi/2) - (\alpha-1)(8/3)]$

Setting $m = h\Omega/c^2$ from (7.2.8) into (10.5.16) yields:

(10.3.17) $\delta E = [GMh\Omega/(Dc^2)][(\alpha\pi/2) - (\alpha-1)(8/3)]$

As $\delta\Omega = \delta E/h$, then (10.3.17) becomes :

(10.3.18) $\delta\Omega = [GM\Omega/(Dc^2)][(\alpha\pi/2) - (\alpha-1)(8/3)]$

If $\alpha=1$, then $I_2=0$. On defining $\delta\Omega^*$ as the resulting δQ:

(10.3.19) $\delta\Omega^* = GM\Omega\pi / (2 D c^2)$

It is seen from (10.3.19) that the assumption that $\alpha=1$ leads to a very uncomplicated formula for the frequency shift in a photon moving by a star.

Part 11–Conclusions

Law L_1 as developed in Aucamp[5] deals with the force exerted by a gravitational ray from a moving body of mass M on another moving body of mass m. In that study it was assumed that v/c is small, where v is the velocity of m as measured with respect to the inertial frame of reference of M at the instant the ray is emitted.

In this current study a law L_3 is proposed as an extension of L_1,where *v/c* is allowed to be large, including the case when *m* is a photon with *v/c=1*.The proposed theory predicts, at least qualitatively, many of the well-known successes of Einstein's GTR. Moreover, "while GTR is of not of any help" in resolving the dark matter (DM) and dark energy (DE) problems of astronomy, the DM problem is resolved by L_1(and by its extensionL_3).

Also, along with L_2as given in Aucamp[6], these laws resolve the DE problem. It is not yet clear whether GTR is in error or whether it is just incomplete. It may be possible these laws can somehow be combined into a single law and co-exist together. But it is important to note that STR has been shown in both Aucamp[1] and Aucamp[2] to be in error, so that GTR is ipso facto in error if it depends in any way on STR.

Concerning the feasibility of GTR, it is argued by this author here and in Aucamp[1-6], as well as in upcoming paper on quantum theory (QT), that Einstein does not have a good track record. To wit: (a) GTR is not helpful in resolving the DM and DE problems, (b)STR is mathematically untenable, (c) the measured speed of light not independent of source, (d) the length and time transformations in STR are in error, (e) the equation for mass in STR is incorrect,(f) EM waves are not photons[see QT]), and (g) the photon energy formula $E=h\Omega$ is not an act of nature, but instead is based on conservation of angular momentum (see QT).

References

[1] Aucamp, D.C. (2018), "A Single Equation Solution to the Electromagnetic Force Problem", Open Access J. Phys., V2, Issue4, pp.1-9.

[2] Aucamp, D.C.(2018),"On the Non-Feasibility of Special Relativity", Open Access J. Phys., V2, Issue 4, pp. 16-23.

[3] Aucamp, D.C.(2019)," An Alternate Theory of Special Relativity and Relativistic Mass", Open Access J. Phys., V3, Issue 1, pp. 1-6.

[4] Aucamp, D.C.(2019), "On the Biased Evaluation of the Inflationary Universe", Open Access J. Phys., V3, Issue1 ,pp. 7-9.

[5] Aucamp, D.C.(2019), "A Solution to the Dark Matter Problem", Open Access j.Phys., V3, Issue 4, pp. 27-36.

[6] Aucamp, D.C.(2020) , "A Solution to the Dark Energy Problem", Open Access J. Phys, V4, Issue 1, pp. 1-5.

[7] Einstein, A. (1905), "On the Electrodynamics of Moving Bodies", translated in "The Principal of Relativity", Dover, pp. 37-65.

[8] Einstein, A. (1911), "On the Influence of Gravitation on the Propagation of Light", translated in "The Principal of Relativity", Dover, pp. 97-108.

[9] Einstein, A. (1916),"The Foundation of the General Theory of Relativity", translated in "The Principal of Relativity", Dover, pp. 111-164.

[10] Einstein, A. (1916),"Hamilton's Principle and the General Theory of Relativity", translated in "The Principal of Relativity", Dover, pp. 167-173.

[11] Perlmutter, S., Adderling, G., Goldberger, G., Knop, R.A., +28, (1998), "Measurement of Omega and Lamba from 42 High Reds hift Supernovae", Astrophysical Journal, V. 717, Issue 2, pp. 565-581.

Citation: *Dr. Donald C. Aucamp, "An Alternative to the General Theory of Relativity", Open Access Journal of Physics, 4(1), 2020, pp. 01-10.*