SECTION 14

The Cosmos' Expansion From The Origin To The Present

This analysis is of the mechanics of the travel of matter outward from its "Big Bang" source [some of it ultimately being we the observers] and of the mechanics of the travel of light from such material sources wherever they are at the time that the light that we later observe is emitted. Because the observing of light from very distant astral sources is the observing of light emitted billions of years ago, this analysis includes the question of how far back into the past it is theoretically possible to observe and of the ultimate fate of the universe.

1 - THE TRAVEL OF MATTER AND LIGHT

The first step is to develop formulations that describe the travel of the two different traveling entities, light and matter, at various times in the past from at the beginning to the present.

The travel of matter originated at the location of the "Big Bang" singularity and was initially radially outward from that location. While mass cannot travel at light speed the initial speed of the "Big Bang" product particles was sufficiently near the then [initial un-decayed] light speed so as to be taken as such as is developed below. Two effects then proceeded to slow the outward velocities: the decay of the speed of light [the upper limit on particle velocity] and the gravitational slowing [the centrally directed gravitational acceleration, caused by the total mass, decelerating the outward velocities].

The treatment here is of the estimated "average" or "typical" cosmic body [e.g. galaxy], treated as that from its initial form as myriad fundamental particles at the instant of the "Big Bang" -- the particles ultimately destined to form that particular "typical" body, through its form as we know it now. [While not of concern in the present analysis, once the outward travel began the particles experienced local gravitational effects in addition to the overall general slowing -- effects that deflected paths from being purely radially outward and that lead to "clumping" and the formation of structure in the universe.]

The travel of light originated from the above traveling matter, at its various locations and times throughout the universe from the first instant on. It was radially outward from wherever its source was at the time of emission. Its speed was the speed of light at the decayed value for the time after the "Big Bang" that the light was emitted.

a. The Travel of Light Outward From Astral Sources

Astral / cosmic source light emitted long ago was emitted at a higher "light speed" than our local contemporary light and continues to travel at that faster speed forever as explained earlier in section 15, beginning on page 255 at "ε, μ, and the Speed of Propagation". [Briefly, the decay is in the generation, in the source, not the propagation. That is the case because the emitted light carries within it its own propagation-determining permeability and dielectric constant, μ and ε. How could it be otherwise since light propagating outward into unoccupied space, into pure nothing, would certainly find no μ and ε there: in nothing ?

On the other hand, the matter originating with the "Big Bang" cannot have traveled at light speed [because its mass would then be infinite] other than nearly so initially before being slowed by gravitation. Therefore, all cosmic source light has been traveling at greater speeds than the cosmic bodies that are home for observers of the light.

Consequently, the most ancient light that it would be theoretically possible for us to observe would be light from a cosmic source that exited the "Big Bang" in the diametrically opposite direction to that of the planetary home [or its components before they became the home planet] of we, the observers. That way, the ancient light has to travel a maximally greater distance from its location where and when emitted to our location where and when we observe it than did our planetary home have to travel from its location when the light was emitted to its location when we observe the light. In other words, ancient light is light that has been traveling a long time and, therefore, has traveled a great distance. The home of we, the observers cannot travel so fast and must, therefore, have a "head start" of distance to be able to arrive at the meeting place of light and observer at the same moment as the faster light. The largest "head start" is the handicapping of the light by placing its source diametrically opposite the location of the observers.

Standard International [SI] units are used; however the great range of magnitudes of the quantities considered calls for their being expressed sometimes in alternative astronomical units: time in *Gyrs = Years·10⁹* rather than *seconds* and distances in *"our" G-Lt-Yrs = 10⁹ × [Light Years at our contemporary speed of light]* rather than *meters*. [Note: G-Lt-Yrs is always "our" G-Lt-Yrs.] Those are obtained by the following factors.

(14-1)

$$k_{time} = 60\cdot 60\cdot 24\cdot 365\cdot 10^9 \quad [sec/Gyr]$$

$$k_{dist} = k_{time}\cdot[\text{"Our" Light Speed}]$$

$$= k_{time}\cdot[2.997{,}924{,}58\cdot 10^8] \quad [meters/G\text{-}Lt\text{-}Yr]$$

The actual practical precision of the calculations is limited to one or two significant figures by the nature of the estimates of quantities such as the density and mass of the universe and the universe's expansion velocities and their distribution. The greater number of significant figures indicated in the data tabulations do not signify greater precision of results. Rather, they are included because they are the actual data used in the calculations before rounding to the real precision, and they are the data used in generating the various graphs. They make the results presented completely reproducible.

For the present the age of the universe is taken to be unknown so that *Age* is a variable. Then the original speed of light, *c(0)*, at the instant of the "Big Bang", just before the first moment of the Universal Decay, is obtained using equation 14-2, the Universal Decay time constant, τ, [from earlier equation 3-9], in equation 14-3, the calculations, below.

(14-2)

$$\tau = 3.57532 \cdot 10^{17} \text{ sec} \quad [\approx 11.3373 \cdot 10^{9} \text{ years}]$$

(14-3)

$$c(t) = c(0) \cdot \varepsilon^{-t/\tau} \text{ meters/sec} \qquad [\text{light universal decay}]$$

$$c(Age) \equiv 2.997{,}924{,}58 \cdot 10^{8} \text{ m/sec} \qquad [\text{"our" c, now}]$$

$$c(Age) = c(0) \cdot \varepsilon^{-Age/\tau} \qquad [\text{set t = Age in first line}]$$

$$c(0) = c(Age) \cdot \varepsilon^{+Age/\tau} \qquad [\text{solve for c(0)}]$$

$$= 2.997{,}924{,}58 \cdot 10^{8} \cdot \varepsilon^{Age/\tau} \text{ m/sec}$$

Then, the speed of light at any arbitrary time, *t*, after the "Big Bang" for any arbitrary age of the universe, *Age*, is as follows.

(14-4)

$$c(t,Age) = c(0) \cdot \varepsilon^{-t/\tau}$$

$$= \left[2.997{,}924{,}58 \cdot 10^{8} \cdot \varepsilon^{Age/\tau}\right] \cdot \varepsilon^{-t/\tau} \text{ meters/sec}$$

b. The Travel of Cosmic Bodies Outward From the Origin of the "Big Bang"

To determine the travel of cosmic bodies outward from the "Big Bang" one needs to know the initial velocities and the manner in which they subsequently were reduced by gravitation and other effects. The initial radially outward velocities were so close to the then speed of light as to be that speed for the practical precision here being used. That determination develops as follows.

(1) The Initial Radially Outward Velocities

The universe has existed for billions of years and is still expanding. Therefore, the initial velocity / energy of the "Big Bang" product particles must have been near, if not at or greater than, the escape velocity / energy. The escape velocity / energy for any one particle of the initial "Big Bang" universe is calculated as follows. [The calculation is done non-relativistically here and consequently produces apparent velocities much greater than that of light. They represent velocities nearly at light speed with greatly increased mass.]

Gravitational escape velocity is that velocity the kinetic energy of which just equals in magnitude the potential energy of position in the gravitational field for which the escape velocity is being determined. The non-relativistic escape velocity of a particle develops as follows.

(14-5)

Kinetic Energy = Potential Energy = Force × Distance

= Gravitational Force of Attraction × Distance from Particle Center to Universe Center

With: v_{esc} ≡ escape velocity

m_p ≡ mass of the particle

m_U ≡ mass of the Universe [after the initial, mutual annihilations]

d_0 ≡ distance [from the particle center of mass to the universe center of mass]

G ≡ gravitation constant [un-decayed original value at the time of the "Big Bang"]

Then:

$$\tfrac{1}{2}\cdot m_p\cdot v_{esc}^2 = G\cdot\left[\frac{m_p\cdot m_U}{d_0^2}\right]\times d_0$$

$$v_{esc} = \left[\frac{2G\cdot m_U}{d_0}\right]^{1/2}$$

For that formulation the needed data are: the gravitation constant, G, the mass of the universe, m_U, and the separation distance, d_0. Estimating the Mass of the Universe, m_U, proceeds by estimating the average mass density, ρ, and the volume. The universe mass is then the product of the two. The mass density of the universe, ρ, develops as follows.

Astronomical analyses treat a "critical density" of the universe, ρ_c, which is the particular value of the average density that is on the boundary separating the case of an open (expanding forever) versus closed (eventually gravitationally recontracting) universe. The critical density relates to the escape velocity presented in equation 14-5, above. The development begins with equating kinetic and potential energy in the form of the next to last line of that equation as in equation 14-6, below.

(14-6)
$$\tfrac{1}{2}\cdot m_p\cdot v^2 = G\cdot\left[\frac{m_p\cdot m_U}{d}\right]$$

The "Hubble Law" states that the velocity of an astral object is proportional to its distance. That law, where H_0 is the "Hubble Constant", is

(14-7) $v = H_0\cdot d$

The total mass inside a sphere of radius d is

(14-8) $M = [\text{Volume}] \cdot [\text{density}] = [4/3 \cdot \pi \cdot d^3] \cdot [\rho]$

Substituting in equation 14-6 for v with equation 14-7 and for m_U with equation 14-8 the result is as follows.

(14-9)

$$\tfrac{1}{2} \cdot m_p \cdot [H_0 \cdot d]^2 = G \cdot \left[\frac{m_p \cdot [[4/3 \cdot \pi \cdot d^3] \cdot \rho]}{d} \right]$$

$$\rho = \frac{3 \cdot H_0^2}{8 \cdot \pi \cdot G} \qquad \text{[Simplifying and solving for } \rho]$$

That formulation is intended to give the average density of a portion of the universe of volume $4/3 \cdot \pi \cdot d^3$ such that the mass is on the boundary between escape from that volume and ultimate recapture. It would also, then, be the critical average density, ρ_c, for the overall universe, except for the following problem.

The very concept of the "Hubble Constant" is only valid in terms of the Hubble - Einstein theory that it is space itself that is expanding. It is that which would, if valid, justify the concept of one number, a "universal constant", representing the ratio of distance to velocity. The analogy given for the Hubble - Einstein concept of H_0 is that of the blowing up of a balloon or the rising of a loaf of bread in both of which examples the separation velocity of two locations within is proportional to their separation distance.

However, the Hubble - Einstein cosmology and its "Hubble Constant" concept are not valid, as already presented. The *form* of equation 14-9 is valid and correct, but the constant, H_0, must be replaced with a valid number, the correct ratio of distance to velocity for the object the escape of which is being considered, and that number is not a constant but, rather, depends on the particular circumstances.

Even in Hubble - Einstein terms, the "Hubble Constant", H_0, would better be referred to as the "Hubble Parameter". Not even the first digit of its numerical value is securely determined and its value has been taken to be over a range of from less than $H_0 = 50$ to nearly $H_0 = 100$ for various calculations and estimates by various researchers.

Further, in the "Hubble Law", $v = H_0 \cdot d$, the distance d is the distance of the astral object from the *observer*. The correct distance for the form of equation 14-9, that is the distance as in Universal Decay terms not Hubble - Einstein terms, is the distance *outward from the origin* of the "Big Bang". In other words, the "law" is that the object's outward velocity from the origin of the "Big Bang" must be, and must have been, relatively faster if its distance outward, the time-integral of that velocity, is greater, which is obvious. The "Hubble Law" is correct to that extent, but only to that.

Of course the Hubble - Einstein cosmology involves even greater error in attributing redshifts solely to the Doppler Effect of the astral object's velocity rather than the dominant cause, the Universal Decay. That means that determinations of the distance of astral objects by taking their outward velocity from the redshift as a purely Doppler effect, an incorrect velocity, and multiplying it by H_0, an invalid number and concept, can produce only distances in error.

Because for lesser distances from now back into the past [perhaps to 4 or 5 Gyrs ago] Hubble - Einstein redshift calculations of distance deviate relatively less from the correct Universal Decay calculations [Figure 14-8] a look at the results given by equation 14-9 may nevertheless be somewhat helpful in estimating universe average mass density. Depending on the value of H_0 used in equation 14-9, various values for the mass density ρ result, for example:

Value of ρ with the now favored $H_0 = 72$ km/sec/mpc:

$$\rho = 9.8 \cdot 10^{-27} \text{ kg/m}^3$$

Value of ρ with the past favored $H_0 = 49$ km/sec/mpc:

$$\rho = 4.5 \cdot 10^{-27} \text{ kg/m}^3$$

On the other hand estimates of ρ, rather than theoretical calculations as just above, have been made by estimating the mass of a typical galaxy, that done by estimating the number of stars in a galaxy and multiplying by the estimated average star mass and considering the galaxy's rotational dynamics; then counting the number of galaxies in a volume of space, the process performed for increasingly larger volumes. That procedure has produced a universe mass density estimate of:

Value of ρ from estimating star mass densities:

$$\rho \approx 10^{-27} \text{ kg/m}^3$$

Having, then, estimates ranging from about 1 to 10 times 10^{-27}, a reasonable value to use for the mass density of the universe would be the average, about:

$$(14\text{-}10) \qquad \rho_U \approx 5 \cdot 10^{-27} \text{ kg/m}^3$$

Next the volume of the universe is needed so as to obtain the universe's mass as the product of the mass density and the volume. The volume of the universe develops as follows.

The particles of matter of the universe cannot have commenced their travel outward from the origin of the "Big Bang" at one same speed; rather their initial speeds must have been over a range of speeds, which would have produced a wide distribution in space as their travel developed. While the preceding analysis has developed an *average* mass density for the universe, ρ, the actual density must vary substantially even on the scale of large volumes. Therefore, to address the issue of to what volume the average mass density is to be applied requires addressing the issue of the distribution of the initial velocities of the matter emerging from the "Big Bang" because that velocity distribution is the cause of the spatial distribution of astral objects.

The analysis further on below related to Figure 14-2c, *First Phase of The Expansion of The Universe -- Velocities for Age = 30 Gyrs Case*, shows that the limits on the range of initial energies of those emerging particles set that range to energies of about

`0 to 3,000 × [the escape energy]`. Those limits are the obvious lower limit of zero and an upper limit of energy so great that the matter fails to slow to non-relativistic speed ever. However, that is a very large range. Even to only `1,000` is quite large. The range used here for sample cases will be from `1 to 1,000 × [the escape energy].` We cannot know the exact distribution of those energies; however, there are known energy distributions of other natural phenomena that can be a guide.

Those considered are Planck Black Body Radiation and the Maxwell - Boltzman treatment of the kinetic theory of gases. Replacing the case-specific constants [*π, h, c, k, 2, and parameter T*] with summary case-neutral constants the form of those distributions is as in equation 14-11, and they appear as in Figures 14-1a and 14-1b, below.

```
(14-11)  Where:
            F = multiple Factor of escape energy
         n(F) = the number of particles of energy multiple F
         p(F) = the probability of interval [F+ΔF], ΔF→0
```

Planck:

$$n(F) = \frac{K1 \cdot F^5}{\varepsilon^{K2 \cdot F} - 1}$$

Maxwell-Boltzman:

$$p(F) = \frac{K3 \cdot F^{1/2}}{\varepsilon^{K4 \cdot F}}$$

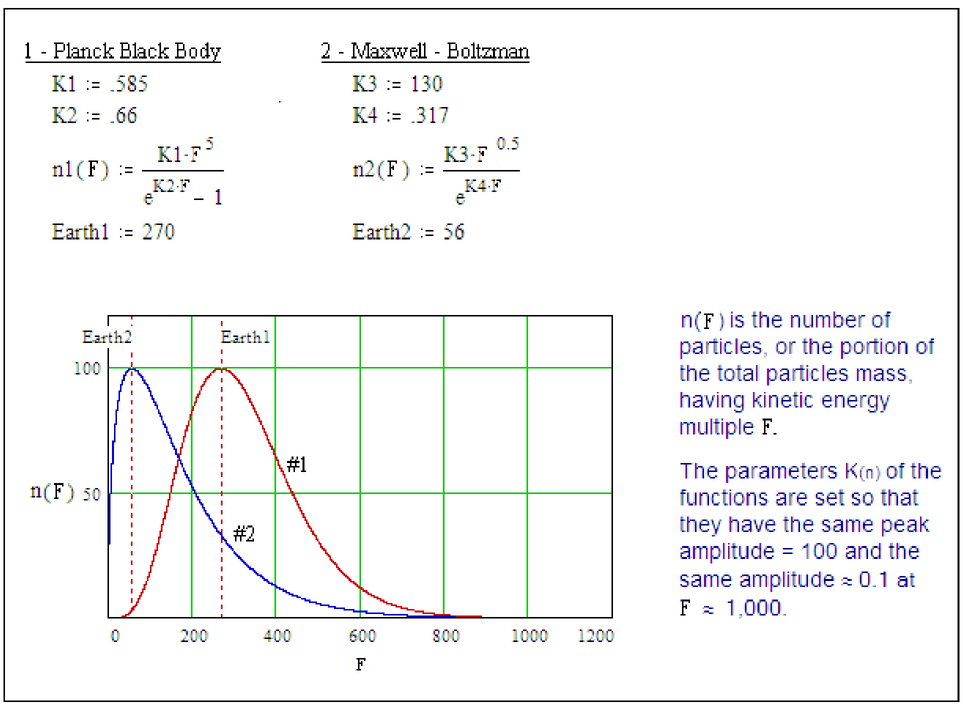

Figure 14-1a "Big Bang": Some Theoretical Rate Distributions of Initial Particle Energies

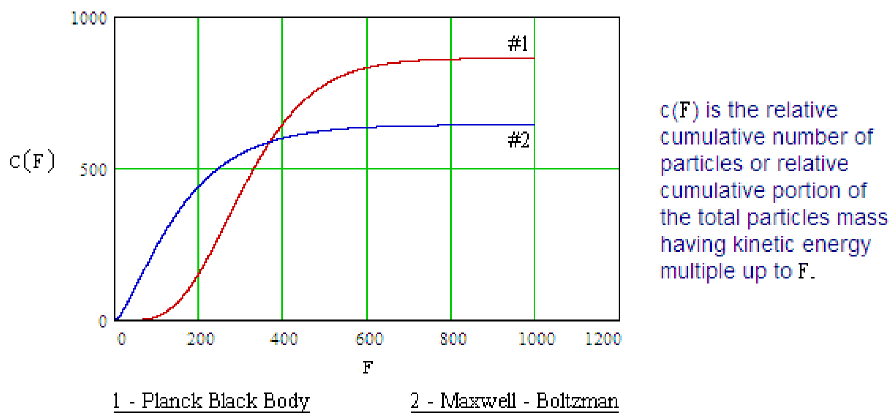

Figure 14-1b Cumulative Distributions for Figure 14-1a

Where we observers on planet Earth fall in the distributions in the above Figure 14-1a should be considered. It can only be presumed that Earth is not unusual with regard to its component particles' initial velocities, which would call for placing it at a distribution peak. But, there are two choices shown, likely neither exact, and Earth is not necessarily so usual as to fall exactly at the peak of any distribution. Form #2 requires less total energy and also is chosen because otherwise the resulting velocities at *Age = 30 Gyrs* would appear to be in error relative to the known velocity of Earth (see before equation 14-24, further below. Calculating for the two cases in Figure 14-1a shows that the variation in choices produces little variation in the overall results and in the age, *30 Gyrs*, of the universe and the theoretical limit, about *27 Gyrs*, on how far back in the past can be observed. The parameter for the Earth case, *F = 55*, [see Tables 14-2a and 14-2b, further below] is chosen to set it at the distribution Form #2 peak.

From the above the summary conclusions in Table 14-1c, below, can be drawn.

Form #1 -- Planck Black Body Radiation			
Percent of Maximum Amplitude, *n(F)*:	*100 %*	*95 %*	*90 %*
Range in Distribution is *F = 0 to*:	*1,000*	*565*	*500*
That Range as Percent of the Maximum	*100 %*	*57 %*	*50 %*
Resulting Indicated Universe Radius	*~14 G-Lt-Yrs*	*~14 G-Lt-Yrs*	*~14 G-Lt-Yrs*
Form #2 -- Maxwell - Boltzman Gas Kinetic Theory			
Percent of Maximum Amplitude, *n(F)*:	*100 %*	*95 %*	*90 %*
Range in Distribution is *F = 0 to*:	*1,000*	*455*	*360*
That Range as Percent of the Maximum	*100 %*	*46 %*	*36 %*
Resulting Indicated Universe Radius	*~14 G-Lt-Yrs*	*~14 G-Lt-Yrs*	*~14 G-Lt-Yrs*

Table 14-1c "Big Bang" Initial Energy Distributions Summary Data Conclusions

In the above table, the "*Resulting Indicated Universe Radius*" is obtained as follows. Figure 14-4d, *Second Phase of The Expansion of The Universe -- Distances for Age = 30 Gyrs Case*, farther on below indicates a present [at *Age of the universe* $\approx$ *30 Gyrs*] radius of the matter-containing volume of the universe as about *8 G-Lt-Yrs*. However, the radius applicable to the above obtained universe mass density should be based on an earlier time because the investigations into estimating that density had to treat astral objects which we observe as they were some time in the past: their distance from us divided by the speed of their light. Taking those earlier times as having been in the range of *0 to 7-8 Gyrs* into the past, which corresponds to volumes in the ratio to each other of the cube of those distances as *[0, 1, 8, 27, 64, 125, 216, 343, 512]*, and cumulatively in ratio as *[0, 1, 9, 36, 100, 225, 441, 784, 1296]* then it is reasonable to take the applicable universe radius as that which existed at the time into the past corresponding to about half the maximum cumulative volume, $t \approx 6.5$ *Gyrs* ago. Figure 4d indicates the radii given in the above Table 14-1c for the related table columns at that time ago, $\approx$ *14 G-Lt-Yrs*.

Then, the estimated radius of the universe for the present calculation is:

$$(14\text{-}12)\quad R_U = 14\ \text{G-Lt-Yrs} = 11 \cdot 10^{24}\ \text{meters}.$$

Therefore the mass of the universe, as the product of its volume based on that radius and its equation 14-10 density, is:

$$(14\text{-}13)\quad M_U = 3 \cdot 10^{49}\ \text{kg}.$$

[Calculating with alternative values for the mass of the universe ranging from 10^{46} to 10^{53} *kg* produces no significant change in the general results developed below as can be verified using the forms of the calculations presented farther on below. That is, while velocities and distances vary somewhat, the necessary age of the universe remains at about the *30 Gyrs* and the maximum distance back into the past that it is theoretically possible to observe remains at about the *27 Gyrs* developed farther on below.]

[A possible concern over circular cause and effect reasoning here is not valid. The results presented are based on numerous iterations of calculations over a range of complexly interacting variables.]

With the mass of the universe now resolved the other quantities needed to calculate the escape velocity of the universe can be addressed. The Separation Distance, d_0, is the radius of the universe at the moment that expansion began being at a rate consistent with the long term development of the universe as compared to its initial more rapid [essentially instantaneous] development commonly referred to as "inflation". That value is $d_0 = 4.0 \cdot 10^7$ *meters*.

$G(0)$, the Gravitation Constant at its original un-decayed value at the time of the "Big Bang" is as follows.

(14-14)

$$G(t) = G(0)\cdot\varepsilon^{-3\cdot t/\tau} \quad meter^3/_{kg\text{-}sec^2} \qquad \text{[grav'n constant universal decay and the [}meter^{\mathbf{3}}\text{] requires } \tau\rightarrow{}^{\tau}/_{\mathbf{3}}\text{]}$$

$$G(Age) = 6.672{,}59\cdot10^{-11} \quad m^3/_{kg\cdot s^2} \qquad \text{["Our" G, now]}$$

$$G(Age) = G(0)\cdot\varepsilon^{-3\cdot Age/\tau} \qquad \text{[Set t = Age in G(t)]}$$

$$G(0) = G(Age)\cdot\varepsilon^{+3\cdot Age/\tau} \qquad \text{[Solve for G(0)]}$$

$$= 6.672{,}59\cdot10^{-11}\cdot\varepsilon^{3\cdot Age/\tau} \quad m^3/_{kg\cdot s^2}$$

Then, the gravitation constant at any arbitrary time, t, after the "Big Bang" for any arbitrary age of the universe, Age, is as follows.

(14-15)

$$G(t,Age) = G(0)\cdot\varepsilon^{-3\cdot t/\tau}$$

$$= \left[6.672{,}59\cdot10^{-11}\cdot\varepsilon^{3\cdot Age/\tau}\right]\cdot\varepsilon^{-3\cdot t/\tau} \quad m^3/_{kg\cdot s^2}$$

Two values for the Age of the universe are addressed in this analysis to present the thesis and its validation. The currently accepted values in Hubble - Einstein cosmology range *Age = 13.5 to 14.7 Gyrs*. Representing those *14.0 Gyrs* will be used. As developed below, the present analysis indicates that *Age = 30.0 Gyrs*. Then, using τ *=11.3373 Gyrs* from Equation 14-1 the following values for $G(0)$ result.

(14-16)

For Age = 14 Gyrs	For Age = 30 Gyrs
$G(0) = 2.711\cdot10^{-9}$	$G(0) = 1.870\cdot10^{-7}$

The escape velocity per equation 14-5 for those cases of age of the universe are:

(14-17)

For Age 14 Gyrs	For Age 30 Gyrs
$v_{esc} = 6.4\cdot10^{16}\ m/_s$	$v_{esc} = 5.3\cdot10^{17}\ m/_s$

Those values are so large relative to the speed of light at the time of the "Big Bang",

(14-18)

For Age 14 Gyrs	For Age 30 Gyrs
$c(0) = 1.031\cdot10^{9}\ m/_s$	$c(0) = 4.227\cdot10^{9}\ m/_s$

that it is certain that the initial particle velocities, at the time of the "Big Bang", were very nearly the then speed of light. That is, the initial particle velocities could not be, nor exceed, light speed as the non-relativistically calculated escape velocities of equation 14-17 call for. The accommodation to relativity means that the actual speeds were very near light speed and the masses were significantly relativistically increased.

As noted earlier, to determine the travel of cosmic bodies outward from the "Big Bang" one needs to know, first, the initial velocities and then the subsequent manner of the reduction in the cosmic bodies' velocities by gravitation and other effects. The initial velocities have been found to be essentially the value of the speed of light at the time of the "Big Bang". At that point two effects proceeded to slow the outward velocities: the decay of the speed of light [the upper limit on particle velocity] and the gravitational slowing [the centrally directed gravitational acceleration caused by the total mass].

(2) The Progressive Reduction in the Cosmic Bodies' Initial Velocities

The overall process must be divided into two phases:

- First, the relativistic phase during which the speed is continuously almost that of light and the effect of gravitation is dominantly not a reducing of the speed but a reducing of the amount that the mass has been relativistically increased, and

- Second, the non-relativistic phase during which the mass, now reduced to essentially rest mass, remains essentially the same and the dominant effect of gravitation is to reduce the speed.

Of course the change from the first to the second phase is not sharp, but rather a gradual smooth transition. For the purposes of these calculations, however, the choosing of a specific transition point [hereafter termed the `ChangePoint`] is needed. That point is determined as follows.

(2a) The First Calculation Phase -- Speed ≈ Light Speed

The first phase calculation is in terms of energy, the gradual transfer of initial kinetic energy into gravitational potential energy. Energy calculations in themselves are not relativistic. The kinetic energy speed will be treated non-relativistically, that is, the mass is taken as at its rest value and the kinetic energy then is taken as all residing in the [theoretical] velocity squared, that theoretical velocity not constrained by a speed of light limitation. Then, the calculated effect of gravitation, of the transfer of kinetic energy into gravitational potential energy, appears as a gradual reduction of that theoretical velocity. When that theoretical velocity has been reduced by gravitation down to the actual [at that time as decayed] light speed then the `ChangePoint` from the relativistic to the non-relativistic treatment has been reached.

During that first phase the distance component of the gravitational potential energy calculation is readily available as the time integral of the known speed, the speed of light. The velocity as a function of time then develops as follows.

The first phase distance, `d(t,Age)`, traveled outward from the "Big Bang" source location, as a function of time is the time integral of the velocity as equation 14-19, below, which is based on equation 14-7, above [and includes the initial separation distance, $d_0 = 4.0 \cdot 10^7$ *meters*, of the earlier above calculation of the mass of the universe, which distance is negligible, however].

(14-19)
$$d(t,Age) = d_0 + \int_0^t c(t) \cdot dt$$
$$= d_0 + \int_0^t \left[\left[2.997,924,58 \cdot 10^8 \cdot \varepsilon^{Age/\tau}\right] \cdot \varepsilon^{-t/\tau} \right] \cdot dt$$

The velocity as a function of time, $v(t,Age)$, is as given in equation 14-20 obtained starting from equation 14-5:

(14-20)
$$v_{esc} = \left[\frac{2G \cdot M_U}{d_0}\right]^{½} \quad \text{so that:}$$
$$v(t,Age) = \left[\frac{2G \cdot M_U}{d(t,Age)}\right]^{½}$$

As pointed out during the evaluation of the mass of the universe earlier above, the matter of the universe moved outward from the "Big Bang" at a wide range of speeds. Those various speeds resulted, of course, from the particles of matter having various initial velocities / energies which, as presented just before and in conjunction with Figures 14-1a and 14-1b, are to be sampled over the range $F = 1$ *to* $1,000 \times$ *[the escape energy]*. That range is incorporated into the formulation by the multiple factor, F, included in the final expression for the first phase $v1(t,Age)$ per below.

(14-21)
$$v1(t,Age) = \left[\frac{\mathbf{F} \cdot 2G \cdot M_U}{d(t,Age)}\right]^{½} \quad \text{[1st Phase Matter Velocities]}$$

The decaying speed of light is per equation 14-3, repeated below,

(14-22)
$$c(t,Age) = \left[2.997,924,58 \cdot 10^8 \cdot \varepsilon^{Age/\tau}\right] \cdot \varepsilon^{-t/\tau}$$

and the value of time, t, producing $\boxed{v1(t,Age) \equiv c(t,Age)}$ is the sought *ChangePoint* for the particular initial velocity / energy multiple factor, F, and *Age*, the end of calculation for the first, the relativistic, phase.

Tables 14-2a and 14-2b, below summarize the results for the first phase for both *Age = 30* and *Age = 14 Gyrs*, and the results are also presented graphically for *Age = 30 Gyrs* in Figure 14-2c, following the tables.

For: Universe Age = 30 Gyrs, which means that:
Initial Light Speed = $4.226,895,62 \cdot 10^9$ m/s
Initial Gravitation Constant, G = $1.870,24 \cdot 10^{-7}$ $m^3/kg\text{-}s^2$

F-Factor		"ChangePoint" At Time[Gyrs]	"ChangePoint" At Velocity[m/s]	Distance From Origin* ChangePoint	Distance From Origin* Now, Age	Relative! Abundance
1		0.004713	$4.225 \cdot 10^9$	0.066	0.005	22.
3		0.01414	$4.222 \cdot 10^9$	0.199	0.014	37.
10		0.04721	$4.209 \cdot 10^9$	0.661	0.047	63.
32		0.1518	$4.171 \cdot 10^9$	2.097	0.152	93.
55	Earth	0.2621	$4.131 \cdot 10^9$	3.568	0.262	100.
100		0.4812	$4.052 \cdot 10^9$	6.364	0.481	90.
316		1.5960	$3.672 \cdot 10^9$	18.222	1.596	23.
1000		6.0840	$2.472 \cdot 10^9$	38.788	6.084	0.1
≈3000		$\rightarrow \infty$	c(t)	$\rightarrow \infty$	$\rightarrow \infty$	

* = Decayed to Change Point, Age; G-Lt-Yrs. ! = Estimate per Fig 14-1a

Table 14-2a
The Universe's First Phase of Expansion, Age=30 Gyrs Case
Relativistic Phase at (Essentially) Light Speed, From t = 0 to t = ChangePoint

For: Universe Age = 14 Gyrs, which means that:
Initial Light Speed = $1.030,357,62 \cdot 10^9$ m/s
Initial Gravitation Constant, G = $2.711,29 \cdot 10^{-9}$ $m^3/kg\text{-}s^2$

F-Factor		"ChangePoint" At Time[Gyrs]	"ChangePoint" At Velocity[m/s]	Distance From Origin* ChangePoint	Distance From Origin* Now, Age	Relative! Abundance
1		0.004715	$1.030 \cdot 10^9$	0.016	0.005	22.
3		0.01416	$1.029 \cdot 10^9$	0.049	0.014	37.
10		0.04721	$1.026 \cdot 10^9$	0.161	0.047	63.
32		0.1518	$1.017 \cdot 10^9$	0.511	0.151	93.
55	Earth	0.2621	$1.007 \cdot 10^9$	0.870	0.259	100.
100		0.48125	$9.878 \cdot 10^8$	1.551	0.471	90.
316		1.5961	$8.953 \cdot 10^8$	4.443	1.488	23.
1000		6.089	$6.024 \cdot 10^8$	9.460	4.708	0.1
≈3000		$\rightarrow \infty$	c(t)	$\rightarrow \infty$	$\rightarrow \infty$	

* = Decayed to Change Point, Age; G-Lt-Yrs. ! = Estimate per Fig 14-1a

Table 14-2b
The Universe's First Phase of Expansion, Age=14 Gyrs Case
Relativistic Phase at (Essentially) Light Speed, From t = 0 to t = ChangePoint

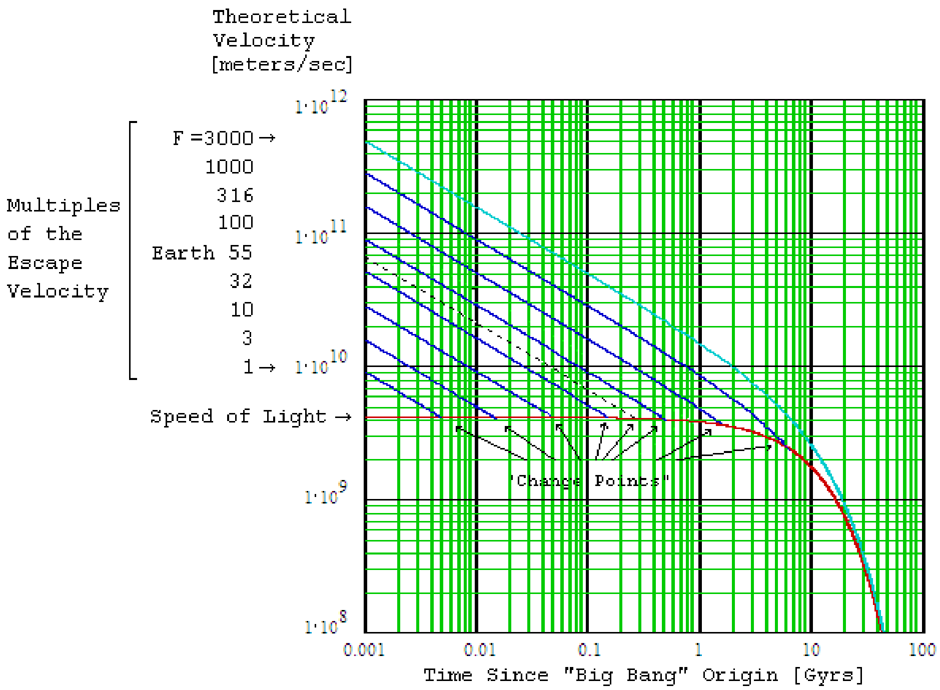

Figure 14-2c First Phase of The Expansion of The Universe Velocities for Age = 30 Gyrs Case

Note that for values of the `F-Factor` at about `F = 3,000` and above the "*ChangePoint*" is never reached because of the decay in the speed of light. For those values the outward moving matter never slows below, essentially, the then on-going decaying light speed.

Note, also, that the large Doppler red shift resulting from `v` nearly equaling `c` combined with large decay redshift due to lack of much decay because the time lies only shortly after `t = 0` results in a redshift relative to our "normal" local wavelengths by a factor of `24 - 28`. The least wavelength of visible light is about `0.38 microns`. That wavelength shifted by that factor as `0.38 x [24 - 28] = [9 - 11] microns`, lies well into the infra-red portion of the spectrum.

Consequently, light which would otherwise lie in the "visible light" portion of the spectrum but was emitted from sources before they reached their "ChangePoints" lies shifted sufficiently into the infra-red that its detection is relatively unlikely. That is the case especially because sources with relatively later "ChangePoints" [more recent, therefore more susceptible to observation] are of relatively small relative abundance. In other words, light emitted from astral sources before they reached their `ChangePoint` is much less likely to be observed.

(2b) The Second Calculation Phase -- Speed < Light Speed

Gravitational slowing is an awkward problem. The amount of gravitational slowing depends on the distance outward from the origin of the "Big Bang"; those distances depend on the velocity function during the travel from the origin outward; and that velocity function depends on the gravitational slowing -- a problem of circular cause and effect. The calculation breaks down into two different modes of behavior because of relativistic effects.

The first phase of the outward expansion, already analyzed above, takes place at essentially the actual speed of light regardless of gravitation. That is because the [theoretical non-relativistic] escape velocities are so large. The kinetic energy essentially resides in the relativistically increased mass until gravitation has reduced the [theoretical non-relativistic] greater than light speed down to passing through and below the actual light speed. During that first phase distances are known because the velocities are known independently of the distance; they are essentially the then current, as decayed, light speeds.

The second phase begins at the end of that first phase's known outward travel to its "*ChangePoint*". At that point the circular cause and effect awkwardness of the problem returns. The inverse square gravitational behavior calls for the current total outward distance squared in its denominator and that depends on the velocity history which depends on the distance history which depends on the velocity history. The solution is to use an approximating function of similar form but not involving velocity. That function can then be adjusted by calibrating it to the known velocity of the Earth now, as developed further below.

The approximating function develops as follows. The precise behavior of the universe's matter expanding outward from the "Big Bang" is as equation 14-23, below, the distance represented by the variable s to avoid confusion with the symbols for differentiation.

(14-23)

$$\text{Gravitational Deceleration} = \frac{d^2s}{dt^2} = -\frac{G\cdot \text{UniverseMass}}{s^2}$$

The general form of the solution to that equation is as equation 14-24:

(14-24)

$$\text{Velocity} = \frac{ds}{dt} = \frac{1}{A\cdot \varepsilon^{B\cdot s} + C}$$

which states that the velocity is inversely proportional to the exponential of the distance, s, as $1/_{\varepsilon}s$. The procedure will be to use as the approximation to the actual exact velocity function the function for the speed of light, $c(t)$, per equation 14-22, multiplied by a factor based on $1/_{\varepsilon}s$.

However, the velocity function must be in terms of time, t, as the independent variable, not distance, s, else the problem of circular cause and effect remains. Using t instead of s, that is representing the actual exact velocity function with a function multiplying the speed of light, $c(t)$, by a factor based on $1/\varepsilon^{t}$ resolves that problem but is less accurate an approximation. The problem of accuracy is addressed by calibrating to the known velocity of our planet Earth at time the *Age* of the universe.

Doppler analysis of the cosmic microwave background radiation, the Doppler variation being due to the Earth's orbit around the Sun, shows that the absolute velocity of the Earth [absolute relative to the location of the "Big Bang" origin] is now about $3.7 \cdot 10^5$ meters/sec. The calibration of the velocity approximating function must be such as to produce approximately that velocity now, at time $t = Age$ after the "Big Bang"; but, for what case, what value of the *F-Factor* ? That issue has been already addressed above and the result is that, for *Earth* $F = 55$ will be used.

For the beginning of the second phase to match smoothly with the end of the first phase the adjustment component, $1/\varepsilon^{t}$, which increases in its effect as t increases, must be formulated so as to produce zero change when the time is $t = ChangePoint$. The resulting expression for the second phase velocity is equation 14-25, below.

(14-25)

$$v2(t,Age) = c(t,Age) \cdot \frac{1}{\varepsilon^{A \cdot (t - ChangePoint)}} \quad \text{meters/sec}$$

where:
A = a constant of value yet to be determined, chosen to calibrate the function, and
$t \geq ChangePoint$.

The calibrating constant, A, for the case of *Earth*, $F\text{-}Factor = 55$ is set to the value that produces a velocity at *Age* of $3.7 \cdot 10^5$ meters/sec, the known value as already presented. The value of A for the highest *F-Factor* case is set to produce a velocity of the current speed of light, $3 \cdot 10^8$ meters/sec, at *Age*. The value of A for each of the other cases is interpolated using a decaying exponential form to provide a general representative set of samples. That form is per equation 14-26, below, and is derived from its depiction in Figure 14-3 *Calibrated Velocities at "Age" for Sample Expansion Cases #1 - 7, and #Earth,* below.

(14-26)

$$Velocity(i) = 5.452 \cdot 10^9 \cdot [\varepsilon^{-2.2127(9-i)}]$$

where i = case # = 1, 2, ... 8

The development of the formulations for the distances is presented further below at equations 14-29A through 14-31B.

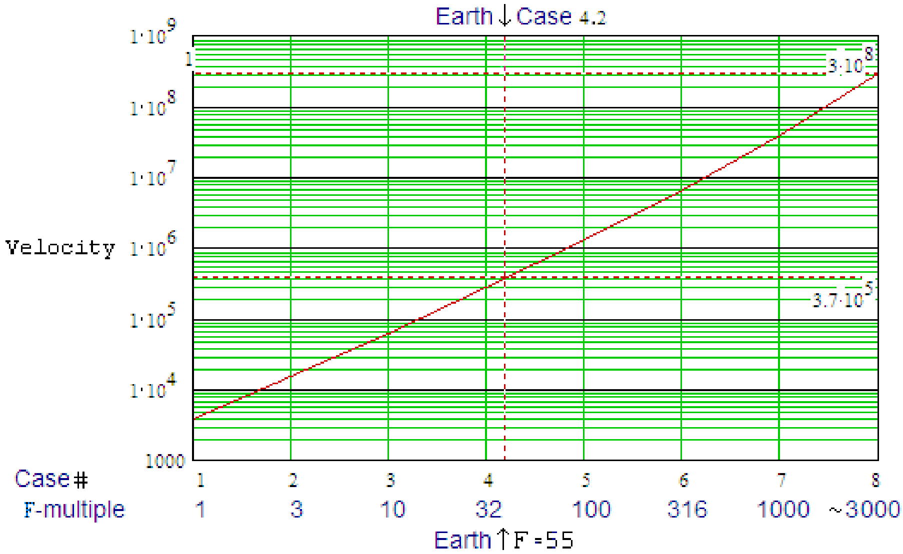

Figure 14-3
Calibrated Velocities at "Age" for Sample Expansion Cases #1 - 7, and #Earth

Tables 14-4a and 14-4b, below, summarize the results for the second phase for *Age = 30 Gyrs* and for *Age = 14 Gyrs*, and the results are also presented graphically for *Age = 30 Gyrs* in Figure 14-4c, *Second Phase of The Expansion of The Universe -- Velocities for Age = 30 Gyrs Case*, and Figure 14-4d, *Second Phase of The Expansion of The Universe -- Distances for Age = 30 Gyrs Case*, on the page following the tables.

For: Universe Age = 30 Gyrs, which means that:
Initial Light Speed = 4.226,895,62·10^9 $m/_s$
Initial Gravitation Constant, G = 1.870,24·10^{-7} $m^3/_{kg-s^2}$

F-Factor	ChangePoint Time[Gyrs]	2nd Phase Constant-A	At Age = 30 Gyrs,[Data*] Velocity [m/s]	Distance[G-Lt-Yrs]
1	0.004713	16.92385	0.00003814·10^8	2.157
3	0.01414	16.98010	0.0001505 ·10^8	2.400
10	0.04721	17.04691	0.0006230 ·10^8	2.727
32	0.1518	17.12856	0.002731 ·10^8	3.205
55	0.2621	17.14622	0.003700 ·10^8	3.374
100	0.4812	17.23245	0.01287 ·10^8	3.980
316	1.5960	17.37183	0.06673 ·10^8	5.388
1000	6.0840	17.57200	0.3974 ·10^8	8.034
≈3000	→ ∞	n/a	2.99792458·10^8	10.526

* = Decayed to Age

Table 14-4a
Summary Data Results for the Universe's Second Phase of Expansion
Non-Relativistic Phase From t = "ChangePoint" Onward, Age = 30 Gyrs

For: Universe Age = 14 Gyrs, which means that:
Initial Light Speed = 1.030,357,62·10^9 $m/_s$
Initial Gravitation Constant, G = 2.711,29·10^{-9} $m^3/_{kg-s^2}$

F-Factor	ChangePoint Time[Gyrs]	2nd Phase Constant-A	At Age = 14 Gyrs,[Data*] Velocity [m/s]	Distance[G-Lt-Yrs]
1	0.004715	16.59278	0.00003814·10^8	1.122
3	0.01416	16.64887	0.0001505 ·10^8	1.268
10	0.04721	16.71513	0.000623 ·10^8	1.477
32	0.1518	16.79505	0.002731 ·10^8	1.811
55	0.2621	16.81082	0.003700 ·10^8	1.954
100	0.4812	16.89330	0.01287 ·10^8	2.417
316	1.5961	17.01200	0.06673 ·10^8	3.669
1000	6.0890	17.09155	0.3974 ·10^8	6.295
≈3000	→ ∞	n/a	2.99792458·10^8	8.034

* = Decayed to Age

Table 14-4b
Summary Data Results for the Universe's Second Phase of Expansion Non-Relativistic Phase From t = "ChangePoint" Onward, Age = 14 Gyrs

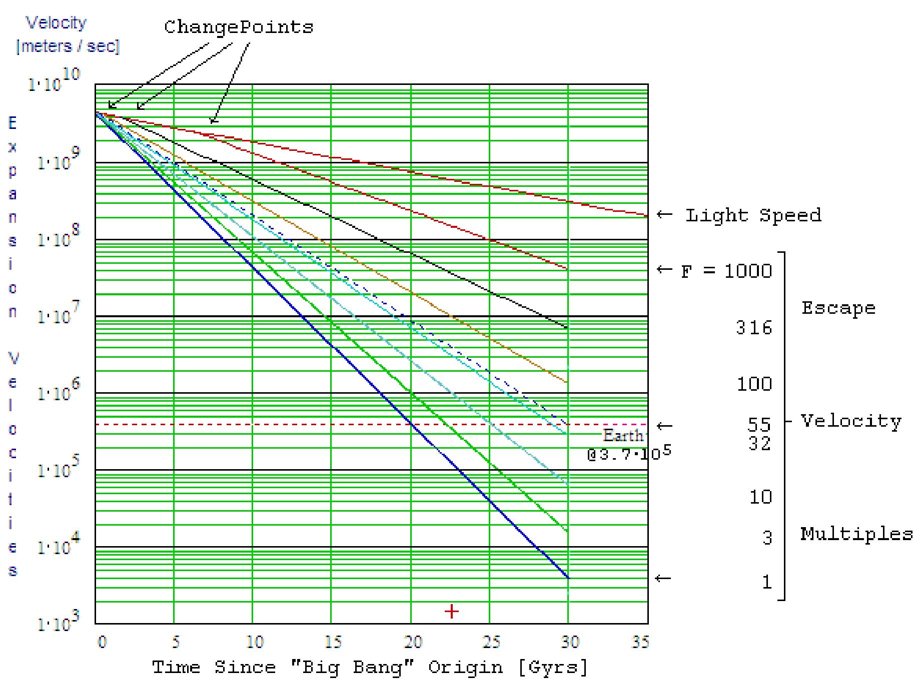

Figure 14-4c
Second Phase of The Universe Expansion -- Velocities for Age = 30 Gyrs Case

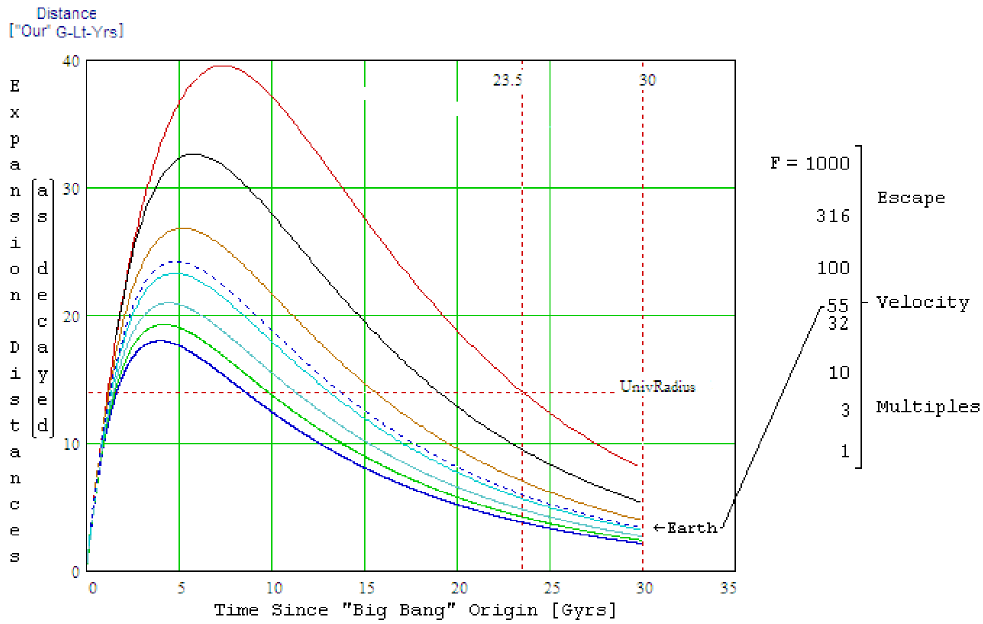

Figure 14-4d
Second Phase of The Universe Expansion -- Distances for Age = 30 Gyrs Case

[The notation "UnivRadius" in the above Figure 14-4d refers to the discussion following Table 14-1c concerning developing the appropriate volume of the universe to use in conjunction with the universe density to obtain the universe mass.]

2 - Observing, from Earth, Light Emitted by Astral Sources

Now that formulations have been developed that describe the travel of the two different traveling entities, light and matter, at various times in the past from at the beginning to the present the problem of observing light from astral sources can be addressed. The problem is to determine under what conditions light emitted long ago will have traveled to the exact present location of an observer that has also been performing its own travel while the light to be observed has been traveling.

For convenience the following quantities are defined.

```
Age  ≡ Age now of the universe = time "now".
Back ≡ how long ago it is theoretically possible to
       observe.
Then ≡ the Age of the universe then [Back ago].
     = Age - Back.
```

The distance that the light travels [continuously at whatever its speed was when it was first emitted from its astral source] from when first emitted at time t until now, at time *Age*, is then:

(14-27)

$$\begin{aligned} \text{LightTravel(t,Age)} &= [\text{Speed(t)}]\cdot[\text{Travel Time}] \\ &= \left[c(t,\text{Age})[m/s]\right]\cdot\left[[\text{Age} - t][s]\right] \\ &= c(t,\text{Age})\cdot[\text{Age} - t] \end{aligned}$$

Per the above mnemonic terminology, *LightTravel(t,Age)*, the motion of the cosmic bodies involved will be termed as in equation 14-28.

(14-28)

$$\begin{aligned} \text{WhereUs(t,Age,F)} &\equiv \text{location of we observers} \\ \text{WhereSource(t,Age,F)} &\equiv \text{location of observed light source} \\ &\approx -\text{WhereUs(t,Age,F)} \end{aligned}$$

[to account for the formulations being of similar form but with their travels diametrically opposite and their "F" values able to be different].

Taking the location of the "Big Bang" singularity as at distance zero and noting that the initial distance, $d_0 = 4.0\cdot10^7$ *meters*, is negligible [less than one "our light years" on a scale of "giga our light years"], then the formulation for *WhereUs(t,Age)* develops as follows.

(14-29) Travel from the "Big Bang" outward

(14-29A) Travel during time t=0 to time t=ChangePoint:

$$\begin{aligned} \text{WhereUsA(t,Age,F)} &= [\text{Travel of Matter in 1st Phase}] \\ &= \int_0^t [\text{Speed of Matter in 1st Phase(t,Age,F)}]\cdot dt \\ &= \int_0^t [\text{Decaying Light Speed(t,Age)}]\cdot dt \\ &= \int_0^t c(t,\text{Age})\cdot dt \end{aligned}$$

(14-29B) Travel from time t=ChangePoint onward:

$$\begin{aligned} \text{WhereUsB(t,Age,F)} &= \\ &= [\text{1st Phase Travel to ChangePoint}] + [\text{2nd Phase Travel(t,Age,F)}] \\ &= [\text{WhereUsA(ChangePoint,Age)}] + [\text{2nd Phase Travel(t,Age,A)}] \quad [F\rightarrow A] \\ &= [\text{1st Term}] + \int_{\text{ChangePoint}}^{t} [\text{Decaying } c(t)]\cdot[\text{GravSlowing}]\cdot dt \\ &= [\text{1st Term}] + \int_{\text{ChangePoint}}^{t} [c(t)]\cdot \frac{1}{\varepsilon^{A\cdot[t - \text{ChangePoint}]}}\cdot dt \end{aligned}$$

where "A" is the "2nd Phase Constant-A" of Tables 14-4a and 14-4b.

However, there is one more factor in the development of *WhereUs(t,Age)*, the general effect of the Universal Decay. The Universal Decay produces an acceleration on all bodies which acceleration is: centrally directed, independent of separation distances, and the same and constant everywhere except that the amount of that acceleration also exponentially decays. Its value now is $(8.74 \pm 0.94) \times 10^{-8}\ cm/s^2$. That acceleration produces a gradual contraction of the overall universe; that is, the exponential decay of the length *[L]* aspect of all quantities is also a decay of the distance spacings in the universe.

The acceleration is evidenced by galactic rotation curves and by the travel of the Pioneer 10 and 11 space craft. That the Universal Decay is not directly observable because our measuring equipment [our "ruler"] is also decaying, as noted earlier above, prevents our direct observation of the contraction in the case of our solar system and that of galactic rotation curves. However, in the case of the Pioneer 10 and 11 satellites and the case of galactic rotation curves, the decay has been detected because it forces orbital / path behavior that would not be present if there were no decay, and that behavior can be and has been observed -- e.g. the Pioneer space craft are not as far outward from the Sun as they should be were there no Universal Decay contraction.

Consequently, as the various bodies in the universe travel outward from the location of the "Big Bang", the distances that they have already traveled continuously decay. And, consequently, the distances traveled by light emitted from the various sources in the universe continuously decay after having been first traveled "undecayed". Therefore, the final form for *LightTravel* is then equation 14-29, below [continued from equation 14-26]. And, the final form for *WhereUs(t,Age)* is equations 14-30A and 14-30B, below [continued from equations 14-29A and 14-29B, above].

(14-30) Distance traveled outward from its source until now, time "Age", by light emitted at time "t":

$$\text{LightTravel}(t,\text{Age}) = [\text{Speed}]\cdot[\text{Travel Time}]\cdot[\textit{As Decayed}]$$

$$= c(t,\text{Age})\cdot[\text{Age} - t]\cdot\varepsilon^{-[(\text{Age}-t)/\tau]}$$

(14-31) Distance traveled outward from the "Big Bang" until time "t" by matter originating at the "Big Bang" [t=0, distance=0]:

WhereUs(t,Age,F):

(14-31A):

Travel during time t=0 to time t=ChangePoint:

$$\text{WhereUsA}(t,\text{Age},F) = [\text{1st Phase Matter Travel}]\cdot[\textit{As Decayed}]$$

$$= \left[\int_0^t c(t,\text{Age})\cdot dt\right]\cdot\varepsilon^{-[t/\tau]}$$

(14-31B):

Travel from time t=ChangePoint onward:

WhereUsB(t,Age,F) =

= [[1st Phase Travel to ChangePoint]·[not decayed] + [2nd Phase Travel]]·*[All as Decayed]*

$$= \left[[1st] + \int_{ChangePoint}^{t} [c(t)] \cdot \frac{1}{\varepsilon^{A \cdot [t - ChangePoint]}} \cdot dt \right] \cdot \varepsilon^{-[t/\tau]}$$

a. The Maximum Distance into the Past That is Observable

The extreme case of observing ancient light is the observing of light that originated diametrically opposite from us, the observers, relative to the origin of the "Big Bang". That light must travel the distance from its source back to the location of the origin of the "Big Bang" and then further outward to the location of us, the observers. The light originates from its source at time *t = Then* and is observed by us at time *t = Age*. That distance, for any age of the universe, *Age*, is as follows.

(14-32)

LightMustTravel(t,Age)
= -WhereSource(Then,Age,F) + WhereUs(Age,Age,F)

As compared to the above requirement, the actual distance that that light does travel is given by equation 14-29 with *t = Then*, as follows.

(14-33)

LightDoesTravel(t,Age)

$$= c(Then,Age) \cdot [Age - Then] \cdot \varepsilon^{[(Age - Then)/\tau]}$$

$$= c(Then,Age) \cdot [Back] \cdot \varepsilon^{-[(Back)/\tau]}$$

For the light to be theoretically observable by us the above two must be the same.

(14-34) LightMustTravel(t,Age,F) = LightDoesTravel(t,Age)

The only variables in equation 14-34 [for a particular *Age* and energy multiple, *F*,] are *Back* and *Then*, either of which determines the other per *Then = Age - Back*. The solution to equation 14-34 is obtained using a computer assisted design program ["Mathcad" in this case]. The applicable form of *WhereUs(t,Age,F)* must be used, *WhereUsA(t,Age,F)* or *WhereUsB(t,Age,F)* depending on the value of *Then* relative to the *ChangePoint*.

The results are presented in Tables 14-5a and 14-5b, below.

For: Universe Age = 30 Gyrs, which means that:
Initial Light Speed = $4.226,895,62 \cdot 10^9$ m/s
Initial Gravitation Constant, G = $1.870,24 \cdot 10^{-7}$ $m^3/kg\text{-}s^2$

F-Factor	ChangePoint Time[Gyrs]	2nd Phase Constant-A	Observable Past Distance Back [Gyrs]	Observable Past Distance Then [Gyrs]	Relative! Abundance
1	0.004713	16.92385	7.5860	22.4140	22.
3	0.01414	16.98010	8.4081	21.5919	37.
10	0.04721	17.04691	9.8790	20.1210	63.
32	0.1518	17.12856	26.0791	3.9209	93.
100	0.4812	17.23245	27.01869	2.98131	90.
316	1.5960	17.37183	27.56523	2.43477	23.
1000	6.0840	17.57200	27.61821	2.38179	0.1

! = Estimate per Fig 14-1a, where Earth, F = 55, is of Abundance 100

Table 14-5a
Distance into the Past That is Observable, Age = 30 Gyrs

For: Universe Age = 14 Gyrs, which means that:
Initial Light Speed = $1.030,357,62 \cdot 10^9$ m/s
Initial Gravitation Constant, G = $2.711,29 \cdot 10^{-9}$ $m^3/kg\text{-}s^2$

F-Factor	ChangePoint Time[Gyrs]	2nd Phase Constant-A	Observable Past Distance Back [Gyrs]	Observable Past Distance Then [Gyrs]	Relative! Abundance
1	0.004715	16.59278	3.4828	10.5172	22.
3	0.01416	16.64877	3.7136	10.2864	37.
10	0.04721	16.71513	4.0702	9.9298	63.
32	0.1518	16.79505	4.6849	9.3151	93.
100	0.48125	16.89330	5.9772	8.0228	90.
316	1.5961	17.01200	8.8230	5.1770	23.
1000	6.0890	17.09155	10.04945	3.95055	0.1

! = Estimate per Fig 14-1a, where Earth, F = 55, is of Abundance 100

Table 14-5b
Distance into the Past That is Observable, Age = 14 Gyrs

For *Age = 14 Gyrs*, as presented in Table 14-5b above, even the most energetic case of observable past distance, that for *F = 1,000*, has a theoretical limit, about *10 Gyrs*, that is less than actual observations have reported [the reported distances based on Hubble - Einstein cosmology].

That Hubble - Einstein cosmology problem is even more severe if the calculations of Table 14-5b are performed with no universal decay, as the Hubble - Einstein cosmology contends. The results for that case are presented in Table 14-5c below in which the greatest observable past distance is barely *8 Gyrs*, quite substantially less than reported observations [their reported distances based, erroneously, on the Hubble Law]. That is so even when a greatly more energetic case, $F = 3000$, is examined. For that extreme the energy is such that the gravitation has not yet slowed that matter down to the speed of light which means that its Doppler redshift would be approaching the infinite, $z \approx \infty$.

For: Universe Age = 14 Gyrs, and no Universal Decay
per Hubble - Einstein Cosmology

F-Factor	ChangePoint Time[Gyrs]	2nd Phase Constant-A	Observable Past Distance Back [Gyrs]	Observable Past Distance Then [Gyrs]	Relative! Abundance
1	0.00471	16.59278	3.5544	10.4456	22.
3	0.01413	16.64877	3.7343	10.2657	37.
10	0.04713	16.71513	3.9972	10.0028	63.
32	0.1518	16.79505	4.4214	9.5786	93.
100	0.471	16.89360	5.1720	8.8280	90.
316	1.489	17.01575	6.5490	7.4510	23.
1000	4.710	17.16130	8.08125	5.91875	0.1
3000	14.13 [>Age]	n/a	8.15	5.85	

! = Estimate per Fig 14-1a, where Earth, F = 55, is of Abundance 100

Table 14-5c
Table 14-5b Re-Calculated with No Universal Decay
and Added Extreme Case

Clearly, the tenets of the Hubble - Einstein cosmology fail because they cannot conform to reality as it is already known.

Returning to Universal Decay cosmology and the age of the universe being $Age = 30\ Gyrs$, that age derives from what is needed to enable observation of redshifts on the order of $z = 10$, as presented in the next section below. It is an estimate because our instrumentation presently limits our ability to observe the past more than the theoretical limit does. Consequently new developments in instrumentation and observation may produce observed redshifts greater than $z = 10$, ones on the order of $z = 12$ or more, and therefore require a corresponding increase in the estimated age of the universe.

The present value for the farthest back into the past that it is theoretically possible to observe regardless of the quality of our instrumentation is a little over $27\ Gyrs$ ago to the time 2 to $3\ Gyrs$ after the "Big Bang". The travel of the light source and of the observer's home and of the emitted light for that case of the most distant source theoretically observable, all from the time of the "Big Bang" to the present are as shown in Figure 14-6, on the following page.

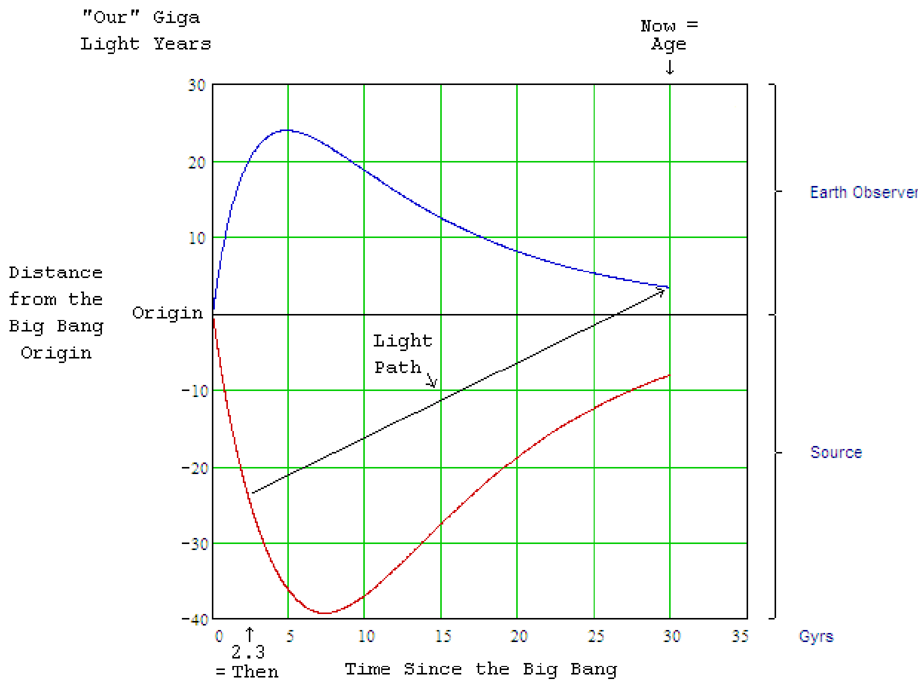

Figure 14-6
The Most Distant into The Past Source [-] Observable by an Earth Observer [+] Diametrically Opposite Relative to the "Big Bang" Origin

b. Redshifts: Universal Decay and Hubble Doppler

There are two causes of the redshifts that we observe: the universal decay and the Doppler shift due to astral objects' velocity away from us.

The universal decay redshift occurs because we observe ancient light traveling at the speed at which it was originally emitted, a speed significantly larger because less decayed than our present local speed of light. We observe the greater speed as a lengthening of all wavelengths in the light [with no change in frequencies]. The formulation for the universal decay redshift, z_τ, of light that was emitted at time $t = T$ after the "Big Bang" and is observed at a later time $t = now = age$ is as follows below.

(14-35) $z_\tau \equiv$ redshift due to the universal decay

$$= \frac{\lambda_{observed} - \lambda_{local}}{\lambda_{local}}$$

$$= \frac{c(\text{time light emitted})}{c(\text{time now})} - 1$$

$$= \frac{c(t{=}0)\cdot\varepsilon^{-[T/\tau]}}{c(t{=}0)\cdot\varepsilon^{-[age/\tau]}} - 1 = \frac{\varepsilon^{-[T/\tau]}}{\varepsilon^{-[age/\tau]}} - 1$$

The formulation for the Doppler shift due to astral objects' velocity away from us, z_D, is as follows, per standard Hubble - Einstein cosmology.

(14-36) $z_D \equiv$ relativistic redshift of the Doppler effect

$$= \frac{[1 + {}^{v}/_{c}]^{1/2}}{[1 - {}^{v}/_{c}]^{1/2}} - 1$$

The formulation for the universal decay redshift, equation 14-35, is a function of time, not velocity. Equation 14-36 can be converted to expressing the Doppler redshift, z_D, in terms of time by using the velocity-as-a-function-of-time expressions for the motion of the astral body products of the "Big Bang" developed earlier above: equations 14-21 and 14-25.

For the period from time $t = 0$ through $t = ChangePoint$ the velocity, equation 14-21, is very nearly the then current decaying speed of light. The ${}^{v}/_{c}$ ratio is very nearly 1.0 so that the redshifts, z_D, are very large, but are also essentially meaningless for any useful purpose.

For the period from $t = ChangePoint$ onward the velocity expression is equation 14-25, repeated below.

(14-25)

$$v2(t,Age,F) = c(t,Age)\cdot\frac{1}{\varepsilon^{A\cdot(t - ChangePoint)}}$$

where A and ChangePoint are given in Table 14-5.

The ${}^{v}/_{c}$ ratio is equation 14-25 divided by $c(t,Age)$:

(14-37)

$${}^{v}/_{c} = \frac{1}{\varepsilon^{A\cdot(t - ChangePoint)}}$$

and by substituting that into equation 14-36 the expression for the Doppler redshift, z_D, is:

(14-38)

$z_D \equiv$ relativistic redshift of the Doppler effect

$$= \frac{[1 + {}^{v}/_{c}]^{1/2}}{[1 - {}^{v}/_{c}]^{1/2}} - 1$$

$$= \frac{\left[1 + \frac{1}{\varepsilon^{A\cdot(t - ChangePoint)}}\right]^{1/2}}{\left[1 - \frac{1}{\varepsilon^{A\cdot(t - ChangePoint)}}\right]^{1/2}} - 1$$

These two principle causes of redshifts are depicted independently in Figure 14-7, below. Of course, the actual observed redshift is the sum of the two.

From the figure it is apparent that the Doppler-caused redshifts are quite minor until one is addressing light emitted only at times too early to be observable.

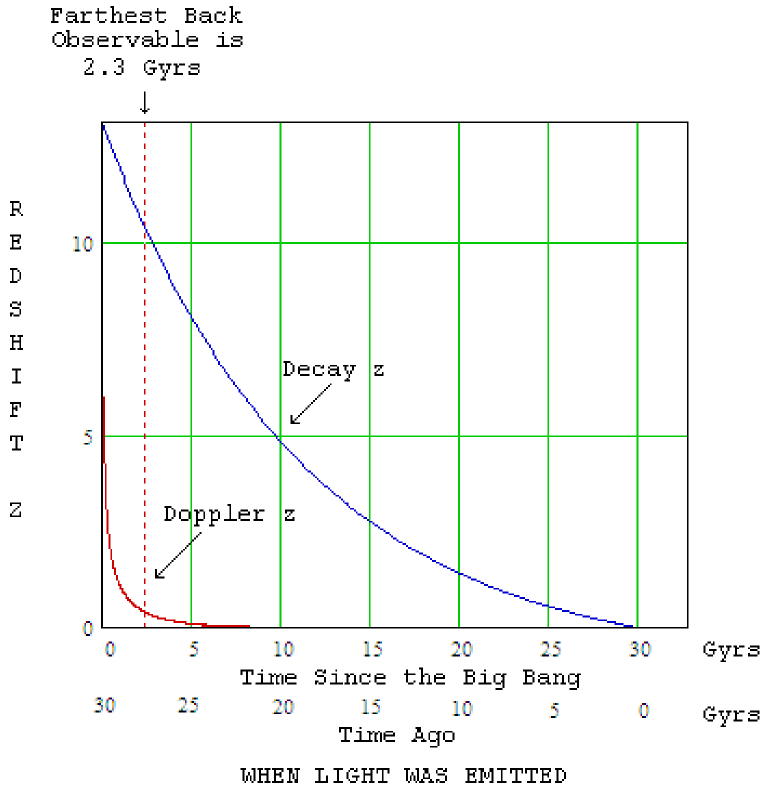

Figure 14-7
Redshifts: Caused by Universal Decay and by the Doppler Effect

The figure also makes clear why the age of the universe must be on the order of $30\ Gyrs$. That amount of time is needed to include enough time constant periods, τ, that is $11.3373\ Gyrs$, each to yield a maximum observable redshift [at $then = 2.3\ Gyrs$] of $z > 10$ as in the figure. A small number of redshifts at $z = 10$ have been reported with some indications of redshifts as high as $z = 12$. Improved instrumentation and techniques may well result shortly in confirmed detection of redshifts at $z > 10$. The value $age = 30\ Gyrs$ is an, at present, conservative best estimate taking into account currently known observational data.

3 - The Fate of the Universe

Although the initial velocities of the "Big Bang" product particles were greater than the there / then escape velocity, as shown earlier above, their velocities now are all well under their escape velocity. We are used to escape velocity being escape velocity -- a simple yes or no proposition. The reason that that is not the case for the overall universe is the effect of the speed of light limitation.

The escape process is the conversion of kinetic energy into gravitational potential energy. If the initial kinetic energy is greater than the maximum possible gravitational potential energy then there will be escape. In the case of a rocket leaving Earth that process is accompanied by the rocket's velocity taking it farther enough away from the Earth that the gravitational effect is reduced in "proper" relation to the process. But the "Big Bang" product particles were not permitted to so travel, their actual velocity being limited to just under light speed as compared to the much larger theoretical non-relativistic velocity at which they would have had to have traveled outward for the accrued distance to correspondingly reduce the gravitational effect in "proper" relation to the process.

The actual velocities and the related escape velocities now at time $t = Age$ for the same distribution of initial "Big Bang" product energies analyzed earlier above is given in Table 14-9, below. As in the earlier analysis of the initial escape velocity, the present analysis is non-relativistic, using velocities greater than the speed of light rather than letting mass relativistically increase.

For: Universe Age = 30 Gyrs, which means that:
Initial Light Speed = $4.226,895,62 \cdot 10^9$ m/s
Initial Gravitation Constant, G = $1.870,24 \cdot 10^{-7}$ $m^3/kg\text{-}s^2$
At Age = 30 Gyrs:

F-Factor	Outward from the Origin of the "Big Bang"* Velocity[m/s]	Distance[G-Lt-Yrs]	Escape Velocity[m/s]
1	$0.00003814 \cdot 10^8$	2.157	$7.418 \cdot 10^8$
3	$0.0001505 \cdot 10^8$	2.400	$7.032 \cdot 10^8$
10	$0.0006230 \cdot 10^8$	2.727	$6.597 \cdot 10^8$
32	$0.002731 \cdot 10^8$	3.205	$6.085 \cdot 10^8$
55 Earth	$0.003700 \cdot 10^8$	3.374	$5.931 \cdot 10^8$
100	$0.01287 \cdot 10^8$	3.980	$5.461 \cdot 10^8$
316	$0.06673 \cdot 10^8$	5.388	$4.693 \cdot 10^8$
1000	$0.3974 \cdot 10^8$	8.034	$3.844 \cdot 10^8$

* = Decayed to Age

Table 14-9
Actual Velocities vs. Escape Velocities Now, at $t = Age$

One must immediately conclude that the entire material universe is ultimately destined to collapse back toward the location of its origin, just as a ball tossed straight up from the Earth's surface ultimately returns to its starting point. However, the case of the universe is more complicated than that of the simple ball and there are also two different considerations for the case of the universe: its matter and its radiation.

a. The Fate of the Universe's Radiation

The fate of the radiation emitted from sources [primarily astral sources] throughout the universe is very different from the fate of the universe's matter. Most of the universe's radiation continues propagating outward forever, reduced in concentration inversely as the square of the distance from its source, and carrying outward in itself a significant amount of the universe's energy, which energy becomes essentially lost to the remainder of the universe, the universe's matter. That comes about as follows.

(1) Gravitational Redshift and Light Escape

When a particle of mass m climbs in a gravitational field its speed is reduced by the gravitation, which speed reduction reduces its kinetic energy, $½\cdot m\cdot v^2$. Conservation is maintained by the kinetic energy loss being replaced by gravitational potential energy increase.

A photon of frequency f has kinetic mass, m_{ph}, [even though it has no rest mass].

$$(14\text{-}41)\quad m_{ph} = {}^{energy}/_{c^2} = {}^{h\cdot f}/_{c^2}$$

As light, with its kinetic mass, m_{ph}, climbs in a gravitational field, instead of its speed being reduced its frequency is shifted lower [toward the red]. The photon cannot slow down [to correspondingly reduce its kinetic energy as a particle of matter would] because it is constrained by its nature to only travel at light speed, c. Instead the photon frequency, f, decreases, which reduces its energy, $h\cdot f$, its energy of motion that corresponds to kinetic energy.

Then, for a photon to be able to escape from a gravitational field in a manner analogous to escape for a particle of mass, the photon energy, $h\cdot f$, must at least just exceed the depth of the gravitational potential energy pit, ${}^{G\cdot M\cdot m_{ph}}/_{R}$, that it experiences at the location where the photon is emitted. On that basis the calculation for photon escape would be that the photon frequency must be at least such that

$$(14\text{-}42)\quad h\cdot f_{minimum} > {}^{G\cdot M\cdot m_{ph}}/_{R}$$

however, the photon mass, m_{ph}, depends on f per equation 14-41 so that a directly solvable relationship cannot be obtained on that basis; photon escape is independent of photon frequency.

(2) The "Schwarzschild Radius" and Escape

Astrophysicists treat a quantity called the "Schwarzschild Radius". The line of thought is that the depth of a gravitational potential energy pit from which a particle must climb in order to escape is ${}^{G\cdot M\cdot m}/_{R}$ where G is the gravitation constant, M is the gravitating mass, m is the mass of the particle attempting escape, and R is the distance from the center of the gravitating mass at which the particle must begin its attempt. To escape, the particle's kinetic energy, $\frac{1}{2} \cdot m \cdot v^2$, must just exceed that potential energy so that, as presented earlier, the escape velocity is $v_{esc} = [2 \cdot G \cdot M / R]^{1/2}$.

From that formulation, as R decreases the required velocity, v increases. Therefore one can calculate a radius, R_S, the "Schwarzschild Radius", for any particular gravitating body mass, M, such that the required escape velocity, v_{esc}, is the speed of light, c, as follows.

(14-43) For Light, a Photon of Mass m_{ph}:

Photon Energy = Gravitational Potential Energy

$$m_{ph} \cdot c^2 = G \cdot M \cdot m_{ph} / R = G \cdot M \cdot m_{ph} / R_S$$

$$R_S = G \cdot M / c^2$$

(14-44) For a Particle of Mass "m":

Kinetic Energy = Gravitational Potential Energy

$$\frac{1}{2} \cdot m \cdot v^2 = G \cdot M \cdot m / R$$

$$m \cdot c^2 = G \cdot M \cdot m / R_S$$

[Because KE = TotalE - RestE, then as $v \to c$ TotalE >> RestE and KE $\to$ TotalE not ½·TotalE all because of the mass increase due to relativity.]

$$R_S = G \cdot M / c^2$$

[Solve for R_S]

[The usual presentation, that ignores the effect as in the above note, is $R_S = \underline{2} \cdot G \cdot M / c^2$]

No matter can travel at light speed, therefore matter located at or nearer to the center of the gravitating mass than R_S cannot ever escape. For radiation escape is independent of the frequency and depends only on the distance, R_S.

For the value of R_S for the universe at the instant of the "Big Bang":

- from equation 14-16 G was $G(0) = 1.870 \cdot 10^{-7}\ m^3/kg\text{-}s^2$,
- from equation 14-13 M was $M_{Universe} = 3 \cdot 10^{49}$ kg, and
- from equation 14-3 c was $c(0) = 4.226 \cdot 10^9$ meters/sec.

Then, the value of R_S for the universe at the instant of the "Big Bang" was $3.14 \cdot 10^{23}$ *meters* which is *[0.033 G-Lt-Yrs]* and at that instant the actual distance from the center of the "Big Bang" was much less, $d_0 = 4.0 \cdot 10^7$ *meters*. Therefore, at that time, $t = 0$, no matter nor light could escape from the "Big Bang" as already demonstrated and summarized for matter in Table 14-9, above. The inability of matter to escape did not change thereafter.

However, in its rapid initial expansion at a speed of very nearly $c(0)$, after time approximately $[R_S \div c(0)]$, that is the first two to three million years, the light-source matter of the universe had moved out from the origin to beyond the "Schwarzschild Radius" and whatever radiation was emitted thereafter was free to travel outward forever.

b. The Fate of the Universe's Matter

The universe's matter, however, was already embedded in the impossibility of escape and it only remains to investigate its fate.

To this point the material presented has consisted of analytical deductions and reasonable estimates based on fundamentals of physics, the available data, and the tenets of the theories involved. Now, with regard to the fate of the universe's matter, some of what is presented must be limited to "educated" speculation as to the implied future while some still remains reasonable analytical deductions.

Clearly the large range of the present velocities of the universe's matter and of its varied present distances outward from the origin per Table 14-9 means that the universe's matter's gradual slowing - direction reversal - inward collapse will result in a wide range of arrival times at the origin of the original expansion of the universe's various portions. [That as juxtaposed to the concept of a universe all together collapsing and then re-exploding outward in a succession of "big bangs" as has been hypothesized in the not too distant past.] There are, then, several possibilities to be considered.

- Matter so arriving at the initial origin crashing into like kind so arriving matter.

  Recently there have been analyses of what happens when a large asteroid crashes into the Earth, the energies involved and the resulting destruction being immense. One can only [speculatively] increase those energies and their results many orders of magnitude to conceive of what would happen at the collision of two planetary bodies, two suns, or two galaxies.

  However, the collision would be kinetic and produce great heat, breakdown into particles, and great kinetic energy of those product particles. It would not be as a nuclear fission nor fusion explosion, that is it most likely would not involve a major conversion of matter to energy.

- Matter so arriving at the initial origin encountering there nothing but empty space.

  Unlike the case of the ball tossed upward from the Earth's surface in which case the Earth is still there when the ball falls back down, it would seem that there is now likely nothing but empty space at the location of the initial origin. A portion of the universe's matter arriving there unopposed would be traveling at high speed [most likely the same [then outward but now inward] speed as was imparted to it in the original "Big Bang" [but as reduced by the Universal Decay of the speed of light]. That body of matter would pass on through and proceed outward again in its own "personal" replay of its earlier role.

Except, that is, that the first time the gravitating matter of the universe was initially all concentrated at the origin whereas the second time that matter is scattered over a large universe volume. The gravitational conditions would be different for the second pass and the escape velocity would also be different. One can only [speculatively] imagine various scenarios for the further travel of that portion of the universe's matter and its peers / partners.

- Matter so arriving at the initial origin and there encountering anti-matter.

There are two alternative hypotheses with regard to anti-matter creation in the "Big Bang":

· Anti-matter was created, but in a lesser amount than ordinary-matter, and quite shortly thereafter all of the anti-matter mutually annihilated with an equal amount of ordinary-matter leaving essentially no remaining anti-matter and a small remaining amount of ordinary-matter, which is the matter of our universe. In this hypothesis there is no, or negligible anti-matter in today's universe.

This alternative voids the "matter arriving encountering anti-matter" possibility.

· Matter and anti-matter were created in equal, "mirror" amounts and, while some of it promptly mutually annihilated, equal amounts of each participated in the outward expansion quickly enough to survive. Thus our universe has matter portions and similar anti-matter portions and their continued separation in space largely preserves their continued independent existence.

In this hypothesis matter so arriving at the initial origin could encounter anti-matter, which would result in a mutual annihilation. Unlike the kinetic collision case, the result would be an immense amount of energy radiated mostly as gamma rays.

With regard to those two alternative hypotheses the last Reference, *The Problem of Big Bang Matter vs. Antimatter Symmetry* favors the second of the two.

The behavior of anti-matter is such that there is no way to discriminate whether a distant astral source is matter or anti-matter: the gravitation is the same; the light emitted is the same.

c. The Ultimate End of the Universe.

(1) The Universal Decay Will Continue

The universe will continue shrinking to beyond the point of extremely minute, all to no noticeable effect on its internal functioning no matter how small it becomes relative to the size that it is now or originally was.

If one looks back one million years ago, lengths then were greater than the corresponding lengths today by a factor of *1.0009*. Clearly the universal decay has little significance in day to day life. In fact, its only significance is for astronomers, because only they can look back into the past far enough to see the effects of the extremely slow decay.

Everything decays proportionately. The ratio at any time, now or in the past or in the future, of the size of things relative to things does not change at all. There is no fixed objective reference by which one could appreciate or notice the decay other than those accessible only to astronomy. Everything is shrinking, but to no noticeable effect. Whatever happens to be left of the universe some inconceivable number of aeons from now will be so extremely minute compared to the size of things in today's universe as to seem to us as nothing. Yet it will operate, function, behave according to the same rules as our universe now, as if it had not decayed at all [again except astronomically], but subject to the events below.

(2) The Universe's Matter Will Gradually Completely Obliterate

Whatever time it takes, eventually all of the universe's matter will be obliterated in mutual annihilations. The process will be a kind of universe "Russian Roulette", annihilations depending randomly on the simultaneous arrival of matter and anti-matter portions of the universe at the location of the initial origin. Such annihilations will extend only to the extent of arriving masses being equal; the un-annihilated surplus of the greater being hurled outward again for another excursion and later chance of annihilation upon its return.

(3)The Universe's Radiation and Energy Will Be Dispersed in Endless Space

All of the radiation and energy of the matter annihilations along with all of the astral and other radiation and energy from the beginning on [including radiation absorbed and subsequently re-radiated] will disperse outward in space, gradually reddening and so reduced by inverse square dispersion as to eventually amount to essentially nothing.

(4) Nothing to Nothing ...

In the same way as for we humans when our span of life ends it is said, "Ashes to ashes and dust to dust ....", so for the universe it can be said, "It came from nothing and eventually passes on to nothing, to that from which it came".

– End –