Journal of Theoretics

Redshift Calculations in the Dynamic Theory of Gravity

Ioannis Iraklis Haranas
Department of Physics and Astronomy
York University
128 Petrie Science Building
York University
Toronto – Ontario
CANADA
E mail: ioannis@yorku.ca

Abstract:

In a new theory called Dynamic Theory of Gravity, the cosmological distance to an object and also its gravitational potential can be calculated. We first measure its redshift on the surface of the Earth. The theory can be applied as well to an object in orbit above the Earth, e.g., a satellite such as the Hubble telescope. In this paper, we give various expressions for the redshifts calculated on the surface of the Earth as well as on an object in orbit, being the Hubble telescope. Our calculations will assume that the emitting body is a star of mass $M = M_{X\text{-ray(source)}} = 1.6\times10^{8}\ M_{\text{solar masses}}$ and a core radius R = 80 pc, at a cosmological distance away from the Earth. We take the orbital height h of the Hubble telescope to be 450 Km.

Introduction:

There is a new theory of gravity called Dynamic Theory of Gravity [DTG]. Based on classical thermodynamics Ref:[1] [2] [3] [9] it has been shown that the fundamental laws of Classical Thermodynamics also require Einstein's postulate of a constant speed of light. DTG describes physical phenomena in terms of five dimensions: space, time, and mass. Ref[4] The theory makes its predictions for redshifts by working in the five dimensional geometry of space, time, and mass, and determines the unit of action in the atomic states in a way that can be calculated with the help of quantum Poisson brackets when covariant differentiation is used:

$$\left[x^{\mu}, p^{\nu}\right]\Phi = i\,\hbar\, g^{\nu q}\left\{\delta_{\mu\mathrm{q}} + \left[\Gamma^{\mu}{}_{s,q}\right]x^{s}\right\}\Phi . \tag{1}$$

In (1) the vector curvature is contained in the Chrisoffel symbols of the second kind and the gauge function Φ is a multiplicative factor in the metric tensor $g^{\nu q}$, where the indices take the values ν, q = 0,1,2,3,4. In the commutator, x^{μ} and p^{ν} are the space and momentum variables respectively, and finally δ_{μ} q is the Cronecker delta. In DTG the momentum ascribed as a variable canonically conjugated to the mass is the rate at which mass may be converted into energy. The canonical momentum is defined as follows below:

$$p_4 = m v_4 , \tag{1a}$$

where the velocity in the fifth dimension is given by:

$$v_4 = \frac{\dot{\gamma}}{\alpha_{\circ}} , \tag{1b}$$

and $\dot{\gamma}$ is a time derivative where gamma itself has units of mass density or kg/m^3, and $\alpha_{\circ}$ is a density gradient with units of kg/m^4. In the absence of curvature, (1) becomes:

$$\left[x^{\mu}, p^{\nu}\right]\Phi = i\,\hbar\,\delta^{\nu q}\,\Phi . \tag{2}$$

From (2) we see that the unit of action is the product of a multiple of Cronecker's δ_{μ} q function and the gauge function Φ. It can be also shown that if we use gauge field equations Ref:[6] then the gauge function Φ is of the form:

$$\Phi = \exp\left[\left[\frac{k(A+Bt)}{R}\right]\exp\left(-\frac{\lambda}{R}\right)\right]. \tag{3}$$

Assuming conservation of photon energy and expanding the exponentials and then comparing this expression with (11), we need then to evaluate the constants A, B, and k. Recalling that the emission time $t_e = 0$ and the received time $t_r = L/c$, the expression for the redshift reduces to the following: Ref[5]

$$z = \frac{\Delta\lambda}{\lambda_{\mathrm{e}}} = \exp\left\{-\left(\frac{G}{c^2}\right)\left[\frac{M_r e^{-\frac{\lambda_{ob}}{R_{ob}}}}{R_{ob}} - \frac{M_e e^{-\frac{\lambda_{em}}{R_{em}}}}{R_{em}}\right] + \left(\frac{HL}{c}\right)\frac{\left(\frac{M_{ob}}{R_{ob}}\right)}{\left(\frac{M_{\oplus}}{R_{\oplus}}\right)} e^{-\frac{\lambda_r}{R_r}}\right\} - 1, \tag{4}$$

where $\frac{M_{\oplus}}{R_{\oplus}}$ is the gravitational potential of the earth, $\frac{M_{ob}}{R_{ob}}$ is the reduced gravitational potential at the detection point, and $\frac{M_{em}}{R_{em}}$ is at the emission point of the radiation. Since $\lambda << R$, expression (4) can be simplified for the earth's surface (Es): Ref [5].

$$\ln[1+z_{Es}] = -\frac{G}{c^2}\left[\frac{M_{ob}}{R_{ob}} - \frac{M_{em}}{R_{em}}\right] + \left(\frac{HL}{c}\right), \tag{5}$$

and for orbiting Hubble telescope (ht) of a height h the following expression:

$$\ln[1+z_{ht}] = -\frac{G}{c^2}\left[\frac{M_{\oplus}}{(R_{\oplus}+h)} - \frac{M_{em}}{R_{em}}\right] + \left(\frac{HL}{c}\right)\left(\frac{R_{\oplus}}{R_{\oplus}+h}\right). \tag{6}$$

As a result of the analysis in Ref[5], we solve two equations with two unknowns, the gravitational potential GM/R and the cosmological distance L of the emitting object. These can be found from:

$$\frac{GM}{R} = c^2\left(1+\frac{R_{\oplus}}{h}\right)\left[\ln[1+z_{ht}] - \left(\frac{R_{\oplus}}{R_{\oplus}+h}\right)\ln[1+z_{Es}]\right] \tag{7}$$

and

$$L = \left(\frac{c}{H}\right)\left[\left(\ln[1+z_{Es}] - \ln[1+z_{ht}]\right)\left(1+\frac{R_{\oplus}}{h}\right) + \left(\frac{GM_{\oplus}}{c^2 R_{\oplus}}\right)\right]. \tag{8}$$

In this theory, the predicted redshifts are significantly different when measured on the surface of the Earth, or at a height of 450 km for example above the surface. In Einstein's theory of relativity, the redshift of an object may be written as follows:

$$z = -\frac{G}{c^2}\left[\frac{M_{ob}}{R_{ob}} - \frac{M_{em}}{R_{em}}\right], \quad (9$$

where the subscripts specify the emitter and observer gravitational potentials respectively. Since the redshift of an object at cosmological distance L is given by:

$$z = \frac{H}{c} L \, , \qquad (10)$$

then the total redshift will be given from: Ref[4]

$$z = -\frac{G}{c^2}\left[\frac{M_{ob}}{R_{ob}} - \frac{M_{em}}{R_{em}}\right] + \frac{H}{c} L \, , \qquad (11)$$

where H is Hubble's constant, c is the speed of light, and L the cosmological distance to the object. Any difference in the redshift will come from the difference between the gravitational potential at the surface of the earth and at some height above the surface. However, this difference will be small due to the small size of the earth compared with cosmological objects. Compared with the Sun, this effect would be of the order of 10^{-5}. In the case $z_{Es} \approx z_{ht}$ (7) and (8) simplify as follows:

$$\frac{GM_{em}}{R_{em}} = c^2 \ln\left[1 + z_{Es}\right] \, , \qquad (11a)$$

$$L = \frac{c}{H}\left[\frac{\mathrm{GM}_{\oplus}}{\mathrm{R}_{\oplus} c^2}\right] . \qquad (11b)$$

Let us now proceed by writing the two fudamental relations predicted by the DTG in terms of emitted λ_{em} and observed λ_{ob}. Since $z = \left(\frac{\lambda_{ob}}{\lambda_{em}}\right) - 1$ we obtain:

$$\frac{GM_{em}}{R_{em}} = c^2\left(1 + \frac{R_\oplus}{h}\right)\left[\ln\left(\frac{\lambda_{ht(ob)}}{\lambda_{em}}\right) - \left(\frac{R_\oplus}{R_\oplus + h}\right)\ln\left(\frac{\lambda_{Es(ob)}}{\lambda_{em}}\right)\right], \quad (12)$$

and

$$L = \left(\frac{c}{H}\right)\left[\ln\left[\frac{\lambda_{Es(ob)}}{\lambda_{ht(ob)}}\right]\left(1 + \frac{R_\oplus}{h}\right) + \frac{GM_\oplus}{R_\oplus c^2}\right]. \quad (13)$$

Solving (13) for the wavelength of the radiation as observed by the Hubble telescope we have:

$$\lambda_{ht(ob)} = \lambda_{Es(ob)} \exp\left[-\left(\frac{h}{R_\oplus + h}\right)\left[\frac{LH}{c} - \frac{GM_\oplus}{R_\oplus c^2}\right]\right]. \quad (14)$$

At the earth's surface the wavelength of the observed radiation has the value of:

$$\lambda_{Es(ob)} = \lambda_{ht(ob)} \exp\left[\left(\frac{h}{R_\oplus + h}\right)\left[\frac{LH}{c} - \frac{GM_\oplus}{R_\oplus c^2}\right]\right]. \quad (15)$$

Similarly, we can find identical expressions as described above for the quantities in terms of an orbital height h, cosmological redshift z, and Earth's gravitational potential at height h. Thus from (12) we have:

$$\lambda_{Es(ob)} = \left[\lambda_{ht(ob)}\right]^{\left(1+\frac{h}{R_\oplus}\right)}\left[\lambda_{em}\right]^{-\frac{h}{R_\oplus}} \exp\left[-\frac{GM_e}{R_e c^2}\left(\frac{h}{R_\oplus}\right)\right] \qquad (16)$$

and

$$\lambda_{ht(ob)} = \lambda_{em} \exp\left[\left(\frac{h}{h+R_\oplus}\right)\left[\frac{GM_{em}}{R_{em}c^2}\right] + \left(\frac{R_\oplus}{R_\oplus + h}\right)\ln\left(\frac{\lambda_{Es(ob)}}{\lambda_{em}}\right)\right]. \qquad (17)$$

Calculating the Redshift Expressions:

For all the expressions above, we now use: mass of the earth $M_\oplus = 5.97\times10^{24}$ kg, h=450 km, R_{ob} = 6.378×10^{6} m, and z_{tot} =4.4. This perticular redshift is associated with the X-ray source 4U0241+61 which has a mass M_{source} = 1.6×10^{8} M_{solar}. An object of such redshift will be at a distance: Ref[7]

$$d_{object} = 10^{10}\left[1 - (1+z)^{-1.5}\right] = 9.203\times10^{9} \text{ light years} \qquad (17a)$$

From (13) and (12) we obtain the following relationships for the wavelengths at the earth's surface and at the Hubble telescope:

$$\lambda_{ht(ob)} \cong 0.750\lambda_{\mathrm{Es(ob)}} \qquad (18)$$

$$\lambda_{Es(ob)} \cong 1.336\lambda_{ht(ob)} . \quad (19)$$

Next, we calculate the same wavelengths with a main contribution due to the quasar's gravitational potential as well as the emitted and observed wavelengths, radius of the earth, and height above of the earth's surface.

$$\lambda_{Es(ob)} \cong 0.999 \left[\lambda_{\text{ht(obs)}}\right]^{1.0705} \left[\lambda_{em}\right]^{-0.0705} \quad (20)$$

$$\lambda_{ht(ob)} \cong 4.832\, \lambda_{\text{em}} . \quad (21)$$

We see that (20) and (21) also contain the emitted wavelength since it appears in the analytical solution for λ_{ht} and λ_{Es}. Let us now choose the commonly occuring Lyman (L_α) line in quasar spectra, having an emitted wavelength λ_{em} = 1216 $\overset{\circ}{A}$. If the quasar's redshift z_{tot} = 4.4, then standard theory predicts that this line would be redshifted by a factor $(1+z_{tot})\,\lambda$ giving 6566 $\overset{\circ}{A}$: Ref[8] Next we find the following results:

$$\lambda_{Es(\mathrm{Re}\,l)_{obs}} = 6566\,\overset{\circ}{\mathrm{A}}$$

$$\lambda_{ht(obs)} = 4924\,\overset{\circ}{\mathrm{A}} \quad (23)$$

$$\lambda_{Es(Dyna)obs} = 6579\,\overset{\circ}{\mathrm{A}}$$

$$\%\text{difference of } \lambda_{\text{Es}} = 0.19\,\%$$

Next, using (22) we obtain:

$$\lambda_{Es(\mathrm{Re}l)_{obs}} = 6566\,\overset{\circ}{\mathrm{A}}$$
$$\lambda_{ht(obs)} = 5875\,\overset{\circ}{\mathrm{A}} \qquad (24)$$
$$\lambda_{Es(Dyna)_{obs}} = 6565\,\overset{\circ}{\mathrm{A}}$$
$$\%\ \text{difference}\ \lambda_{\mathrm{Es}} = -0.01\%$$

Calculation of the Dynamical Redshifts

Given the total redshift of the quasar $z_{tot} = 4.4$ we can obtain and solve the system of equations which DTG claims for the dynamical redshifts on the earth and at the height of the Hubble telescope. Using the distance to the quasar as given in (17a) and taking its mass to be $M_{X\text{—Ray Quasar}} = 1.6\times10^{8}\ M_{Solar\text{-}Masses} = 3.04\times10^{38}$ kg, we need to solve the system of the following equations:

$$\begin{aligned} &5.841\times10^{-4} - 15.173\left[\ln(1+z_{ht}) - 0.934\ln(1+z_{Es})\right] = 0 \\ &0.491 - \left[15.173\left[\ln(1+z_{Es}) - \ln(1+z_{ht})\right] + 6.937\times10^{-10}\right] = 0 \end{aligned} \qquad (25)$$

from which we obtain the percent change of redshift:

$$\begin{aligned} &z_{ht} = 0.583\% \\ &z_{Es} = 0.635\% \\ &\Delta z = 0.052\% \\ &z_{Es} = 1.089 z_{ht}\%, \end{aligned} \qquad (26)$$

If we take the value of $z_{ES} = 4.4$ we find that:

$$z_{Es} = 4.400\%$$
$$z_{ht} = 4.040\% \qquad (27)$$
$$\Delta z = 0.359\%$$

Dynamical Redshift Equations

If we now allow the potential due to the emitting body to change in general by a factor A, in the system of equations in (25) then we can write two solutions for $\mathrm{z_{ht}}$ and $\mathrm{z_{Es}}$ in the following form:

$$z_{Es} = 1.635\,\mathrm{e}^{\left[1.769\times10^{-5} A\right]} - 1$$
$$z_{ht} = 1.583\,\mathrm{e}^{\left[1.769\times10^{-5} A\right]} - 1 \qquad (28)$$

or in-terms of the emitted wavelength we have:

$$\lambda_{\mathrm{Es}} = 1.635\lambda_{\mathrm{em}} e^{1.769\times10^{-5} A}$$
$$\lambda_{ht} = 1.583\lambda_{em} e^{1.769\times10^{-5} A}. \qquad (29)$$

Simirarly, we can obtain the dynamical redshifts at the surface of the earth and at the height of the Hubble telescope if we allow for the cosmological redshift to change (smaller or larger) by a factor B. Thus we obtain:

$$z_{ht} = 1.000\, e^{0.459407 B} - 1$$
$$z_{Es} = 1.000\, \mathrm{e}^{0.491824\mathrm{B}} - 1 \qquad (30)$$

which in-terms of the emitted wavelength becomes:

$$\lambda_{ht} = 1.000\lambda_{\text{em}} e^{0.459407\,B}$$
$$\lambda_{\text{Es}} = 1.000\lambda_{\text{em}} e^{0.491824B}. \qquad (31)$$

To obtain a dynamical redshifts or dynamical wavelengths at the surface of the earth or at the Hubble telescope our constants A and B should in general have the following values:

$$A(z_{Es}) = 56529\ln[0.611(0.4z_{Es}+1)]$$

$$A(z_{ht}) = 56529\ln[0.631(z_{ht}+1)]$$

(31a)

$$A(\lambda_{\text{Es}}) = 56529\ln\left[\frac{0.611\lambda_{\text{Es}}}{\lambda_{\text{em}}}\right]$$

$$A(\lambda_{\text{ht}}) = 56529\ln\left[\frac{0.631\lambda_{\text{Es}}}{\lambda_{\text{em}}}\right]$$

also

$$B(z_{Es}) = 2.033\ln[0.999(z_{Es}+1)]$$

$$B(z_{ht}) = 2.033\ln[0.999(z_{ht}+1)]$$

(31b)

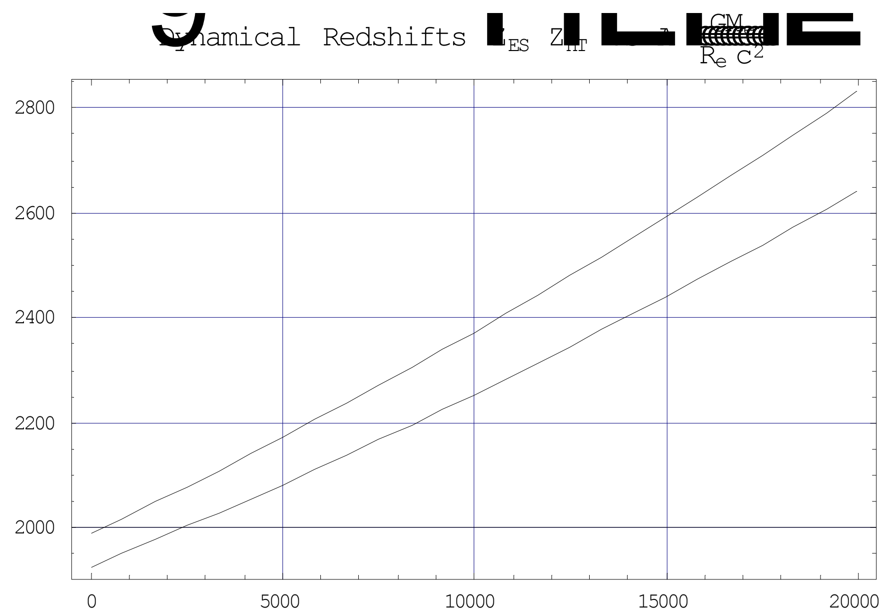
$$B(\lambda_{\text{Es}}) = 2.033\ln\left[\frac{0.999\lambda_{\text{Es}}}{\lambda_{\text{em}}}\right]$$

$$B(\lambda_{\text{ht}}) = 2.176\ln\left[\frac{0.999\lambda_{\text{ht}}}{\lambda_{\text{em}}}\right]$$

Plotting the Equations

To plot equations (28) and (29) we let A take some values below and above relative to $z_{gravitational}(quasar) = \dfrac{GM_e}{R_e c^2}$ and we obtain the following graphs in Figure 1 and 2

z_{Es}, z_{ht}



A (G M_e/ R_e c^2)

Figure:1 Plots of Dynamical Redshifts at the Earth's Surface and at Hubble Telescope versus Quasars's Gravitational Redshift Factor.

$\lambda_{Es}, \lambda_{ht}$

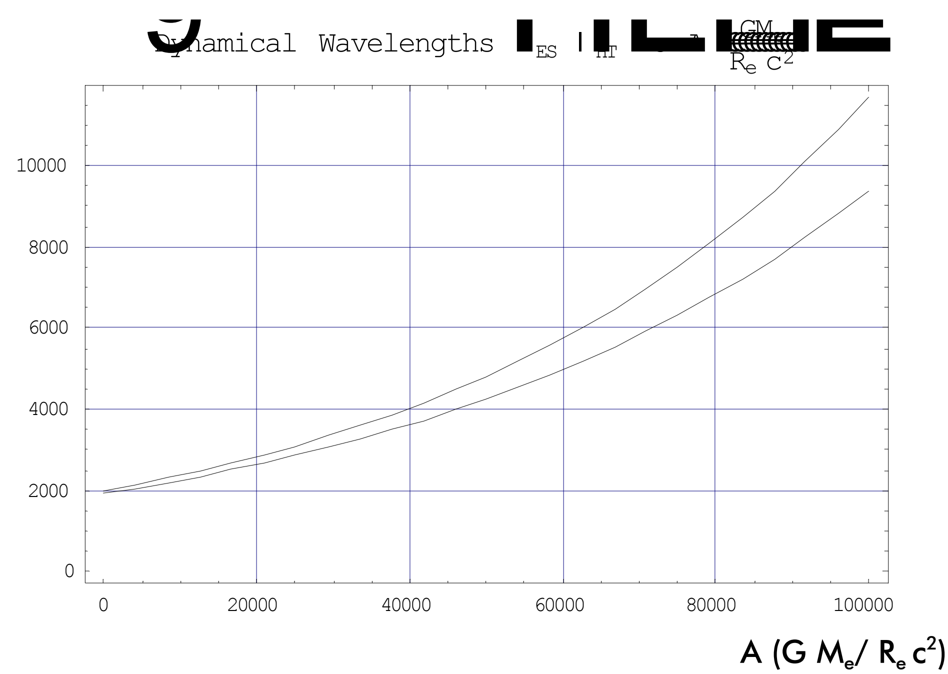


Figure:2 Plots of Dynamical Wavelengths at the Earth's Surface and at Hubble Telescope versus Quasars's Gravitational Redshift Factor.

Similarly for the equations (30) and (31) containing B we obtain two graphs in figures 3 and 4:

z_{Es}, z_{ht}

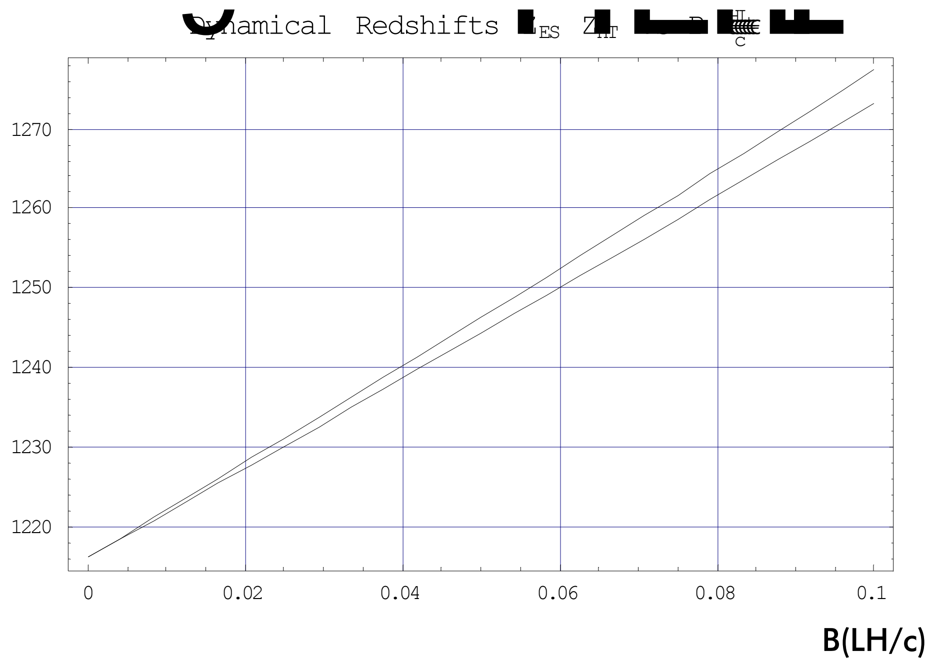


Fig:3 Plot of Dynamical Redshifts at Earths Surface and Hubble versus Cosmological Redshift Factor.

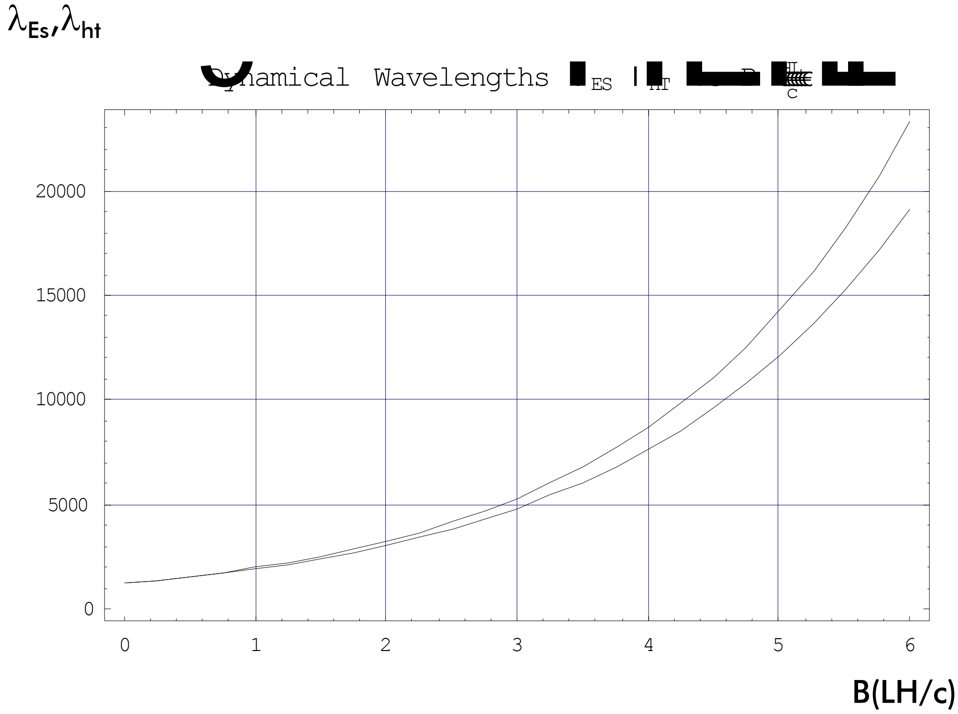


Fig: 4 Plots of Dynamical Wavelengths at the Earth's Surface and at Hubble Telescope versus Quasars's Gravitational Redshift Factor.

Conclusions:

In this paper, we have highlighted a few aspects of the dynamic theory of gravity. Analytical expressions were obtained for the observed wavelengths on the earth's surface and for an orbital height h given the gravitational potential, the cosmological distance, and the redshift factor. Finally, all these expressions for the wavelengths on the earth's surface, as well as at the height of the Hubble telescope, were calculated for a particular quasistellar object of mass $M_{X\text{-ray(source)}} = 1.6\times10^{8}\, M_{\text{solar masses}}$ and radius R = 80 pc.

We see that, in the dynamic theory of gravity those equations which describe the values of the wavelength-change at the earth's surface, and at the height of the Hubble telescope, produce changes relative to the original wavelength. For the observer, the light emitted from the quasar on the earth will be slightly redder in this theory than in the relativistic one. The same wavelengths will also be redder w.r.t the Hubble telescope observed wavelength. There is a 0.19 % percentage difference between the DTG and the total relativistic prediction at height h above the surface of the earth, when the total redshift is the sum of relativistic and cosmological. It seems that at the Hubble height the wavelength observed will be 1.336 times less than that from DTG on the earth's surface.

When the observed wavelength at the surface of the earth and at Hubble are given interms of the gravitational potential of the quasar, and at a height h above the earth, as well as the relativistically observed wavelength on the earth's surface and the emitted wavelengths, then there is a –0.01% percentage difference between the total relativistic redshift and that which DTG predicts. The observed wavelength at Hubble wavelength is also 1.117 times less than that observed at the surface of the earth.

Next, solving the system of two equations in two unknowns for the same quasar, the percent changes of the redshifts at the earth's surface and at Hubble were calculated, and from there the actual z values. A percentage difference of

–8.18% was found, and also a $\Delta z = 0.359$ between the two values of z_{ES} and z_{HT}.

Finally, general solutions of z's and λ's were obtained in-terms of A and B being some multiple or submultiple values of gravitational and cosmological redshift, and then plotted. For very large values of A and B, the DTG redshifts and wavelengths seem to diverge, whereas at small values of A and B, they both follow a linear behaviour that seems to converge to each-other at A = 0 and

B =0. This could mean that there is no distinction between DTG and relativistic gravitational effects when A and B are very small. The effects become distinct at larger values of A and B as shown by the graphs. Here it may be resonable to assume that objects of large redshift and potential might be canditates in detecting DTG effects.

References

[1] P. E. Williams, " On a Possible Formulation of Particle Dynamics in Terms of Thermodynamic Conceptualizations and the Role of Entropy in it." Thesis U.S. Naval Postgraduate School, 1976.

[2] P.E. Williams, "The Principles of the Dynamic Theory" Research Report EW-77-4, U.S. Naval Academy, 1977.

[3] P. E. Williams, "The Dynamic Theory: A New View of Space, Time, and Matter", Los Alamos Scientific Laboratory report LA-8370-MS, Feb 1980.

[4] P. E. Williams, " Quantum Measurement, Gravitation, and Locality in the Dynamic Theory", Symposium on Causality and Locality in Modern Physics

and Astronomy: Open Questions and Possible Solutions, York University, North York, Canada, August 25-29, 1997.

[5] P. E. Williams, Using the Hubble Telescope to Determine the Split of a Cosmological Object's Redshift into its Gravitational and Distance Parts, Apeiron, Vol. 8, No. 2, April 2001.

[6] P. E. Williams, The Dynamic Theory: A New View of Space-Time –Matter, 1993, http:// www.nmt.edu/~pharis/

[7] Science Journal, Summer 2000, Vol:17, No.1, p: 3
http:// www.science.psu.edu / journal / sum2000 / DistObj.html

[8] P. J. E. Peebles, Principles of Physical Cosmology, Princeton University Press, 1993, p: 548

[9] P. E.Williams, Mechanical Entropy and Its Implications, Entropy, 2001, 3, 76-115/ www.mdpi.org/entropy/

Journal Home Page