Global Journal of Science Frontier Research
Physics and Space Science
Volume 13 Issue 6 Version 1.0 Year 2013
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Rotating Light House Effect

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We find that the Hubble relation can equally well be a consequence of galaxies rotating differentially around a common center of mass. It is shown that New-tonian mechanics can account for all major anamolies quoted against it when space-time relationship involving acceleration is properly taken into account.

GJSFR-A Classification : FOR Code: 020199

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I. Introduction

In continuation of our earlier papers (Rajamohan and Satya Narayanan [1], [2]) and references therein, we derive in section 4, a direct solution for the rate of change of redshift for an accelerating observer. This effect is also shown to account for the observed redshift from the center of the Sun's disk.

II. Relation Between Periods

In this section we introduce the simple concept of a rotating light source. Let us assume that the period of a rotating light source be P_e (need not be unity). Also the distance between two consecutive pulses is CP_e, where C is the velocity of light. The distance D_0 travelled by the N^{th} pulse to meet the receiver will be NCP_e.

$$D_0 = NCP_e = Ct_0 \tag{1}$$

Here t_0 is the time. The period P_e is related to the distance travelled and the number of pulses by the relation

$$P_e = \frac{d_0}{NC} = \frac{t_0}{N} \tag{2}$$

For an observer in relative motion, the period is given by

$$P = \frac{P_e}{(1-\bar{V}/C)} \tag{3}$$

Here $\bar{V}$ is the average velocity. It is easy to see that

$$NP = NP_e + \frac{\bar{V}}{C}\frac{P_e}{(1-\bar{V}/C)}N \tag{4}$$

$$= NP_e + \frac{\bar{V}P_e}{C-\bar{V}}N \tag{5}$$

Thus for uniform motion

$$P = P_e + \frac{P_e}{N} \tag{6}$$

Also

$$P_{Observed} = P_e + \triangle P_e = P_e + \frac{P_e}{N} \tag{7}$$

For an accelerating observer, we can write

$$P = P_e + \frac{1}{2}\frac{2P_e}{N} \tag{8}$$

Here we wish to make an important statement about the periods and period derivatives. For a moving observer with uniform velocity V, the difference in the periods at different time intervals will remain the same. This would imply that the variation in the periods, or the period derivatives would simply be identically zero. However, for an accelerating observer, the difference in the periods at different time intervals would be different. Such a difference would produce period derivatives. It is important to realize that a pulse which has met an accelerating observer who has moved CP_e kms, an additional time interval of P_e seconds has to be accounted for. This additional time interval P_e will contribute significantly to period derivatives.

The first term in the above equation is the contribution due to uniform motion, while the second term contributes to the change in the period due to acceleration of the moving observer, as P_e seconds has to be accounted for every CP_e km due to acceleration. As mentioned above the contribution to the period derivative would come from the second term. For an accelerating observer, $\bar{V}$ is the average velocity so that the contribution due to acceleration would be of the order of $2\bar{V}$. A simple calculation would yield the following relation for the variation in the period.

$$\dot{P} = \frac{2P_e}{N} \tag{9}$$

$$= \frac{2P_e^2}{t_0} = \frac{2CP_e^2}{D_0} \tag{10}$$

Thus

$$\frac{\dot{P}}{P_e} = \frac{2}{t_0} \tag{11}$$

In terms of time, we can write as follows: The total time interval T,

$$T = \frac{d_0}{\bar{V}} + [\frac{d_0 + (d-d_0)]}{C} \tag{12}$$

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d/C contains N - intervals of $\bar{P}$ so that

$$[\frac{T}{N}]N = [\frac{T_0}{N}]N + [\frac{\bar{P}}{N}]N^2 \tag{13}$$

Therefore the period derivative is

$$\dot{P} = \frac{P_e}{T_0(1 - V/C)} \tag{14}$$

As $V \to 0$

$$\dot{P} = \frac{P_e}{T_0} \tag{15}$$

It is important to realise that when we calculate the variation in the periods, we have to divide the period with time intervals ($t - t_e$) and then subsequently take the limit of $t_e \to 0$. Whenever we say that we are measuring time, one must remember that we actually measure time intervals. A more detailed derivation of the relation between the period and period derivatives is provided in section 4. The simple relation between the periods and period derivative have interesting applications in astrophysics as discussed in the following sections. We first clarify in section 3, as to how a precession period appears in the observed periodic phenomenon in Astrophysics. As the two phenomena are related, it is shown that the observed result can be accounted for by differential rotation of objects around a common center of mass.

III. Precession

Let two objects A (e.g. Earth) and B (e.g. Mercury) revolve around a common center of Mass (e.g. Sun) with periods P_A and P_B, respectively. Let at time t = 0, A, B and C be aligned and let this line point to a distant object (quasar). The difference in angular motion will again lead to a similar alignment given by the well known Synodic period P_S. However, this alignment will be pointing towards a different distant object. Let us ask the question when will a given alignment with respect to the same distant object repeat itself. The question is, considered as two clocks with two different periods, were to start in phase at t = 0, what would be the time interval taken for them to come in phase again.

Let P_L be this time interval. P_L is obviously related to the relative acceleration in the angles involved for which a simple solution can be found.

In the synodic period P_S given by

$$2\pi/P_S = 2\pi/P_B - 2\pi P_A \tag{16}$$

Object A moves through an angle $\triangle\theta$ given by

$$\triangle\theta = \frac{V_A}{R_A} \cdot P_S \tag{17}$$

In the same time interval, object B moves through an angle

$$2\pi + \triangle\theta = \frac{V_B}{R_B} \cdot P_S \tag{18}$$

Thus

$$2\pi = (\dot{\theta_B} - \dot{\theta_A})P_S = \dot{\theta_{rel}} \cdot P_S \tag{19}$$

Squaring the above equation, we get

$$2\pi = \frac{(\dot{\theta_B} - \dot{\theta_A})^2}{2\pi} \cdot P_S^2 = \frac{\dot{\theta_{rel}}^2}{2\pi} \cdot P_S^2 \tag{20}$$

Hence two hypothetical objects moving along the same circle with $\dot{\theta}$ and $\dot{\theta}^2/2\pi$ will be aligned in phase again and again at intervals of P_S^2 seconds. Hence this precession period will be reflected in the data as

$$\frac{2\pi}{P_S^2} \;/\; per \;\; second \tag{21}$$

$$= \frac{2\pi}{10^{14}} \times 3.1 \times 10^9 \times 2.063 \times 10^5 arcsec/century \tag{22}$$

$$\approx 41 \;\; arcsec/century \tag{23}$$

This is in good agreement with the observed value of 43 arcsec/century. Orbital inclinations and eccentricity will lead to higher order terms.

A similar situation occurs in the case of binary pulsars. In the determination of orbital paramaters of a binary system for example, the position angle of the semimajor axis and the time of periastron passage assumes that the observer is stationary. The relative motion of the Sun is not taken into account. This effect of rotation of the axis leads to a precession of the orbit (spurious) when not taken into account. The signal emitted [(e.g) from velocity maximum] towards the Sun cannot repeat after one orbital period unless the ratio P-orbital to P-emission is an integer. The time required for such a repetition can be calculated as follows.

The height through which the pulsar drops in its orbit is $(1/2)V^2P_e^2/D$ in P_e seconds, where 'V' is the orbital velocity and 'D' is the radius of the orbit. For a circular orbit, the number of divisions of $(1/2)V^2P_e^2/D$ in '4D' is

$$\frac{8D^2}{V^2P_e^2} \tag{24}$$

This would be the time interval needed for repetition of the same phenomenon in phase; for the signal to originate from the same position in its orbit.

The observed precession per pulse would then be

$$\frac{2\pi V^2P_e^2}{8D^2} = \frac{\pi V^2P_e^2}{4D^2} = \frac{\pi^3V^2P_e^2}{4\pi^2D^2} = \frac{\pi^3P_e^2}{P_{orb}^2} \tag{25}$$

This result is in good agreement with the observed value of precession of binary pulsars. We can obtain the same result by introducing $\pi/2$ as a scale factor. As acceleration is $V^2P_e^2/D^2$, the precession observed per pulse would be

$$\frac{1}{2}\cdot\frac{\pi}{2}\cdot\frac{V^2P_e^2}{D^2} \tag{26}$$

IV. Redshifts

a) Redshift for unit light travel time

Transverse motion involves acceleration given by (V^2/d) where 'V' is the relative transverse velocity, 'd' is the distance that separates the emitter and the receiver at time t = 0.

Let an accelerating observer starting from x = 0 be at station A at time t_A and station B ahead at time t_B. Let $X_B - X_A = CP_e$ kms. Let one of the signals emitted at intervals of 'P_e' seconds by a relatively stationary emitter meet the observer at station B at time t_1. The next signal will be 'CP_e' kms behind at station X_A as $X_B - X_A = CP_e$ where 'C' is the signal speed.

Let this second signal meet the moving observer at X_2 at time t_2. Then the observed period is $(t_2 - t_1)$. The time 't_2' must satisfy the following two relations.

$$t_2 = t_a + \frac{X_2 - X_a}{(1/2)a(t_2+t_A)} \tag{27}$$

as

$$X_2 - X_a = (1/2)a(t_2^2 - t_A^2) = (1/2)a(t_2+t_A)(t_2-t_A)$$

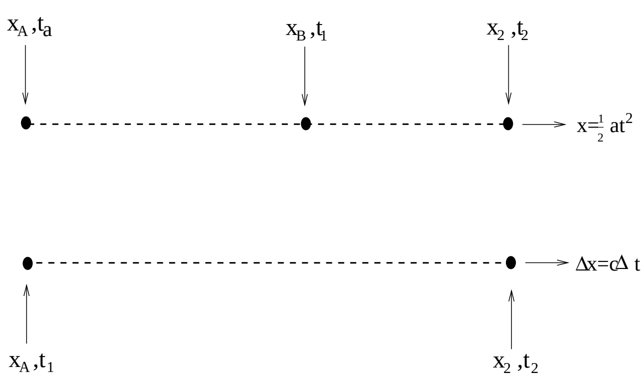

Figure 1 : The relative positions of the two signals

$$t_2 = t_1 + \frac{X_2 - X_a}{C} \tag{28}$$

as

$$C(t_2 - t_1) = X_2 - X_a$$

Subtracting equation (23) from equation (24) we get

$$(t_1 - t_a) - \frac{X_2 - X_a}{(1/2)a(t_2+t_A)}(1 - \frac{(1/2)a(t_2+tA)}{C}) = 0$$

$$(t_1 - t_a) = (t_2 - t_A)(1 - \frac{(1/2)a(t_2+t_A)}{C})$$

as

$$\frac{X_2 - X_a}{(1/2)a(t_2+t_A)} = (t_2 - t_A)$$

Therefore

$$(t_2 - t_A) = \frac{(t_1 - t_A)}{(1 - \frac{(1/2)a(t_2+t_A)}{C})} \tag{29}$$

$$(t_2 - t_1) = \frac{(1/2)a(t_2+t_A)}{C}\frac{(t_1 - t_A)}{(1 - \frac{(1/2)a(t_2+t_A)}{C})} \tag{30}$$

It is important to note that the time interval $(t_2 - t_1)$ must satisfy the condition

$$(t_2 - t_1) = \frac{V}{C}(t_2 - t_A)$$

where $\bar{V}$ is the average velocity in the time interval $(t_2 - t_A)$.

For uniform motion

$$(t_2 - t_1) = \frac{V}{C}\cdot\frac{CP_e}{V(1 - V/C)}$$

or

$$(t_2 - t_1) = \frac{V}{C}\cdot\frac{(t_1 - t_A)}{(1 - V/C)}$$

and

$$X_2 - X_A = \frac{X_1 - X_a}{(1 - V/C)}$$

When acceleration is involved the same relationship is as that given by equation (30).

$$(t_2 - t_1) = P = \frac{(1/2)a(t_2+t_A)}{C}\cdot\frac{(t_1 - t_A)}{(1 - \frac{(1/2)a(t_2+t_A)}{C})}$$

$$P = \frac{(t_2+t_A)}{(t_1+t_A)}\cdot\frac{P_e}{(1 - \frac{(1/2)a(t_2+t_A)}{C})}$$

Setting $t_A = 0$, we get

$$P = \frac{t_2}{t_1}\cdot\frac{P_e}{(1 - \frac{(1/2)a(t_2+t_A)}{C})} \tag{31}$$

$$P = \frac{t_1 + (t_2 - t_1)}{t_1}\cdot\frac{P_e}{(1 - \frac{(1/2)a(t_2+t_A)}{C})}$$

$$P = \frac{P_e}{(1 - \frac{(1/2)at_2}{C})} + \frac{PP_e}{(1 - \frac{(1/2)a(t_2+t_A)}{C})t_1} \tag{32}$$

Hence the rate of change of P is

$$\dot{P} \approx 2P_e/t \tag{33}$$

b) The Redshift in General

Let d_0 be the distance between the emitter and the receiver at time t = 0. If the receiver and emitter are relatively stationary, the observed period P_E will be the same as the emitter period. If the observer is moving towards or away from the receiver, with uniform velocity, the observed period would be $P_e/(1 + V/C)$ or

$P_e/(1-V/C)$, respectively. When acceleration is involved, the common error made is to assume that the rate of change of observed period is $\dot{P}=\dot{V}P_e/C$. We will show that this is not true and $\dot{P}$ is given by $2\dot{V}P_e/V$. The simplest way of approach is V (average) $\triangle T = CP_e$ where V is the average velocity in the time interval $\triangle T$.

$$\frac{1}{\triangle T}=\frac{V}{CP_e};-\frac{\triangle\dot{T}}{\triangle T^2}=\frac{\dot{V}}{CP_e}or-\frac{\triangle\dot{T}}{\triangle T}=\frac{\dot{V}}{CP_e}\triangle T=\frac{\dot{V}}{V} \tag{34}$$

That is, as the observer accelerates, the time interval in CP_e kms is smaller and smaller and is a function of time. The similarity with frequency and wavelength of light is to be noted.

$$\lambda\nu=C;\frac{1}{\nu}=\frac{\lambda}{C};-\frac{\dot{\nu}}{\nu^2}=\frac{\dot{\lambda}}{C};-\frac{\dot{\nu}}{\nu}=\frac{\dot{\lambda}}{C}\nu=\frac{\dot{\lambda}}{\lambda} \tag{35}$$

Consider an observer moving away from the emitter and is at a distance d_0 at time T_0 from the origin (d =0).

$$d_0=(1/2)aT_0^2 \tag{36}$$

Let one of the signal meet the receiver at d_0 at time T_0 and let the nth signal be at d = 0 at $T = T_0$. Let the nth signal meet the receiver at a distance d_1 at time T_1.

$$T_1=T_0+(T_1-T_0)$$

and

$$d_1=d_0+d_1-d_0=(1/2)aT_0^2+[(1/2)aT_1^2-(1/2)aT_0^2] \tag{37}$$

$$T_1=T_0+d/C=T_0+\frac{d_0}{C(1-\bar{V}/C)} \tag{38}$$

where $\bar{V}$ is the average velocity in the time interval 0 to T_1. and $C(T_1 - T_0) = d_1$. Therefore

$$T=[\frac{CP_e}{(1/2)aT_0}+\frac{P_e}{1-\bar{V}/C}]\frac{d_0}{CP_e} \tag{39}$$

Since the number of signal n occupies the same space d_0, between two signals, the number of seconds on an average is $CP_e/(1/2)aT_0$.
The relationship is of the kind

$$X=(u+(1/2)at)t$$

where 't' is the time interval corresponding to the space interval X. Equation (17) can be written as

$$T_1=\frac{CP_e}{(1/2)aT_0}\cdot\frac{d_0}{CP_e}+\frac{CP_e^2}{d_0(1-\frac{(1/2)a(T+T_0)}{C})}\cdot\frac{d_0^2}{C^2P_e^2}$$

Hence the acceleration in arrival times is CP_e^2/d_0 per cycle, per $CP_e/(1/2)aT_0$ seconds. Thus

$$\dot{P}=\frac{CP_e}{d_0}\cdot\frac{(1/2)aT_0}{C}=\frac{(1/2)aT_0\cdot P_e}{(1/2)aT_0^2}=\frac{P_e}{T_0}$$

$$\frac{\dot{P}}{P_e}=\frac{1}{T_0}$$

In terms of the light travel times, equation (39) gets modified as

$$T_1-T_0\approx P_e\cdot\frac{d_0}{CP_e}+\frac{(1/2)aT_0}{C}\cdot\frac{d_0}{CP_e}$$

$$\dot{P}=\frac{(1/2)aT_)}{C}\cdot\frac{cP_e}{d_0}=\frac{(1/2)aT_0}{(1/2)aT_0^2}\cdot P_e=\frac{P_e}{T_0}$$

Introducing a factor 2 for acceleration, as $NP = P_iN+(1/2)\dot{P}P_iN^2$ where N is the number of cycles and is the initial period

$$\frac{\dot{P}}{P_e}=\frac{2}{T_0} \tag{40}$$

Note that the change in the velocity by 'aP_e' occurs for every 'VP_e' kms. In the length interval CP_e, the change in 'V' is therefore

$$\frac{CP_e}{VP_e}\cdot aP_e$$

Hence the rate of change of period per unit light travel time is given by

$$\dot{P}=\frac{aP_e}{V}=\frac{P_e}{T}$$

Introducing 2 as a factor for acceleration

$$\frac{\dot{P}}{P_e}=\frac{2}{T}$$

This result can be directly obtained from equation (38) by replacing t_1 by T_0 which satisfies the relation $d_0=(1/2)aT_0^2$.

c) Comparison with observations

The relative transverse velocity of two objects A and B moving around a massive common center of mass is given by

$$V_A-V_B=(\frac{GM}{R_A})^{1/2}-(\frac{GM}{R_B})^{1/2}$$

where R_A and R_B are the radius vectors.

$$V_{rel}=(GM)^{1/2}\{\frac{1}{R_A^{1/2}}-\frac{1}{R_B^{1/2}}\}$$

Let $R_B=|R_A-d|$, where $d=|R_A-R_B|$.

$$V_{rel} = (GM)^{1/2}\{\frac{1}{R_A^{1/2}} - \frac{1}{(R_A - d)^{1/2}}\}$$

$$= (GM)^{1/2}\{\frac{1}{R_A^{1/2}} - \frac{1}{R_A^{1/2}(1 - d/R_A)^{1/2}}\}$$

$$= (GM)^{1/2}\{\frac{1}{R_A^{1/2}} - \frac{1}{R_A^{1/2}}\{1 + \frac{d}{2R_A} + \frac{3d^2}{8R_A^2}\}\}$$

$$= (GM)^{1/2}\{\frac{1}{R_A^{1/2}} \cdot \frac{d}{R_A} + \frac{1}{R_A^{1/2}}\frac{3d^2}{8R_A^2}\}$$

The redshift $\dot{P}/P_e$ is

$$\frac{1}{2}\sqrt{2}\frac{V_{rel}}{d} = \frac{1}{\sqrt{2}}[(\frac{GM}{R_A})^{1/2} - (\frac{GM}{R_B})^{1/2}]/|R_A - R_B|$$

$$\approx \frac{1}{\sqrt{2}}\frac{(GM)^{1/2}}{R_A^{3/2}} + \frac{1}{\sqrt{2}} \cdot \frac{3}{8}\frac{(GM)^{1/2}}{R_A^{3/2}} \cdot \frac{d}{R_A}$$

$\frac{(GM)^{1/2}}{R^{3/2}}$ is proportional to the reciprocal of the orbital period. Identifying R_A with R_{Sun}, we expect the observed period derivatives of pulsars to be proportional to the distance of pulsars from Sun. This is well corroborated as shown in Rajamohan and Satya Narayanan [2]. This result is in good agreement with the observed period derivatives of pulsars and its relation to the distance from the Sun.

$$d_0 = (1/2)aT_0^2 \tag{41}$$

Therefore

$$\frac{2}{T_0} = \sqrt{2}\frac{v_\tau}{d_0} \tag{42}$$

$\sqrt{2}$ is an approximation to $\pi/2$. The redshift therefore observed from the center of Sun's disk is given by

$$\pi/2\frac{407}{1.5 \times 10^8} \approx 4.24 \times 10^{-6}$$

which is in close agreement with observed values (Weinberg [3]). We can therefore speculate that the Hubble relation is a consequence of this effect if galaxies were to be differentially rotating about a common center of mass. Then the reciprocal of H_0 is proportional to the rotation period of the Milky Way galaxy around such a center.

V. Conclusion

The relationship between space and time as defined by the law of Gravitation and Galilean transformation can account for major anamolies quoted against the law.

The observed precession is an artifact and can be accounted for by differential rotation effects. The same is true of period derivatives of pulsars since the observed P is not intrinsic to the pulsar. The period derivatives being proportional to the distance can be again accounted for by differential rotation of objects around a common center of mass (Rajamohan and Satya Narayanan [2]).

As acceleration, and in turn rotation appears to be fundamental in nature (i.e., satellites around planets, planets around Sun, Sun and stars around the Milky Way), we suggest that the Hubble relation is a consequence of differential rotation of galaxies around a common center of mass. Many such local universes might exist in infinite space.

The effect derived in this paper shows that the average observed period of pulsars and their dependence on their distance from the Sun is a kinematic effect caused by differential rotation of the galaxy. It leads to the conclusion that Newton's law of gravitation is true to one part in 10^{16}. It also shows that the velocity of light is constant to the same degree of accuracy. The Hubble relation interpreted as differential rotation of galaxies around a common massive center indicates that the above conclusions are true to one part in 10^{19}.

This effect also mitigates the requirement of a large amount of missing mass in the observable universe that are proposed to account for the observed relation be-tween velocity and distance.

The general design of the Nature appears to repeat the same phenomenon of a massive bulge (core) with differentially revolving smaller objects around it - from satellites of planets around the mother planet, planets around the Sun, Sun and stars around the galactic center, and the galactic center with its entire family of Milky Way members around a distant center. Such a center appears to be in the constellation of Virgo, where a clustering of clusters of galaxies is seen.

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Global Journal of Science Frontier Research (A) Volume XIII Issue VI Version I Year 2013