A creationist cosmology in a galactocentric universe

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The observations that place the earth near the centre of the universe are consistent with God's focus on mankind. The Bible implies that there are a finite number of stars, which suggests that the universe is finite.[1] A creationist cosmology requires a finite universe that is most likely spherically symmetric about our galaxy. This would then create a spherically-symmetric gravitational potential, which in turn determines what type of redshifts we should see. Three models—and their consistency with a creationist cosmology—are investigated: Humphreys', Gentry's and Carmeli's. In these models the resulting gravitational redshifts are much smaller than the observed Hubble-Law redshifts. Therefore, it is concluded that the former will always be masked by the latter. Also, the two types of redshift, caused by gravitation and cosmological expansion, are independent and can be described by a product of the ratio of the wavelengths. This fact will aid in building a creationist cosmology.

Any creationist cosmology must be able to explain the observed redshifts in a universe that is most likely centred on our galaxy. Because mankind is the focus of God's attention, the universe was specially created by God. It is a reasonable assumption that He placed us in the centre of His universe so we would see how great He is. That is, we are likely very near the centre of the universe filled with billions of galaxies with billions of stars in each. This is what Edwin Hubble concluded; his observations of the galaxies' redshifts indicated to him that we are at the centre of a symmetric matter distribution. But Hubble rejected his own conclusion—that we are in a very special place—on philosophical grounds.[2] And Hubble wasn't alone in realizing this situation:

> '"People need to be aware that there is a range of models that could explain the observations," Ellis argues. "For instance, I can construct you a spherically symmetrical universe with Earth at its center, and you cannot disprove it based on observations." Ellis has published a paper on this. "You can only exclude it on philosophical grounds. In my view there is absolutely nothing wrong in that. What I want to bring into the open is the fact that we are using philosophical criteria in choosing our models. A lot of cosmology tries to hide that."'[3]

Given the focus of God on us, it is a reasonable assumption that the universe is finite (though extremely large) and bounded. As the psalmist said:

> 'He determines *the number* of the stars and calls them *each by name*' (Psalms 147:4) [emphasis added].

And as God told Abraham:

> 'I will surely bless you and make your descendants as numerous as the stars in the sky and *as the sand on the seashore*' (Genesis 22:17) [emphasis added].

Though I can't prove it from the Bible, it is a reasonable assumption that, like the grains of the sand by the seashore, the number of stars is unimaginably large but still finite. Therefore, it follows that the universe is also bounded.

Those who reject the Lord have tried to get around this with the Cosmological Principle, which says that there is nothing special about our location and, more importantly, that the universe has no centre and no edge. The 'no centre and no edge' idea provides for an easy solution for Einstein's field equations for the cosmos. This is how Friedmann, in 1922, and Lemaître, in 1927, reasoned. But the evidence clearly indicates otherwise, that we are in a privileged location in the universe. I contend that the evidence is consistent with God's Word and we are part of a special creation.[4]

In this paper, I will review the consequences of the above assumption, from the perspective of a finite, bounded matter-distribution, centred on our galaxy. This view radically changes the boundary conditions that we need to apply to our mathematical models; it also raises questions, such as, 'What sort of redshift would we see in such a universe?', which I will attempt to answer.

A spherical distribution of matter of finite extent (a ball of dust) will have a special point towards which there is a net gravitational force. That is the centre of the ball if it is evenly spread out in all directions (i.e. isotropic). This point can be likened to the centre of a depression inside a circular ring of hills. The gravitational potential—the energy stored in the gravitational field—then becomes a significant concept. In the Friedmann–Lemaître (FL) models based on the Cosmological Principle, this energy is not considered to produce any special effects. In FL models, by definition, over the largest scales, there can be no gravitational potential differences from place to place.

In this paper the gravitational potentials in three cosmologies are analyzed and their resulting redshifts compared. All three models consider a universe made up of an isotropic, but not necessarily homogeneous, distribution of matter centred on our galaxy. These models are:

A. the white-hole cosmology[5] of Russ Humphreys,
B. the new redshift interpretation[6] of Robert Gentry, and
C. the cosmological general relativity of Moshe Carmeli.[7]

The Carmeli model makes assumptions only about the visible universe and constructs a metric based on that. Both Humphreys and Gentry assume that the universe is finite and that we, the observers, are actually physically near its centre.

Expanding universe

The standard FL big bang solutions of Einstein's field equations use the Riemannian geometry of the Robertson–Walker (RW) metric:

$$ds^2 = c^2dt^2 - S^2(t)\left[\frac{dr^2}{1-kr^2} + r^2(d\theta^2 + \sin^2\theta\, d\phi^2)\right] \quad (1)$$

where (r,θ,ϕ) are the co-moving coordinates of the extragalactic source and t is the cosmic time as measured by a co-moving clock. S is a monotonically-increasing function describing the scale size in the universe. From this comes the usual assumption of the expanding universe. In the FLRW cosmologies, hypersurfaces of constant t are homogeneous and isotropic with constant curvature k = -1, 0, +1 for negative, zero or positive spatial curvature, respectively. The redshift of a galaxy is given by:

$$1+z = \frac{S(t_0)}{S(t)} \quad (2)$$

where z is the redshift of the light from the galaxy, t is the epoch when the light left the galaxy, and t_0 is the epoch when it is observed. Because measured redshifts (z) increase with distance and hence time in the past, the values of $S(t) < S(t_0)$ for $t < t_0$, and the universe is said to be expanding. But this is an interpretation based on the source of the redshift and the assumed cosmological model. By definition $S(t_0) = 1$ and t_0 is the current epoch.

Hubble's Law

The Hubble 'constant' is calculated from:

$$H_0 = \frac{\dot{S}(t_0)}{S(t_0)} = \dot{S}(t_0) \quad (3)$$

where the dot denotes the time derivative. Note: H is subscripted H_0 because it is evaluated at the current epoch t_0. The Hubble Law then takes the form:

$$v = H_0 r \Rightarrow \frac{v}{c} = z = \frac{H_0}{c} r \quad (4)$$

where v is the recession velocity and r the radial proper distance to the galaxy. For $v << c$ (the speed of light), the redshift is easily obtained.[8] The constant c/H_0 then is a scale factor of the universe called the Hubble Distance.

A: Humphreys' model

Since we are dealing with matter of very low density distributed through all observable space, the gravitational potential-energy function can be written in the Newtonian form with little error. The Humphreys model, based on the Klein metric, suggests some unusual features for the early dense universe, but those features do not affect this analysis. What is relevant is that his signature change surface reached Earth well before most of the light we see in the current visible universe left its sources. According to the figure 2b of 'New Vistas',[9] the earth leaves the 'timeless region' when the expansion factor $1/(1+z)$ reaches about 0.29. For the parameters chosen by Humphreys, this is at a redshift resulting from expansion $z \approx 2.4$. This means the light that left a galaxy with $z < 2.4$ is not subject to any timeless zone effects. In the following we will consider only this region, which is most of the visible universe.

In any 3-dimensional, finite, spherically-symmetric volume bounded by radius $r = R$, the gravitational potential-energy function (Φ) may be written as:

$$\Phi(r) = -\frac{3}{2}\frac{GM}{R}\left(1 - \frac{1}{3}\frac{r^2}{R^2}\right), \quad \text{for } r \leq R \quad (5a)$$

$$\Phi(r) = -\frac{GM}{r}, \quad \text{for } r > R \quad (5b)$$

where R is the radius of the finite matter distribution, M

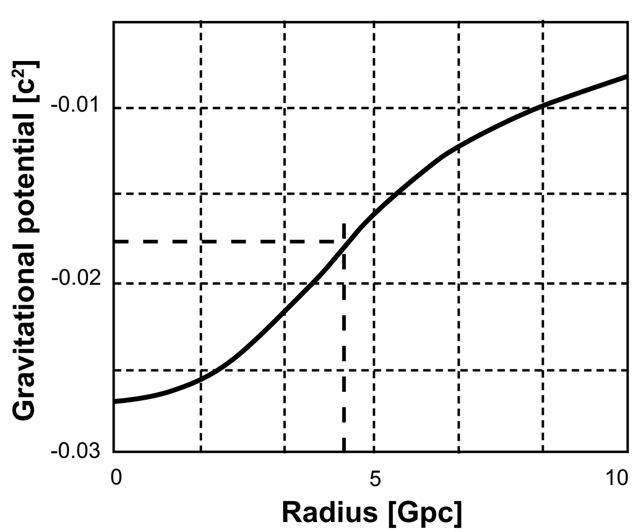


Figure 1. *Gravitational potential function due to Humphreys as a function of radius or distance in Gpc. The broken lines indicate the limit of the region inside the matter distribution. Outside is empty space. The demarcation is a thin shell of water.*

is the total mass/energy of the universe contained within the volume, and G is the universal gravitational constant. The parameter Φ then describes a *potential well* for the usual values given. See fig. 1.

Considering the finite sphere of matter, the gravitational redshift of light seen by an observer (# 2) at the centre of the distribution resulting from a source (# 1) located at radius r from the observer is given by:

$$1 + z_{grav} = \sqrt{\frac{g_{00}\ (\#2)}{g_{00}\ (\#1)}} \qquad (6)$$

where g_{00} is the 00th component of the metric tensor, and may be expressed by $g_{00} = 1 + 2\Phi/c^2$, where the potential Φ is a function only of r.[10] In each model in this paper, we will examine the form of the gravitational redshift. In this case it may be approximated as:

$$1 + z_{grav} = \sqrt{\frac{1 + \frac{2\Phi\ (\#2)}{c^2}}{1 + \frac{2\Phi\ (\#1)}{c^2}}} \qquad (7)$$

This model assumes a potential-energy function exactly like (5a) with all matter contained within the sphere bounded by a shell of water. Humphreys' boundary conditions require that the potential-energy function goes to zero at r = ∞ and a negative constant at $r = 0$. From the form of his metric, considering co-moving source and observer, we can write:

$$z_{grav} = \sqrt{\frac{1 + \frac{2\Phi\ (r=0)}{c^2}}{1 + \frac{2\Phi\ (r)}{c^2}}} - 1 \qquad (8)$$

for $r = 0$ from (5a), $\Phi(0) = -\frac{3GM}{2R}$ which is constant. Therefore:

$$z_{grav} \approx \frac{\sqrt{1 - \frac{3GM}{c^2 R}}}{\sqrt{1 + \frac{2\Phi\ (r)}{c^2}}} - 1 \approx \frac{0.972}{\sqrt{1 + \frac{2\Phi\ (r)}{c^2}}} - 1 \qquad (9)$$

for $R = 4.5$ Gpc,[11] and an average mass/energy density $\rho_m = 3 \times 10^{-28}$ kg m^{-3}, which is a figure commonly cited.[12] This results in a universe of mass $M \sim 3.4 \times 10^{51}$ kg. If we assume that the average mass of a galaxy is 10^{41} kg then there would be 3.4×10^{10} galaxies in the universe, which is consistent with the number of galaxies observed.

Because the expression on the bottom of (9) is always larger than that on the top (i.e. at any radius the potential is always less negative than at the centre), the value of the gravitational 'redshift' is negative. This means, in fact, that the light is blueshifted.[13] So if we consider the current state of the universe, light from all galaxies should be blueshifted. From the edge of the universe, for the chosen value of R, $z_{grav} \sim -0.009$ (blueshift). Photons travelling down the potential well, as shown in fig. 1,[14] would always gain energy and hence be blueshifted. See curve 1 in fig. 4.

B: Gentry

The Gentry model[6] does not have this blueshift problem[13] as his model has a slightly different form of the potential function. The model assumes a potential-energy function like (5a) with all matter contained within the sphere bounded by a thin outer shell of hot hydrogen at a distance R. But in this case (5a) is modified by the addition of a term

$$-\frac{GM_S}{R}$$

and becomes:

$$\Phi(r) = -\frac{GM_I}{R} - \frac{GM_S}{R}, \text{ for } r \le R \qquad (10)$$

where M_I represents the mass/energy internal to the shell and M_S is the mass of the shell. M_S is related to M_I by:

$$M_S = -\frac{3}{2} M_I \qquad (11)$$

The first term in (10) is the same as (5a) and may be written in terms of densities:

$$-\frac{GM_I}{R} = -\frac{2\pi G}{3}\left(3R^2 - r^2\right)\{\rho_m - 2\rho_v\}, \text{ for } r \le R \qquad (12)$$

where Gentry has applied a different expression for the mass/energy density (in the curly brackets). Here ρ_m is

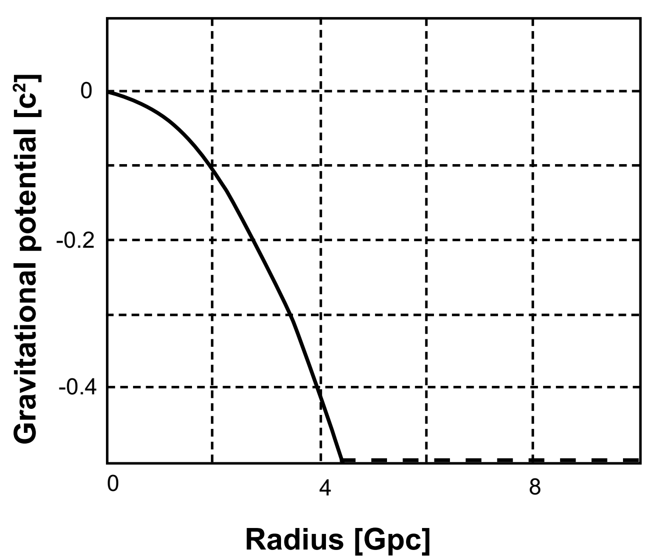


Figure 2. *Gravitational potential function due to Gentry as a function of radius or distance in Gpc. The solid line is the limit of the region inside the shell of hot hydrogen. I have extended the line (broken) to indicate that the potential function tapers off according to what Gentry says in words in his paper.*

the average density of normal baryonic matter and ρ_v is the vacuum energy density of the universe excluding the shell (M_S). The pressure $p_v = -\rho_v$, and this provides a type of cosmological constant term pushing out on the galaxies. Standard hot big-bang inflationary cosmologies with a cosmological constant also have an expansion term.[15] The vacuum pressure contribution to vacuum gravity is $-2\rho_v$, therefore the term $\rho_m - 2\rho_v$ appears in the expression for the mass in the region within the shell. Since always $\rho_v > \rho_m$, the density term $\rho_m - 2\rho_v$ is negative, but also larger in magnitude than the normal matter density ρ_m. As a result, M_1 is effectively a negative mass and is given by:

$$M_1 = \frac{4\pi}{3} R^3 (\rho_m - 2\rho_v) \tag{13}$$

It is this vacuum density parameter that changes the sign of the potential-energy function (compared with (5a)), thus M_1 is negative instead of positive. As a result, Gentry's gravitational potential-energy function does not describe a potential well but a *potential hill*, and is given by:

$$\Phi(r) = \frac{2\pi G r^2}{3} (\rho_m - 2\rho_v), \text{ for } r \le R \tag{14}$$

Gentry's model (see fig. 2) also has quite different boundary conditions to that of Humphreys. Gentry chooses $\Phi(0) = 0$. Therefore $\Phi(r)$ is zero at $r = 0$ and elsewhere is always negative. From this expression and the curve in fig. 2 we can see that photons from distant stars have to climb the potential hill and, as a result, would always be redshifted.

Gentry also adds relativistic Doppler terms, particularly a Doppler component from a rotating cosmos, and outward radial motion for the galaxies in a flat universe. However, let's consider just the gravitational redshift component. In this model, using (14) and the boundary condition at $r = 0$, (8) becomes:

$$z_{grav} = \frac{1}{\sqrt{1+\frac{2\Phi(r)}{c^2}}} - 1 = \frac{1}{\sqrt{1+\frac{4\pi G r^2 (\rho_m - 2\rho_v)}{3c^2}}} - 1 \tag{15}$$

Because $4\pi r^3 (\rho_m - 2\rho_v)/3$ represents the enclosed negative mass at any radius r, and hence the expression on the bottom line is always less than unity, the gravitational redshift is always positive and hence truly red. (See curve 2 in fig. 4.) As the potential goes to zero the gravitational redshift also goes to zero. This is a result of the boundary conditions.

From (11) and (13) the mass of the shell may be calculated for the values of $\rho_m = 10^{-28}$ kg m^{-3}, $\rho_v = 8.8 \times 10^{-27}$ kg m^{-3} chosen by Gentry to satisfy his conditions of the CMB[16] temperature. The total mass of the shell comes to $M_S = 2.5 \times 10^{53}$ kg contained outside a radius of $R = 14.24$ billion light-years, or approximately 4.368 Gpc. This is more than the maximum estimated mass of the universe with 10^{11} galaxies of 10^{41} kg each. We can calculate the shell density (ρ_S) made of normal matter (hot hydrogen) as a function of thickness of the shell (a) from:

$$\rho_S = \frac{\rho_m - 2\rho_v}{\left(\frac{R+a}{R}\right)^3 - 1} \tag{16}$$

From this we can see that, with a density of $\rho_S = 10^{-28}$ kg m^{-3}, the thickness $a \approx 20$ Gpc, which is hardly thin. For $\rho_S = 10^{-18}$ kg m^{-3}, 10 orders of magnitude denser, the thickness becomes $a \approx 25$ pc, so it could be considered thin compared to the rest of the universe. But the density is comparable to a normal galaxy, so it would be a hot, glowing source in every direction in the sky, which is not observed. It would give rise to another paradox, similar to the well-known Olber's paradox.[17,18]

Gentry's model also has a Doppler term and hence the total redshift becomes:

$$z = \frac{1 + v_r/c}{\sqrt{1 + \frac{4\pi G r^2 (\rho_m - 2\rho_v)}{3c^2} - \frac{v^2}{c^2}}} - 1 \tag{17}$$

where v_r is the outward radial speed of a galaxy being observed, which is interpreted as Hubble expansion due to the enclosed negative mass within the volume interior to the galaxy's position. For small z (hence r) (17) becomes $v_r = z.c = H.r$ with:

$$H = \sqrt{4\pi G (2\rho_v - \rho)/3} \tag{17a}$$

The model also adds a small tangential velocity (v_θ—not shown in (17)) such that:

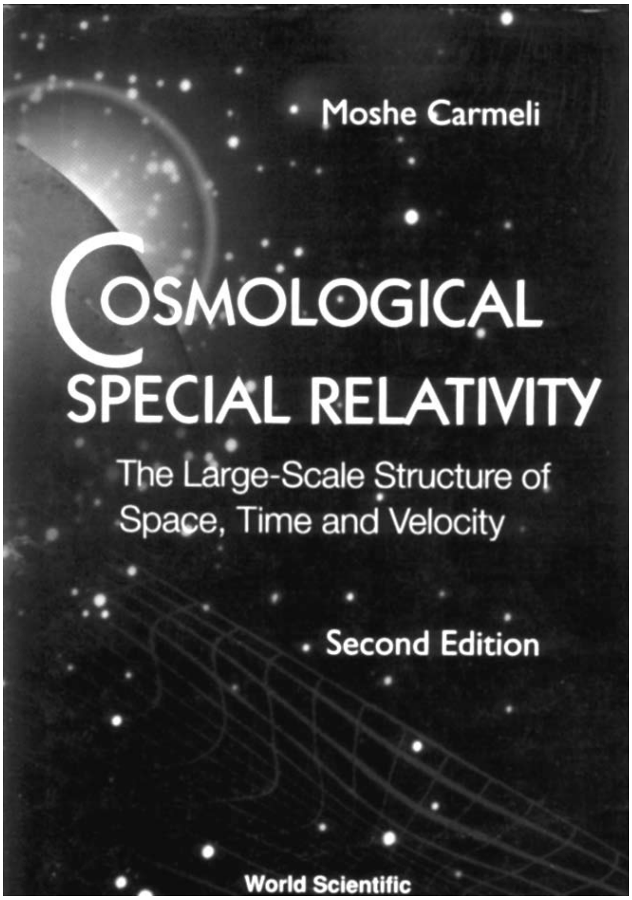
$$v^2/c^2 = (v_r^2 + v_\theta^2)/c^2 \tag{17b}$$

Thus, the observed redshift will rise rapidly as a function of distance and also as the velocity (v) becomes comparable to the speed of light. Also the mass term in the denominator of (17) approaches –1 as the radial distance r approaches 4.368 Gpc. From these two facts, Gentry predicts that galaxies with redshifts of order 10 will be observed.[19]

C: Carmeli

The metric used by Carmeli is unique in that it extends the number of dimensions of the universe by either one dimension (if we consider only radial velocity of the galaxies in the Hubble flow) or by three (if we consider all three velocity components). We will confine the discussion here to only one extra dimension, as does Carmeli.

The motivation for the development of the new theory, *cosmological special relativity* (CSR) comes from an analogue to special relativity. In special relativity the speed of light (c) is a universal constant. In CSR the universal



constant is the parameter τ—a time constant. Carmeli recognized that the Hubble Law (4), an experimentally determined law, valid for the brightest cluster galaxies in the cosmos, is not an expression relating the time derivative of the spatial coordinate distance r of the galaxy. Instead, it is more like an equation of state, as is the Ideal Gas Law (PV = nRT) in thermodynamics. That is, in (4) $v \neq dr/dt$. As a result, the velocity in the Hubble expansion is truly an independent coordinate that extends the 4D metric of general relativity to one of 5D. The Hubble Law is assumed as a fundamental axiom of the universe and the galaxies are distributed accordingly.

The line element in five dimensions becomes:

$$ds^2 = \left(1+\frac{\Phi}{c^2}\right)c^2dt^2 - dr^2 + \left(1+\frac{\Psi}{\tau^2}\right)\tau^2 dv^2 \qquad (18)$$

where $dr^2 = (dx^1)^2 + (dx^2)^2 + (dx^3)^2$ and Φ and Ψ potential functions are to be determined. The time t is measured in the observer's frame. The new dimension (v) is the radial velocity of the galaxies in the expanding universe, in accordance with Hubble flow. The parameter τ is a constant at any epoch and its reciprocal h is approximately the Hubble constant H_0.

The line element represents a spherically-symmetric universe. The expansion is observed at a definite time and thus $dt = 0$. Taking into account $d\theta = d\phi = 0$ (isotropy condition), (18) becomes:

$$-dr^2 + \left(1+\Psi/\tau^2\right)\tau^2 dv^2 = 0 \qquad (19)$$

By putting the potential $\Psi = 0$ in (19) and making the substitutions $\tau \to c$ and $v \to t$, we recover the line element of special relativity, involving the Minkowski metric. This relationship motivated Carmeli's construction of the new phase–space equation (19) describing the *space-velocity* structure of the universe as we see it now.

This solution to (19) (given by equation B.38 and solved in section B.10 in ref. 7) is reproduced here:

$$\frac{dr}{dv} = \tau\sqrt{1+(1-\Omega_m)\frac{r^2}{c^2\tau^2}} \qquad (20)$$

where τ (= $1/h$) is the Hubble time constant of the universe. The parameter Ω_m is the mass/energy density of the universe expressed as a fraction of the critical, or 'closure', density, which in this model is:

$$\rho_c = \frac{3}{8\pi G\tau^2} \sim 10^{-26}\ \mathrm{kg\ m^{-3}}$$

i.e. $\Omega_m = \rho_m/\rho_c$ where ρ_m is the averaged baryonic mass/energy density of the universe. It is important to note that Ω_m is not the same as that used in standard big bang FL cosmologies.

Carmeli constructed the energy–momentum tensor in Einstein's field equations; with the usual definitions, as follows:

$$G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = \kappa T_{\mu\nu} \qquad (21)$$

such that the speed of light (c) is replaced with the Hubble time constant (τ), hence $\kappa = 8\pi k/\tau^4$ (in general relativity κ

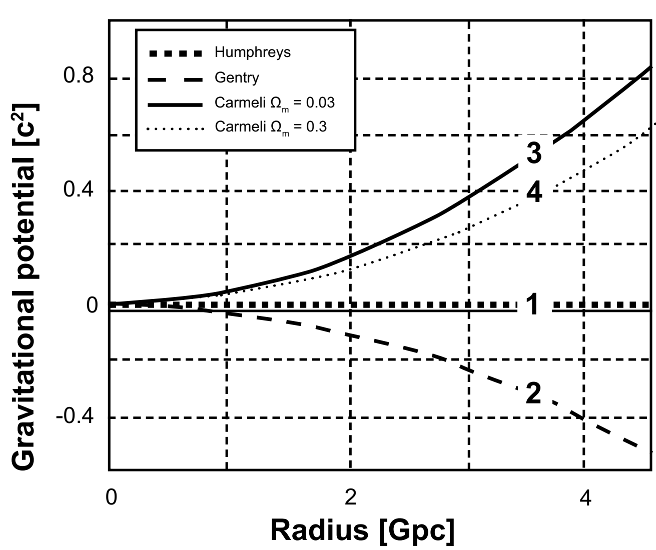


***Figure 3.** Gravitational potential functions of three models as a function of radius or distance in Gpc. Curve 1 is due to Humphreys, curve 2 due to Gentry and curve 3 and 4 are due to Carmeli.*

is given by $8\pi G/c^4$) where $k = G\tau^2/c^2$. However, because the universe is filled with matter it never has zero density; he therefore assigns $T_0^0 = \rho_{eff} = \rho_m - \rho_c$ in units of $c = 1$. Accordingly, $T^{\mu\nu} = \rho_{eff} u^\mu u^\nu$ where $u^\mu = dx^\mu/ds$ is a four-velocity.[20] The result is that we can view the universe, in *space-velocity*, or phase space as being stress free when the matter density of the universe is equal to the critical density. That is, $\rho_{eff} = 0$.

Now (20) may be integrated exactly to get:

$$r(v) = \frac{c\tau}{\sqrt{\Omega_m - 1}} \sin\left(\frac{v}{c}\sqrt{\Omega_m - 1}\right) \quad \text{for } \Omega_m > 1 \qquad (22a)$$

and

$$r(v) = \frac{c\tau}{\sqrt{1-\Omega_m}} \sinh\left(\frac{v}{c}\sqrt{1-\Omega_m}\right) \quad \text{for } \Omega_m < 1 \qquad (22b)$$

Because of the identity $\sinh(ix) = i\sin(x)$, these equations can be grouped into one:

$$r(v) = \frac{c\tau}{\sqrt{1-\Omega_m}} \sinh\left(\frac{v}{c}\sqrt{1-\Omega_m}\right) \ \forall\ \Omega_m \qquad (22c)$$

Carmeli expands (22c) in the limit of small $z = v/c$[21] and small Ω_m. It becomes:

$$r(v) = \tau\, v\left\{1 + (1-\Omega_m)\frac{v^2}{6c^2}\right\} \Rightarrow \frac{r}{c\tau} = z\left\{1 + (1-\Omega_m)\frac{z^2}{6}\right\} \qquad (23)$$

where $\Omega_m < 1$, which reproduces the Hubble Law for small z, i.e. $v = H_0 r$ with $1/\tau \approx H_0$.

With this model, Carmeli was able to successfully predict an *accelerating* expanding universe,[22] two years before it was measured from high-z supernova redshift observations in 1997–1998.[23-25]

Equations (22a, b) describe a tri-phase expansion. Firstly (22a) describes a decelerating expansion, when $\Omega_m > 1$ but decreasing in value.

When $\Omega_m = 1$, the expansion experiences a momentary coasting stage followed by an accelerating expansion described by (22b) when $\Omega_m < 1$ and decreasing in value.

From (23) we get:

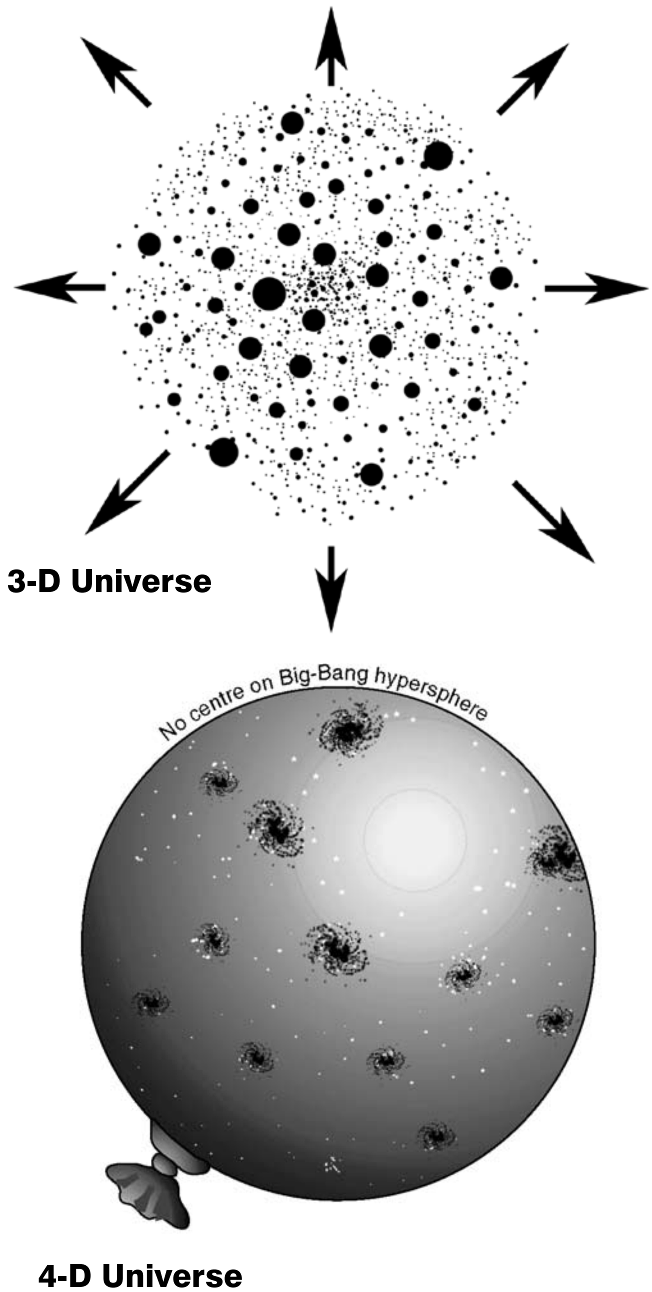
$$H_0 = h[1 - (1-\Omega_m)\frac{z^2}{6}] \qquad (24)$$

where $h = \tau^{-1}$. The further the distance, the lower the value of H_0, which can only result when $\Omega_m < 1$. WMAP data gives a figure of $H_0 = 72\ (^{+4}/_{-3})$ km s^{-1} Mpc^{-1}. Assuming $H_0 = 72$ km s^{-1} Mpc^{-1}, it follows from (24) that $h = 80$ km s^{-1} Mpc^{-1}. Equation (24) indicates that H_0 is distance-dependent—a result which has been confirmed by observations.[26,27]

Let us now consider the gravitational redshift in such a universe where the potential Φ resulting from the solution of (18) is given by:

$$\Phi = \frac{(1-\Omega)}{\tau^2} r^2 - \frac{2GM(r)}{r} \qquad (25)$$

and $M(r)$ is a function of distance (r). Carmeli assumes a potential such that it goes to zero at the origin, as does Gentry with the mass function $M(r)$ (representing the enclosed mass out to a radius r). See curve 3 in fig. 3. Quite clearly this also is a *potential well*. If we assume the same mass distribution as in (5a) for a finite, bounded universe, we get a potential well with negative potential at the origin, but the shape remains the same as that of curve 3. This is



A 3-D spherical ball of space and matter has a centre and thus a net gravitational force. However in the big bang model, the matter of our universe is thought to be spread over the surface of a 4-dimensional or higher dimensional space (pictured as a 3-D balloon with 2-D galaxies on its surface). A 3-D universe, spread over a 4-D space, has no centre in the known 3-dimensions, and thus no net gravitational force.

consistent with claims that the origin of the potential-energy function is arbitrary.

In addition, I have plotted the Carmeli potential-energy function for $\Omega_m = 0.03$ (curve 3 in fig. 3) (corresponding to the measured average baryonic mass/energy density), and also for $\Omega_m = 0.3$ (curve 4 in fig. 3)—corresponding to a universe dominated by so-called dark matter; Carmeli assumes a universe of this type, though in his book he uses $\Omega_m = 0.245$. In both cases, the potential well is much deeper than that of Humphreys (curve 1 in fig. 3), which, on the same scale, is hardly visible. Gentry's potential hill is clearly seen on the same graph (curve 2 in fig. 3). The magnitude is the result of the assumed much larger vacuum energy density.

As before, # 2 is the observer, and so $r = 0$. With (5a), and appropriate boundary conditions such that $\Phi(0) = 0$, from (25), it follows that the gravitational redshift in Carmeli's model is given by:[28]

$$z_{grav} = \left(1 + \frac{1-\Omega_m}{c^2\tau^2} r^2 - \frac{2GM(r)}{c^2 r}\right)^{-1/2} - 1 \qquad (26)$$

Notice that in the limit of $\Omega_m = 1$ we recover the usual gravitational redshift relation found in flat space. Also we recover it locally because the non-standard term (with $1-\Omega_m$) is zero for small r. For calculations with this model I assumed an averaged mass/energy density of $\rho_m = 3 \times 10^{-28}$ kg m^{-3} out to 4.5 Gpc, and $\tau = 3.8 \times 10^{17}$ s, which is equivalent to $h = 80$ km s^{-1} Mpc^{-1}.

Discussion on redshifts

The first consequence of the creationist assumptions about the universe as outlined above is that there would be a non-zero gravitational potential, and since we know that gravity affects light, redshifts will occur where photons try to escape from that potential.

Fig. 4 shows curves for the gravitational redshift that results in the various models compared here, and for the redshift resulting from the Hubble Law for redshifts $z < 0.5$ (curve 4) (where $H_0 = 72$ km s^{-1} Mpc^{-1}—the latest value from WMAP data[29]—has been used for the Hubble constant). Curve 1 is the gravitational redshift (z_{grav}) in Humphreys' model calculated with an averaged mass/energy density in the universe of $\rho_m = 3 \times 10^{-28}$ kg m^{-3} and a radius to the edge of the universe of $R = 4.5$ Gpc. Curve 2 is z_{grav} in Gentry's model with the densities Gentry assumed in his paper[6] and the edge of his shell at $R = 4.368$ Gpc. Curve 3 is z_{grav} in Carmeli's model with $\Omega_m = 0.03$.[30] The same value of averaged mass/energy density (ρ_m) as in Humphreys' case was assumed and the universe was assumed to have a radius of $R = 4.5$ Gpc.

What is immediately apparent is that the effect is smallest in the Humphreys model (curve 1 in fig. 4). However, in both Humphreys' (curve 1) and Carmeli's (curve 3) models there is a blueshift (or negative redshift), while in the Gentry's (curve 2) model there is a corresponding redshift. This is because Gentry introduces a negative mass/energy density through the vacuum energy. Gentry assumes that the zero-point energy of the vacuum makes a significant contribution to gravity. Gentry uses a value for this that is two orders of magnitude higher than the mass/energy density of normal matter. In his paper,[6] he discusses how this generates virtual particles with 83 electron masses, something that has never been observed; however, such speculations in cosmology are not unusual.

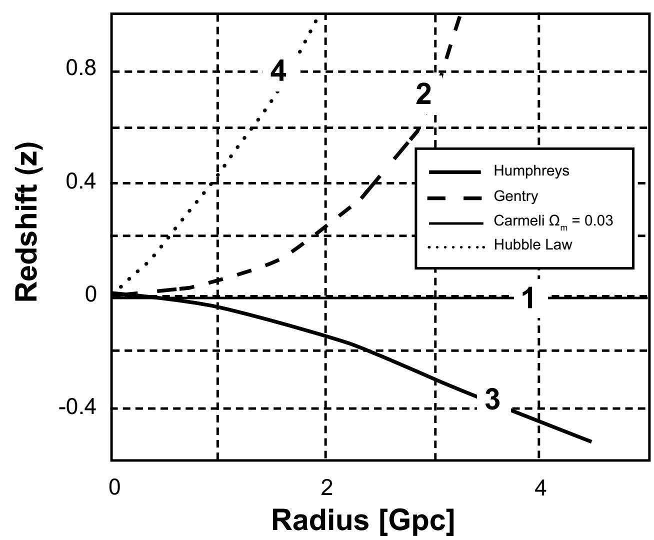


Figure 4. *Gravitational redshifts of three models (curves 1–3) as a function of radius or distance in Gpc. Curve 4 is the redshift of the Hubble Law. Curve 1 is due to Humphreys, curve 2 due to Gentry and curve 3 is due to Carmeli.*

In the comparisons made here I have assumed a constant density, when in fact the density varies with redshift and hence distance from the observer. Therefore, from this analysis only, a qualitative comparison can be made at high redshift (z) and hence distance (r). Near the origin ($r = 0$ and $z \approx 0$), which I will assume is the centre of our galaxy, the gravitational redshift is of the form

$$z_{grav} = A \times 10^{-x} r^2 \qquad (26a)$$

in all three models. On the scale of the universe, Earth is very close to $r = 0$, and can be assumed to be so in this analysis. In Humphreys' model A = -4.7 and $x = 16$; in Gentry's model A = +2.6 and $x = 14$; and in Carmeli's model[31] A = -2.07 and $x = 14$. All are a function of the square of the radial proper distance (r).[32] Notice that only Gentry's model produces a positive sign. This is because his model constrains the gravitational energy in the universe to have the form of a *potential hill*, while in the other two models has the form of a *potential well* or valley.

In Gentry's model, photons coming from distant galaxies have had to climb that potential hill; as a result, they lose energy to warped space (actually a gravitational energy field) and are reddened—their wavelengths are shifted towards the red end of the spectrum). In Carmeli's model the opposite occurs: we are near the bottom of the well and see photons gaining energy from the warped space; this 'blueshifts' them—their wavelengths are shifted towards the blue end of the spectrum. Humphreys' model gives the same results, but to a far lesser extent.[33]

In none of these models is the dependence of redshift on distance anything like the Hubble Law, which gives a redshift that is directly proportional to the radial distance *r* when *r* is small. In Humphreys' and Gentry's models the effects described by the Hubble Law are provided by other means. In Carmeli's model the Hubble Law is assumed as an underlying fundamental postulate. This results in an additional cosmological term (the $1 - \Omega_m$ term) in the potential which is dependent on the matter density. (The matter density in turn is dependent on the expansion state of the universe.) From fig. 4, it is easily seen that (an) additional term(s) is/are needed to reach the magnitude of the Hubble Law (curve 4). In Humphreys' and Carmeli's models this occurs through the expansion of space; in Gentry's model, it is the result of outward radial motion of the galaxies through space itself.

Any creationist cosmology must account for the fact that, at a cosmological scale, we observe only redshifts.[34] I suggest that the correct potential is the potential well derived from a simple Newtonian consideration of the matter distribution in the cosmos. Gentry's model assumes that the universe is bounded, but by a shell of hot hydrogen that turns out to have a mass more than 10 times the mass of the universe. He says it is 'thin', but when one calculates what this means it adds a dilemma. If we assume that the hot hydrogen has a density similar to the averaged matter density of the current universe, then the thickness of the shell is 20 Gpc, which is hardly thin. If we assume a density 10 orders of magnitude higher, the thickness becomes 25 pc, a value that could be considered thin compared to the rest of the universe. But that density is comparable to that of a normal galaxy, so Gentry's shell would be a hot glowing source in every direction in the sky—something which is not observed. This would give rise to another Olber's paradox.[17,18] I consider that Gentry's model is weakened by his assumptions about this shell of hot hydrogen, and also by his assumption that the redshifts are in part due to the motions of the galaxies through space. I believe that God's Word favours the stretching of 'space' itself (Isaiah 42:5; 45:12; 51:13 and Jeremiah 10:12).

A blueshift due to a gravitational potential well must be present, but it is currently masked by a redshift resulting from the fact that God stretched out space with the galaxies attached to it. If these two effects are independent, they can be represented by a product of the ratios of the wavelengths due to each effect. Therefore,

$$1 + z_{obs} = (1 + z_{exp})(1 - z_{grav}) \tag{27}$$

where all *z*'s are positive. In (27), the value for z_{grav} results from a potential well and the value of z_{exp} is due to spatial expansion between the time of emission and reception. Clearly, if z_{exp} is much larger than z_{grav} the resultant z_{obs} will be positive and, hence, a redshift. Note that in (27) the z_{grav} can be written this way because $z_{grav} << 1$. If $z_{grav} \geq 1$, then a quotient must be taken on the right-hand side of (27). Caution, however, should be taken here with Carmeli's model because the potential well we are discussing is a *spacetime* potential, but the expansion of space described by (22) is a *spacevelocity* expansion.

Conclusion

I have considered three cosmological models. Two are explicitly creationist in nature, though Gentry's does not give any hint about the starlight-travel-time problem. Humphreys' model generates a very small blueshift due to a gravitational potential well. Carmeli's model is not explicitly creationist, but is a centro-symmetric model of the visible universe. It, too, generates a blueshift due to a gravitational potential well. Gentry's model incorporates no stretching of the fabric of space, unlike the other two; instead Gentry's galaxies move through space. His model generates a redshift due to a gravitational potential hill. Gentry's model is weakened by his assumptions about a shell of hot hydrogen, and also by his assumption that the redshifts are in part due to the motions of the galaxies through space. From the text of the Bible it seems that God's Word favours the stretching of space itself.

In fact, in principle, this aspect of Gentry's model is much the same as the hot big bang inflationary model, because if you look far enough back in that model, beyond the era of re-ionization[35] ($z \sim 20$), you would expect to see only hot hydrogen, just as in Gentry's model. In the galactocentric model I propose, because the earth is near the centre of the universe and the creation process started near Earth, there is a natural look-back-time horizon beyond which we cannot see; this is due to the fact that the light from those initial events has already passed by Earth.

One simple conclusion may be drawn from this discussion. That is, that a blueshift due to a gravitational potential well should be present in a galactocentric universe, but is currently masked by a cosmological redshift due to the effects of the stretching of space with the galaxies embedded in it. These two effects, blueshift and redshift, are independent, and therefore can be considered as a product of the ratios of the wavelengths resulting from each effect. This information will help us to build a further creationist cosmology. The discussion is continued in *Dark matter and a cosmological constant in a creationist cosmology?*[36] and planned future articles: *Creation episodes in a creationist cosmology* and *Cosmological expansion in a creationist cosmology***.**

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31. The Carmeli model, if considered in an infinite universe or unbounded finite universe, would have no gravitational redshift for the same reason that Friedmann–Lemaître–Robertson–Walker cosmologies don't, i.e. they have no centre or no edge. Carmeli's model is inherently different to the other two compared here because it admits a new dimension, the velocity of the galaxies in the Hubble flow. To calculate the contribution from the gravitational potential in a finite universe, equation (19) needs to be solved allowing for that solution, which adds terms to (20).
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