(Section 21 here resumes after the preceding interruption in order to present the solution of the differential equation of the universal oscillations and their decay.)

ENERGY CONSIDERATIONS

In section *14 - A Model for the Universe (4) - Magnetic and Electromagnetic Field*, in its treatment of electromagnetic field and waves, the nature of energy at the center-of-oscillation level of reality was developed. Briefly reviewed it is as follows.

- Energy is a force acting through a distance or the ability of a force to so act, also referred to as work or the ability to do work. The ability to do work is potential energy. Work taking place is active energy.

- For a center-of-oscillation the component of its oscillation that is spherically symmetrical is energy in rest form. Any deviation from spherical symmetry is energy in kinetic form. These both are potential energy when they are unchanging since there is then no force acting, no changes in the speed nor in the amount of energy in kinetic form.

- Should a change of speed occur it can only be due to a force acting through a distance, some amount of energy, that results in either acceleration or deceleration, increase or decrease of speed, change in the amount that the oscillation of the center deviates from the spherically symmetrical.

- That is, work is done when, and only when, there is a change in the shape of the center's oscillation (and, of course, in the center's resulting U-wave field propagation pattern).

- The energy of the mutual annihilation of a particle and its anti-particle is the conversion into propagated active energy of the entire mass of the two particles. The mass of each of the particles is its oscillation and at annihilation those oscillations cease, cancel each other out. Since the center oscillations cease the last U-waves propagated are followed by no U-waves at all from those centers, the greatest possible change in the centers' oscillation and its U-wave propagation.

In summary:

> The center's oscillation and its corresponding U-wave field are potential energy, the ability to do work. A <u>change</u> in the shape of the center's oscillation and in its propagated U-wave field is active energy, work being done.

Then, the magnitude of an energy must be related to the magnitude of the change associated with it. As we subjectively perceive change there are two aspects to the magnitude of a change: the difference in the amount of the quantity that changes (the "change") and the rapidity with which the change

occurs. (Subjectively we would consider a change from fast to halted that occurs in a brief moment, such as running into a stone wall, to be much more significant than that taking place over a long time as in gradually slowing down.)

The same pairing of a quantity and a time is found in the formulation for the energy in a center's oscillation, $W = h \cdot f$, because the dimensions of f, the oscillation's frequency, are $1/T$. Thus the formulation is equivalent to $W =$ *"h per time"*.

Thus energy is change per time, a change taking place over some particular time interval, at some particular rate. The dimensions of energy are $[ML^2/T^2]$ because energy is given by

$$force \cdot distance = [mass \cdot acceleration] \cdot distance$$

Then the dimensions of change must be $[ML^2/T]$ which are also the dimensions of h, Planck's constant. *Then Planck's constant would appear to be change*. (Planck's constant is sometimes referred to as *action*.)

Phase having already been found to not be significant for center-of-oscillation purposes, there are only two meaningful changes that can take place in a center's oscillation: its amplitude and its frequency. Clearly the frequency relates to how rapidly a change occurs. Then the actual quantity that is changing at that rate must correspond to the oscillation's amplitude. The h of $W = h \cdot f$ must correspond to the amplitude of the oscillation in some sense since the f of $W = h \cdot f$ is the frequency and the phase is of no significance.

The oscillation repeating the same form of cycle, cycle after cycle, is potential energy in an amount independent of how long the repetition goes on, independent of how many cycles occur and of their rate or frequency. That fixed amount of potential energy becomes converted completely to active energy upon the oscillation completely ceasing.

The total energy of a center's oscillation being that of a change in oscillation amplitude from peak to zero at frequency f then the full amplitude of a center must correspond in some sense to the quantity h because the annihilation energy is $W = h \cdot f$. That energy, stored in the center's oscillation, also has an electrical analogue.

As already pointed out, an oscillation consists of the energy of the oscillation being exchanged back and forth between the two aspects of the oscillation by a flow between them. In the electrical circuit the energy is stored alternately in the inductance and the capacitance, the amounts being $W_L = \frac{1}{2} \cdot L \cdot i_L^2$ and $W_C = \frac{1}{2} \cdot C \cdot e_C^2$. The flow between them is a circulatory current within the electrical circuit. The amount of energy in the inductance and the capacitance varies from zero to peak, the two being $180°$ out of phase. Thus the total stored energy is equal to the peak energy stored in either. If the oscillation is quenched (analogous to the center-of-oscillation being annihilated) it is that amount of energy that is released.

The corresponding analogue applies to the core.

(21-32) $W_N = \frac{1}{2} \cdot N \cdot j_N 2$ and $W_S = \frac{1}{2} \cdot S \cdot v_S 2$

But, what is the flow in this case; what is this j_N? It is not the outward flow of medium that produces the effects which we call charge and electric field. Rather

it is the internal circulatory flow, j_{circ} (see Figure 21-5, earlier above), that shifts the energy from being stored in the N to being stored in the S and back and forth.

Referring back to the original equation of the core's flow, equation 21-13 the circulatory flow supporting the oscillation is identified.

(21-13)

$$j(t) = \frac{d[\upsilon(t)]}{dt}$$

$$= \upsilon_c \cdot \varepsilon^{-t/\tau} \cdot 2\pi \cdot f \cdot \mathrm{Sin}(2\pi \cdot f \cdot t) - \cdots$$

$$\cdots - \frac{\upsilon_c}{\tau} \cdot \varepsilon^{-t/\tau} \cdot [1 - \mathrm{Cos}(2\pi \cdot f \cdot t)]$$

$$= \upsilon_c \cdot \varepsilon^{-t/\tau} \cdot 2\pi \cdot f \cdot \mathrm{Sin}(2\pi \cdot f \cdot t) - \frac{1}{\tau} \cdot \upsilon(t)$$

$$= \underbrace{\qquad j_{circ} \qquad}_{\text{Flow associated with or supporting the decaying center's core medium oscillation.}} + \underbrace{\qquad j_{prop} \qquad}_{\text{Flow that accounts for the balance of the medium, that propagated.}}$$

From the above the circulatory flow and its maximum are as follows.

(21-33)

$$j_{circ} = [2\pi \cdot f \cdot \upsilon_c \cdot \varepsilon^{-t/\tau}] \cdot \mathrm{Sin}(2\pi \cdot f \cdot t)$$

$$J_{circ} = 2\pi \cdot f \cdot \upsilon_c$$

$$= 2\pi \cdot f \cdot \tau \cdot [c \cdot q] \quad \text{[Per equation 21-19]}$$

$$= 2\pi \cdot f \cdot \tau \cdot [Q] \quad \text{[do]}$$

[Compared to the maximum propagated flow, J_{prop}, of simply $c \cdot q = Q$]

When the flow in the inertialance, N, is at the peak J_{circ} then all of the oscillation energy is stored solely in the inertialance. Likewise, when the potential on the storeance, S, is at its peak, V_{circ}, then all of the energy of the oscillation is stored solely in the storeance. Between those states the total energy is stored partially in the inertialance and partially in the storeance. When the oscillation is at the moment when all of the energy is stored in the inertialance, N, the W_N of equation 21-32 must be the W of $W = h \cdot f$. The same applies at the other side of the oscillation when v is V_{circ} and all of the energy is in the storeance, S.

The energy stored in the oscillation not only equals h·f --- it is h·f.

For any particular center-of-oscillation f is its frequency of oscillation, a constant (at rest), and corresponds to the mass of the particle that the center is. That is, f is f_{ctr} and

(21-34)

$$f_{ctr} = \frac{m_{ptcl} \cdot c^2}{h}$$

Therefore

(21-35) $$W_{ctr,ptcl} = h \cdot f_{ctr} = \tfrac{1}{2} \cdot N \cdot J_{circ}^2$$
$$= \tfrac{1}{2} \cdot N \cdot [2\pi \cdot f_{ctr} \cdot \tau \cdot c \cdot q]^2 \quad [J_{circ} \text{ from 21-33}].$$

Using the fine structure constant, α,

(21-36) $$\alpha = \frac{\tfrac{1}{2} \cdot \mu_0 \cdot c \cdot q^2}{h} \quad \text{from which} \quad h = \frac{\tfrac{1}{2} \cdot \mu_0 \cdot c \cdot q^2}{\alpha}$$

then, substituting for h in equation 21-35 with the value obtained in equation 21-36

(21-37) $$h \cdot f_{ctr} = \tfrac{1}{2} \cdot N \cdot [2\pi \cdot f_{ctr} \cdot \tau \cdot c \cdot q]^2 = \frac{\tfrac{1}{2} \cdot \mu_0 \cdot c \cdot q^2}{\alpha} \cdot f_{ctr}$$
$$N = \frac{\mu_0}{4\pi^2 \cdot f_{ctr} \cdot \tau^2 \cdot \alpha \cdot c} \quad [\text{Solve the above for N}]$$
$$= \frac{\mu_0 \cdot h}{4\pi^2 \cdot m_{ptcl} \cdot c^3 \cdot \tau^2 \cdot \alpha} \quad [\text{Per equation 21-34}].$$

Using the value of N just obtained and the requirement that $1/2\pi \cdot \sqrt{N \cdot S} = f_{ctr}$ the value of S is obtained as follows.

(21-38) $$S = \frac{1}{4\pi^2 \cdot f_{ctr}^2 \cdot N} = \frac{1}{4\pi^2 \cdot f_{ctr}^2} \cdot \frac{4\pi^2 \cdot f_{ctr} \cdot \tau^2 \cdot \alpha \cdot c}{\mu_0}$$
$$= \frac{\tau^2 \cdot \alpha \cdot c}{f_{ctr} \cdot \mu_0}$$
$$= \frac{\tau^2 \cdot \alpha \cdot c^3 \cdot \varepsilon_0}{f_{ctr}} \quad [\text{using } \mu_0 \cdot \varepsilon_0 = 1/c^2]$$
$$= \frac{\tau^2 \cdot \alpha \cdot c \cdot \varepsilon_0 \cdot h}{m_{ptcl}} \quad [\text{again per equation 21-34}]$$

From the relationship that $\tau = 2 \cdot S \cdot O$ and using the S just obtained O is obtained as follows.

(21-39) $$O = \frac{\tau}{2 \cdot S} = \frac{f_{ctr}}{2 \cdot \tau \cdot \alpha \cdot c^3 \cdot \varepsilon_0}$$
$$= \frac{f_{ctr} \cdot \mu_0}{2 \cdot \tau \cdot \alpha \cdot c} \quad \left[c^2 = \frac{1}{\mu_0 \cdot \varepsilon_0}\right]$$
$$= \frac{h \cdot f_{ctr}}{\tau \cdot c^2 \cdot q^2} = \frac{W_{ctr}}{\tau \cdot c^2 \cdot q^2} \quad [\text{Using equation 21-36}]$$

N, S, AND THE SPEED OF PROPAGATION, c

In section *16 - A Model for the Universe (6) - The Neutron, Newton's Laws* the speed of propagation along an electrical transmission line was used to develop the speed of propagation of U-waves. From that development, the speed of propagation along the transmission line, the speed of propagation through a medium of distributed inductance and capacitance of values per unit length of L_p and C_p was obtained as

(21-40) $$c = \frac{1}{\sqrt{L_p \cdot C_p}}$$

Because that same result applies to light, the speed of light is the already frequently presented

(21-41) $$c = \frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}}$$

However, the electromagnetic waves of light are merely an imprint on the flowing medium. It is medium that travels at the speed c. That speed is the speed of light only because light "rides" as an imprint pattern on the U-waves, which are themselves propagating at c. It is the medium flowing at c which is the only "hard" reality. The rest is merely effects of it.

But medium is characterized by inertialance, N and storeance, S, not μ_0 and ε_0. Yet its speed must still be based on μ_0 and ε_0 because it has already been found to be so based. Clearly then, it must be that:

(21-42)

(a) $$c = \frac{1}{\sqrt{N_p \cdot S_p}}$$ [where N_p = the inertialance per unit length and S_p the storeance per unit length in free space]

and that

(b) $$N_p = a \cdot \mu_0$$ [Where "a", a constant, must yet be determined]

$$S_p = \left[\frac{1}{a}\right] \cdot \varepsilon_0$$

so that

(C) $$c = \frac{1}{\sqrt{[a \cdot \mu_0] \cdot \left[\frac{1}{a}\right] \cdot \varepsilon_0}}$$ [Substituting equation 21-42(b) into 21-42(a)]

$$= \frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}}$$

but, what is "a" ?

In addition to the characteristic speed as just addressed there is a second characteristic quantity of propagation through any medium of transmission such as a transmission line or free space. That characteristic quantity also depends on

the L and C or the N and S per unit length, L_p and C_p or the N_p and S_p, in the propagation path. It is Z_0, termed the *characteristic impedance* and develops as follows.

Returning to the transmission analogy, the pertinent figure, Figure 16-9, is repeated below.

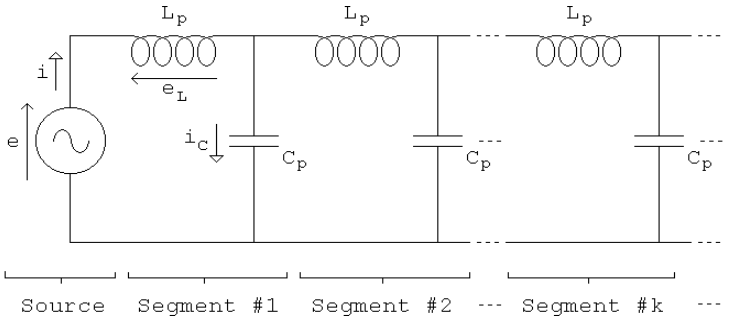

Figure 16-9

In the figure, the current, i, that is caused to flow into the line by the applied potential, e, is limited just as if the line had an equivalent electrical resistance, R_{eq}, instead of the string of L - C segments even though there is no actual resistance present. That is,

(21-43) $$R_{eq} = \frac{e}{i}$$

for which

(21-44) $$\frac{e}{i} = \frac{L_p \cdot v \cdot i}{C_p \cdot v \cdot e}$$ [per equation 16-29]

[per equation 16-30]

$$\frac{e^2}{i^2} = \frac{L_p}{C_p}$$ [rearrangement]

$$R_{eq} = \left[\frac{L_p}{C_p}\right]^{1/2}$$ [combining 21-43 with 21-44]

This is the characteristic impedance of the transmission line.

(21-45) $$Z_0 = \left[\frac{L_p}{C_p}\right]^{1/2}$$

For free space it is

(21-46) $$Z_0 = \left[\frac{\mu_0}{\varepsilon_0}\right]^{1/2}$$

If a characteristic retardance of the core is analogously defined it is obtained as

(21-47)

$$Y_0 = \left[\frac{N}{S}\right]^{1/2}$$

$$= \frac{1}{2\pi\cdot\tau^2\cdot\alpha\cdot c^2}\cdot\left[\frac{\mu_0}{\varepsilon_0}\right]^{1/2}$$ [Substituting "N" and "S" from equations 21-37 and 21-38]

Squaring equation 21-47 and rearranging it

(21-48)

$$\left[\left[\frac{N}{S}\right]^{1/2} = \frac{1}{2\pi\cdot\tau^2\cdot\alpha\cdot c^2}\cdot\left[\frac{\mu_0}{\varepsilon_0}\right]^{1/2}\right]^2$$

$$\frac{\mu_0}{\varepsilon_0} = \left[2\pi\cdot\tau^2\cdot\alpha\cdot c^2\right]^2\cdot\frac{N}{S}$$

Because the ratios are taken, μ_0/ε_0 and N/S, it does not matter whether the quantities are per-unit-length or not; the effect cancels in the ratios. Therefore, equation 21-48 applies to N_p and S_p, the inertialance and storeance per unit length in free space. This provides the solution to the question of what a is (the a of equation 21-42).

(21-49)

(a) $$a = \frac{1}{2\pi\cdot\tau^2\cdot\alpha\cdot c^2}$$

(b) $$N_p = \frac{1}{2\pi\cdot\tau^2\cdot\alpha\cdot c^2}\cdot\mu_0 \qquad S_p = \left[2\pi\cdot\tau^2\cdot\alpha\cdot c^2\right]\cdot\varepsilon_0$$

(c) $$\mu_0 = \left[2\pi\cdot\tau^2\cdot\alpha\cdot c^2\right]\cdot N_p \qquad \varepsilon_0 = \frac{1}{2\pi\cdot\tau^2\cdot\alpha\cdot c^2}\cdot S_p$$

The medium "came first" (is the cause) of course. It is N_p and S_p, direct consequences of the N and S of the core of the center-of-oscillation as the core's gradual decay produces propagation of medium outward into and throughout space, which are the cause of μ_0 and ε_0 which simply result from N_p and S_p per equation 21-49(c).

Not only is the medium flow the cause of μ_0 and ε_0, but even more the core of a center-of-oscillation is the cause of that medium flow, the center's propagation of medium. The original fundamental reality was / is N and S. N_p and S_p are merely that portion of a core's N and S represented in the minute amount of medium propagated. The action of that N_p and S_p appears to us as being μ_0 and ε_0.

(In the case of electrical transmission lines the characteristic impedance, Z_0, has a special significance. At any location along such a transmission line the impedance "seen looking in at that point" appears to be Z_0. The purpose of such a line is to carry signals to some end point use, for example a loudspeaker. If the impedance of that end point equipment equals Z_0 then the transmission line "looks to the signal as if the line goes on forever". That means that all of the energy sent down the line continues going that way. But if the equipment at the end of the line has an impedance other than Z_0 the line "looks to the signal as if

it ends there" (at least partially). The signal (at least partially) reflects, "bounces" off the termination and returns toward its source.

(That reasoning might lead one to expect that the "transmission line" of U-waves have a characteristic retardance, Y_0, equal to the core's opposeance, O. However, the "transmission line" for U-waves is the "signal itself"; the medium lays itself down as the transmission line as it flows. It cannot reflect at a termination mismatch and, more importantly, there is no "terminating piece of equipment". The "transmission line" goes on forever (while inverse - square spreading out.)

N_p and S_p can also be derived as follows.

(21-50) $c = f \cdot \lambda$ [The speed of any wave is its wavelength times the frequency.]

$$\lambda_{ctr} = \frac{c}{f_{ctr}}$$

$$= \frac{\frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}}}{\frac{1}{2\pi \cdot \sqrt{N \cdot S}}} \qquad \left[= c\right] \qquad \left[= f_{ctr}\right]$$

$$= \frac{2\pi \cdot \sqrt{N \cdot S}}{\sqrt{N_p \cdot S_p}}$$ [Simplify the above and use equation 21-49(c).]

$$= \frac{4\pi^2 \cdot N \cdot S}{N_p \cdot S_p} \quad \text{or} \quad N_p \cdot S_p = \frac{4\pi^2 \cdot N \cdot S}{\lambda_{ctr}^2}$$

Allocating:

$$N_p = \frac{2\pi \cdot N}{\lambda_{ctr}} \qquad S_p = \frac{2\pi \cdot S}{\lambda_{ctr}}$$

Then using N and S of equations 21-37 and 21-38 and $f_{ctr} \cdot \lambda_{ctr} = c$ the result agrees with equation 21-49.

$$N_p = \frac{\mu_0}{4\pi^2 \cdot f_{ctr} \cdot \tau^2 \cdot \alpha \cdot c} \cdot \frac{2\pi}{\lambda_{ctr}} \qquad S_p = \frac{\tau^2 \cdot \alpha \cdot c^3 \cdot \varepsilon_0}{f_{ctr}} \cdot \frac{2\pi}{\lambda_{ctr}}$$

$$= \frac{\mu_0}{2\pi \cdot \tau^2 \cdot \alpha \cdot c^2} \qquad = 2\pi \cdot \tau^2 \cdot \alpha \cdot c^2 \cdot \varepsilon_0$$

It should be observed that, as essential to conform with reality, N_p and S_p (and, therefore μ_0 and ε_0) are not dependent on f_{ctr}, the center's frequency, nor on m_{ptcl}, the particle's mass, even though N and S are so dependent. (More properly stated the center's frequency and the particle's mass are the result of the values of its N and S.) The speed of propagation, c, is the same for all centers-of-oscillation, all particles, regardless of their core oscillation frequency as set by their individual N and S.

While N and S, which are core characteristics, came causally before N_p and S_p, which are characteristics of propagating medium, it is the latter, N_p

and S_p, which are universally constant (except for the general exponential decay). The values of N and S are different for each different particle, each different center-of-oscillation.

FREQUENCY CONSIDERATIONS

Analogously to the inductive and capacitive impedances, Z_L and Z_C, the inertial retardance, Y_N, and the storeal retardance, Y_S, are as follows.

(21-51) $Y_N = 2\pi \cdot f \cdot N$ and $Y_S = \dfrac{1}{2\pi \cdot f \cdot S}$

The f here is a variable. That is the inertial and storeal retardances vary according to the frequency of the medium flow and medium potential involved just as inductive and capacitive impedances vary with the frequency of the relevant voltage and current.

From equation 21-15 it is seen that the inertial retardance increases as the frequency acting in it increases and the storeal retardance correspondingly decreases with increasing frequency. The resonant frequency is the frequency at which the two retardances are equal. (The resonant frequency is the oscillation frequency of the center-of-oscillation and it is the f of the relationship $m_{particle} \cdot c^2 = h \cdot f_{center}$.)

That frequency behavior is a description, in center-of-oscillation terms, of the behavior of an electrical tuned, or resonant, circuit. The typical behavior versus frequency of such a configuration or circuit is as depicted in Figure 21-11 below. It is characterized by low values at the extremes and a peak centered on the resonant frequency. The peak is characterized by its *band width*, which is the difference between the upper and lower "cut-off" frequencies ($[f_u - f_l]$ in the figure).

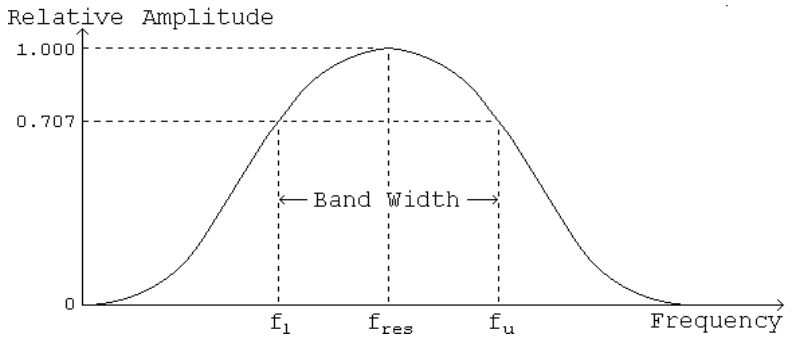

Figure 21-11

The value 0.707 is equal to $[1/2]^{½}$ and is selected because the energy and power involved in oscillations is proportional to the square of the flow or the potential. Therefore, when the amplitude of the flow or the potential is down to $[1/2]^{½}$ of its peak value the corresponding level of the energy or power is $1/2$ of the peak. That level is an arbitrary defining value for measuring the rate of falling off of amplitude but it is reasonable.

The calculation of the band width marking frequencies, f_l and f_u, for a center-of-oscillation proceeds as follows.

(21-52)

(a) N_p and S_p can be obtained from equation 21-50. (μ_0, ε_0, and α are all well determined and reported in the previously referenced CODATA bulletin. The value of τ was estimated to be about $11.9 \cdot 10^9$ years which is about $3.8 \cdot 10^{17}$ seconds.)

$$N_p = 1.9 \cdot 10^{-40} \qquad S_p = 5.9 \cdot 10^{22}$$

(b) With N_p and S_p obtained the values of "N" and "S" for any specified λ or $f = c/\lambda$ can be obtained per equation 21-50. Likewise, with a frequency specified the value of "O" can be determined from equation 21-39.

(c) The band width limits, f_l and f_u, occur when the net retardance of "N" and "S" equals the opposeance, "O", exactly analogously to the behavior of an electrical or mechanical equivalent structure because of having the same form of mathematics. If the band width is relatively large then f_u can be determined considering only the inertialance and f_l considering only the storeance because the omitted effects will be negligible.

(d) Therefore, from equation 21-51

$$\text{Inertial Retardance} = \text{Opposeance} \qquad \text{Storeal Retardance} = \text{Opposeance}$$

$$Y_N = O \qquad Y_S = O \quad \text{["Oh", not zero]}$$

$$2\pi \cdot f_u \cdot N = O \qquad \frac{1}{2\pi \cdot f_l \cdot S} = O$$

$$f_u = \frac{O}{2\pi \cdot N} \qquad \text{and} \qquad f_l = \frac{1}{2\pi \cdot S \cdot O}$$

Now, applying these formulas for the upper, f_u, and lower, f_l, band width defining frequencies to the fundamental centers-of-oscillation the results are as follows.

For a proton these are

(21-53) $f_{res} = 2.3 \cdot 10^{23}$ Hz

$N = 3.9 \cdot 10^{-56}$
$S = 1.2 \cdot 10^{7}$
$O = 1.6 \cdot 10^{10}$

$f_u = 6.5 \cdot 10^{64}$ Hz
$f_l = 8.3 \cdot 10^{-19}$ Hz

and for the electron

(21-54) $f_{res} = 1.2 \cdot 10^{20}$ Hz

$N = 7.5 \cdot 10^{-53}$
$S = 2.3 \cdot 10^{10}$
$O = 8.0 \cdot 10^{6}$

$f_u = 1.7 \cdot 10^{58}$ Hz
$f_l = 8.3 \cdot 10^{-19}$ Hz

These are immense band widths. Even though there is only one frequency present in an electron or a proton, the resonant frequency which

corresponds to the mass, the available band width is enough to conveniently encompass an enormous frequency range. That is consistent with the ready shift in frequency of these particles with changes in their speed of motion. The extremely wide band width means that the amplitude change with those (quite modest compared to the band width) speed - related frequency shifts is negligible.

The wide band width also means that the centers can oscillate at various different frequencies as their motion may require without difficulty. That is as compared to the narrow band width devices controlling the frequency of electromagnetic oscillators, such as for radio and television communications and radar for which any deviation of the frequency from the intended resonant frequency is to be avoided.

All of this raises several questions. What was the situation with the "Cosmic Egg"; what was its band width and frequency content ? How is it that the electron and the proton have different values of N and S (which result in the different frequencies and masses for the two particles). After all, the electron and the proton have the same medium amplitude (the same electric charge) and should have the same medium except for one being in $+U$ and the other in $-U$. The $^{+U}/_{-U}$ difference is not enough to make the frequency difference and in all other respects the two regions must be identical so that they maintain conservation by netting out to nothing.

To address those questions first requires some preparation -- that of returning once again to the analysis of the fundamentals of space and medium.

SPACE: ITS ANALYSIS ONE MORE TIME: F AND τ

Space is the potentiality for volume as presented in sections 7 and 16. Until that potentiality is realized there is nothing. The Origin was the start of the realizing of that potentiality. Space became realized, initially, at the core of the Origin, but immediately thereafter outward in all directions at the speed of light.

That process is still going on at this very moment. The initial medium propagated from the Original core has since been traveling on outward continuously realizing space as it goes. It has traveled at the initial (before decay) speed of light for the immense time that is equal to the age of the universe. "Out there" that initial wave front is still advancing into nothing, into what is merely the potentiality for what is about to happen to happen, and it is there realizing it into medium-occupied volume.

It is now time to adjust our conception of the Coulomb's Law action. Because the law accurately gives the correct Coulomb effect results by using the magnitude of each of the two interacting charges has resulted in our thinking that the physical action is that way. However, we have seen that the "source" charge's propagation, upon arriving at the "encountered" charge, does not combine or act jointly with that charge. The only activity at the encountered charge is that that center-of-oscillation's own propagation focuses some of the incoming source propagation onto its core, with the consequent further effect that that requires an adjustment in the encountered core's own propagation and, therefore in its motion, all as developed in section 16.

The action is not the traveling of the effect of the source core's q_s (the effect of flowing $[source\ medium]$) but rather of its q_s^2 (of flowing

[what we have been calling source medium]^2) from the source to the destination. At the destination the part of that flow that is focused onto the encountered core forces a distortion in that core's own propagation (of *[its core's medium]*^{2}) and, therefore, its motion. That which produces the action is the source medium corresponding to the source charge squared and of dimensions $\{q_s^2\} = [M \cdot L]$.

This discussion is related in our minds to thinking of the medium, both that within the core and that which is being propagated, as the relatively "hard" tangible substance involved with its related energy as an intangible "thing", there because of the medium, that we only perceive when and because of a tangible energy-involved action taking place. Yet, the medium corresponds only to the effects which we think of as electric field and charge, effects no more tangible than energy, and perhaps less so. Thus it is just as reasonable to think of the core as filled with some form of energy as to think of it in medium or charge terms.

The actual energy-related quantity of medium is not energy as we think of it; it is *energy per cycle per second*, Planck's constant, with dimensions $[M \cdot L^2/T] = [M \cdot L^2/T^2]$ (energy) *per* $1/T$ (frequency). This can easily be seen as follows. The electron and the proton both involve the same amounts of core medium and of its propagation, the related charge and the related electric field. Only the $+U/-U$ signs are opposite. But, they have quite different energies. The proton is about 1836 times more massive than the electron and has a corresponding energy about 1836 times as much. Since both have the same medium amounts but have different energies, energies that are different solely because of their oscillation frequencies, that is energies of $W = h \cdot f$, then the energy characteristic common to both, the common energy characteristic of medium, must be just the h, a kind of energy rate, Planck's constant.

Thus we are seeking an energy-related expression for the core medium that has the dimensions of q_s^2, $\{q_s^2\} = [M \cdot L]$. The quantity h/c meets that requirement. The "fine structure constant", already encountered a number of times in this work, relates charge and Planck's constant. From that start it can be reasoned as follows.

(21-55)
$$\alpha = \tfrac{1}{2} \cdot \mu_0 \cdot c \cdot \frac{q^2}{h}$$

$$h/c = q^2 \cdot \frac{\mu_0}{2 \cdot \alpha} \qquad \text{[rearranging the above]}$$

$$= [q^2 \cdot \tau^2 \cdot c^2] \cdot \frac{\mu_0}{2 \cdot \alpha \cdot \tau^2 \cdot c^2}$$

$$= \upsilon^2 \cdot [\pi \cdot N_p] = \upsilon^2 \cdot \frac{\pi}{c^2 S_p} \qquad \text{[per equation 21-49]}$$

This has the form of a number of other physical processes such as the flow of electricity and the flow of water. The form is that the <u>*potential*</u> [electrical potential or voltage, hydraulic "head", core medium h/c] <u>*equals*</u> the <u>*product of*</u> the <u>*flow*</u> [electric current, water flow, medium flow υ^2] <u>*times*</u> the <u>*retarding effect*</u> [electrical resistance, pipe and viscosity limitation, *retardance* due to the *inertialance* and *storance*, N_p and S_p].

Planck's constant, h, is the primary energy-related constant of fundamental physics. It is sometimes given the name *action*. That quantity, that effect, now appears to be more than merely a constant in equations. It is an aspect of, it essentially is, the fundamental medium, itself.

The ultimate reality that is within the core, then, is its supply of medium of dimensions $[M \cdot L]$. To so be as an h - based form of energy it must be as h/c which, of course, is also of dimensions $[M \cdot L]$. The medium and its propagation, as medium and as *action*, h, can be compared and described as follows.

(a) The Core in Terms of Medium and Its Flow

	Within the Core	As Propagating
Quantity	medium	medium flow
	$\{\upsilon^2\} = M \cdot L$	$\{\upsilon^2 \cdot c^2\} = \frac{M \cdot L^3}{T^2}$
Appears as	charge	electric field
	$\{q\} = [M \cdot L]^{1/2}$	$\{E = u = q \cdot c\} = [M \cdot L]^{1/2} \cdot \frac{L}{T}$
with flow		*[q flowing at c]^2 producing $q^2 \cdot c^2$
and its Dimensions		$\left[M \cdot L\right] \cdot \left[\frac{L}{T}\right]^2 = \frac{M \cdot L^3}{T^2}$

[* This is medium flow expressed in Universal Physics terms. In classical physics this is the static electric field existing, not flow of charge.]

(b) The Core in Terms of Action and Its Flow

	Within the Core	As Propagating
Quantity	medium	medium flow
	$\{\upsilon^2\} = M \cdot L$	$\{\upsilon^2 \cdot c^2\} = \frac{M \cdot L^3}{T^2}$
Appears as	potential mass-volume	mass-volume flow
	$\{h/c\} = M \cdot L$	$\{h/c \cdot c^2\} = \frac{M \cdot L^3}{T^2}$
with flow		h flowing at c producing h·c
and its Dimensions		$\left[\frac{M \cdot L^2}{T}\right] \cdot \left[\frac{L}{T}\right] = \frac{M \cdot L^3}{T^2}$
The dimensions of the h·c flow are the dimensions of mass flow - volume flow.		$= \left[\frac{M}{T}\right] \cdot \left[\frac{L^3}{T}\right]$

Table 21-12

The core's medium supply, h/c, is the equivalent of the ability to realize ultimately F volumes of space each equal to one simple core volume,

$4/3\pi\cdot\delta^3$ $[L^3]$. It is the ability to (theoretically) propagate a constant h/c worth of $[M\cdot L]$ for time τ $[T]$ or (actually) to propagate exponentially decaying h/c forever (see Figure 21-9).

The fundamental constant, F, addresses the relationship between the apparent volume of the core (as viewed from space external to it) and the amount of space that it can realize by propagation of its contents, the relationship between its conception as a volume and as an amount of medium (constituting a singularity by virtue of its occupying zero volume as medium in the core).

(21-56a)
$$F = \frac{\text{Core Medium Supply}}{\text{Core Volume}}$$

Medium, its propagation and the realization of space, can then be conceived of as in Table 21-13 and F is per equation 21-56b.

Alternative Conceptions of Medium, Its Propagation, & Space

Medium	Action	Mass - Volume
[q flowing at c interacting with other q flowing at c]	[h flowing at c]	[Mass & Volume Each Flowing Outward at c]
producing	producing	producing
$q^2\cdot c^2$	$h\cdot c$	Realized Space
of dimensions	of dimensions	of dimensions
$\left[\sqrt{M\cdot L}\right]^2\cdot\left[\frac{L}{T}\right]^2$	$\left[\frac{M\cdot L^2}{T}\right]\cdot\left[\frac{L}{T}\right]$	$\left[\frac{M}{T}\right]\cdot\left[\frac{L^3}{T}\right]$
$=\frac{M\cdot L^3}{T^2}$	$=\frac{M\cdot L^3}{T^2}$	$=\frac{M\cdot L^3}{T^2}$

Table 21-13

(21-56b)
$$F = \frac{\text{Volume Equivalent of Core Medium Supply}}{\text{Core Volume}}$$
$$= \frac{h/c}{4/3\pi\cdot\delta^3}$$
$$= 7.93801\cdot10^{60}$$

(21-57)
$$\tau = \frac{\delta\cdot F}{3\cdot c}$$
$$= 3.57532\cdot10^{17} \text{ seconds}$$
$$= 11.3373\cdot10^{9} \text{ years}$$

However, there appears to be a problem here. The dimensions of F from equation 21-56 are $\{F\} = {}^{M \cdot L}/_{L^3}$. But equation 21-57 requires that F be dimensionless to result in the correct dimension for τ, $\{\tau\} = T$.

The solution to the dilemma is as follows. The content of the core flows outward at a volumetric flow rate, $4 \cdot \pi \cdot \delta^2 \cdot c$. Although the decaying exponential process goes on forever, the total amount of such flow is a finite quantity, the area under the decaying exponential curve. That area also corresponds to, then, a finite volume (produced by the medium outflow). The total magnitude of that area under the curve, that finite volume propagated during the decay's process from time $t = 0$ to time $t = \infty$ is the same as the original amount available to so propagate, the original core medium content. Then the numerator of equation 21-56b, ${}^{h}/_{c}$, is also an ultimate volume of dimensions $[L^3]$, which results in a quotient that is dimensionless.

The equations 21-56 denominator is what the core singularity would be if in space. The equations' numerator is the reality of the core. In itself the core is the quantity ${}^{h}/_{c}$ of dimensions $[M \cdot L]$, and causes the effects and appearances that we perceive as charge, energy, space, etc. by propagating its $[M \cdot L]$ outward at c^2 realizing F core volumes of flowing ${}^{M}/_{T} \cdot {}^{L^3}/_{T}$.

(The nature of the core medium now settled, the q^2 medium concept can now be set aside in favor of retaining consistency with electric tradition.)

THE CORE AGAIN: N, S AND OSCILLATION FREQUENCY

Shortly ago above it was asked:

> "How is it that the electron and the proton have different values of N and S (which result in the different frequencies and masses for the two particles)."

After all, the electron and the proton, and the positron and the negaproton, all must have the same medium amplitude because they all have the same magnitude of electric charge. And the medium of the four of them must be identical in all other respects, the sole exception being that the proton and positron are in $+U$ and have $"+"$ medium that is exactly offset by the $"-"$ medium of the electron and negaproton in $-U$. The ${}^{+U}/_{-U}$ difference is not enough to produce the frequency difference between the proton and the electron, nor that between the positron and the negaproton, and in all other respects the two regions must be identical so that they maintain conservation by netting out to nothing.

Since the character of the medium of the two particles, the proton and the electron, must be identical except for its ${}^{+U}/_{-U}$ sign, and yet the N and S of the two particles must be different so that their oscillation frequencies ${}^{1}/_{2\pi \cdot [N \cdot S]^{½}}$ are different it must be, the only alternative would seem to be, that in some manner the amount or density of the core medium is different in the two cases, that the "size" of the core singularity or the implied "volumetric density" within it is different in the two cases. Yet, even that variation from particle type to particle type must preserve the decay constant, τ, of each particle unchanged and must preserve the charge, q, of each particle unchanged. How can all that be ?

There is some reasonableness to the oscillation frequency differences of the various different particles relating to the core "size" or its "shape" or to the "density within it". As developed in section *13 - A Model for the Universe (3) -*

Motion and Relativity, the overall oscillation frequency of a center of oscillation varies with its motion. At rest the frequency is f_{rest}, whereas in motion the overall frequency is f_v with the wavelength shortened forward and lengthened rearward. That is, a change in the oscillation frequency is associated with a change in the size and shape of the propagation pattern. Perhaps there is a corresponding change in the size or shape of the core and perhaps that produces the frequency change.

There is another circumstance in which this issue arises -- the cores of the centers-of-oscillation that are the nuclei of the various atomic species as presented in section *17 - A Model for the Universe (7) - The Atomic Nucleus - The Nuclear Species.* Equation 17-2, repeated below, calls for each different atomic nucleus to have a different oscillation frequency complex. The complex oscillation is the sum of an oscillation at frequency $A \cdot f_{proton}$ and one at the smaller frequency $[A - Z] \cdot f_{electron}$.

(17-2)

$$U\left[{}_{Z}Sym^{A}\right] = \left[A \text{ protons} + [N = A-Z] \text{ electrons}\right]$$

$$= U_c \cdot \left[A - \cos[2\pi \cdot A \cdot f_p \cdot t] + -\left[N - \cos[2\pi \cdot N \cdot f_e \cdot t]\right]\right]$$

$$= U_c \cdot \left[Z - \cos[2\pi \cdot A \cdot f_p \cdot t] + \cos[2\pi \cdot N \cdot f_e \cdot t]\right]$$

(The N of equation 17-2 is the number of nuclear neutrons, not the inertialance. To remove confusion here it will be expressed as $[A - Z]$, its equivalent.)

The problem of insuring that the frequency - determining effects do not change τ nor the charge is not at all difficult. All of the centers-of-oscillation, whether simple ones or atomic nuclei, have an average value and an oscillation about that average value. It is the average value that determines the amount of the charge. Likewise the general decay is primarily a decay of the average amount of the medium in the core. Of course, the oscillation being inextricably involved results in the amplitude of the oscillation likewise decaying. But the oscillation has no effect on the average value regardless of the type center and regardless of the frequency or frequencies of the oscillation. Thus the charge and the decay constant remain inviolable with regard to actions or effects of the oscillatory part of the center-of-oscillation's wave form.

Likewise the amplitude of the oscillatory part of the overall wave form of all of the centers-of-oscillation, regardless of the particle represented, has been found to be the same, U_c a universal constant (this result was developed following the original equation 17-2). The oscillation amplitude is thus unaffected by the average value of the wave form, unaffected by the charge and the decay constant.

In the analysis of gravitation it was found that the mass of the encountered particle, m_e, entered into the cause, the force $F = G \cdot m_s \cdot m_e / d^2$, as well as the result, the acceleration $a = F / m_e$. The consequence of that is that gravitational acceleration is independent of the encountered mass.

Somewhat analogous to that, the frequency of a simple center-of-oscillation, f_{ctr}, depends on the values of N and S while at the same time those values of N and S that determine the value of $f_{res} = f_{ctr}$ are themselves dependent on the value of f_{ctr}.

(21-58)

$$f_{ctr} = \frac{1}{2\pi \cdot \sqrt{N \cdot S}}$$

$$N = \frac{\mu_0}{4\pi^2 \cdot f_{ctr} \cdot \tau^2 \cdot \alpha \cdot c}$$

$$S = \frac{\tau^2 \cdot \alpha \cdot c}{f_{ctr} \cdot \mu_0}$$

It would appear that the net effect is that f_{ctr} may take on any value that it wishes.

N and S set the frequency of the oscillation by setting the rate at which energy can be exchanged between being stored in the N and in the S. The larger the N the slower the rate at which flow can be built up in it. The larger the S the longer the time required to build up potential on it. (This is exactly analogous to the current and voltage in an electrical inductance - capacitance circuit.)

But in the case of N and S those rates or times vary inversely as the frequency that they control If f_{ctr} should increase that reduces the value of N and S which then calls for f_{ctr} to have that increased frequency. What is the significance of all this ?

The significance is as follows.

1. The center-of-oscillation can oscillate at any frequency; however,

2. Once at some particular frequency, f_{ctr}, it is held there, is stable there, because the then current values of N and S require that frequency and that frequency requires the then current values of N and S.

3. A change from that stable state can only occur because of an imposed change from some cause external to equations 21-58 alone.

Such an external cause would be the type effects described in section *13 - A Model for the Universe (3) - Motion and Relativity* that must take place when a center's motion changes. For example, taking the simple case of a center at rest changing to motion at some velocity. The center must propagate less medium forward than had been the case because the medium propagated just before is moving away at absolute speed c but at speed $[c - v]$ relative to the center. Effectively the fraction of the medium that the center had been propagating forward builds up because it cannot be propagated. It is unable to get out of the way, therefore it increases the medium amount present and consequently increases the values of N and S forcing a reduction in f_{ctr}.

This effect happens smoothly, continuously, in effect in infinitesimal increments. There is no "medium buildup". The slightest tendency in that direction produces immediate adjustment of f_{ctr} and all of the other factors and relationships. The corresponding inverse set of events and reactions simultaneously take place rearward.

The result is an imperative in the forward direction to reduce the center frequency by the factor $[1 - V/c]$. In the rearward direction the opposite is the case, an imperative to increase the center frequency by the factor $[1 + V/c]$. The combined effect of the two, operating through equations 21-58, is that the center oscillates at the frequency determined by the combination of the forward and rearward effects, equation 13-5.

(13-5)
$$f_v = f_r \cdot \left[1 - \frac{v^2}{c^2}\right]^{\frac{1}{2}} \qquad \text{[Center frequency decreases]}$$

THE "COSMIC EGG" BAND WIDTH

It has already been estimated in section *20 A Model for the Universe (10) - The "Cosmic Egg"* that N_0, the number of Original protons and of electrons (the number of envelopes to the "Cosmic Egg" wave form) was in the range of 10^{82} to 10^{86}. That range represents the highest multiple of the f_{env} of the "Cosmic Egg" that would have to have been accommodated by the band width. Equation 20-6, repeated below, displays the envelope frequency of the "Cosmic Egg" as follows.

(20-6)
$$U(t) = \pm 2 \cdot q \cdot \text{Cos}^{N_0}\left[2\pi \cdot \frac{f_p - f_e}{2} \cdot t\right] \cdot \text{Cos}\left[2\pi \cdot \frac{f_p + f_e}{2} \cdot t\right]$$

$$f_{env} = \frac{f_p - f_e}{2} = 1.3438 \cdot 10^{23}$$

$$\approx 10^{23} \qquad \text{[The precision is limited in view of the limited precision of } N_0\text{.]}$$

That would require that the band width of the "Cosmic Egg", its upper "cut-off" frequency be

(21-59)
$$f_u = [f_{env}] \cdot [N_0] = [10^{23}] \cdot [10^{82} \text{ to } 10^{86}]$$

$$\approx 10^{105} \text{ to } 10^{109}$$

From the above equations 21-37, 21-38, and 21-52:

(21-60)
$$f_u = \frac{O}{2\pi \cdot N} = O \cdot \frac{1}{2\pi} \cdot \frac{1}{N}$$

$$= \frac{f \cdot \mu_0 \cdot c}{\tau \cdot \alpha \cdot c} \cdot \frac{1}{2\pi} \cdot \frac{4\pi^2 \cdot f \cdot \tau^2 \cdot \alpha \cdot c}{\mu_0}$$

$$= 2\pi \cdot \tau \cdot f^2$$

That is, the upper "cut-off" frequency is directly proportional to the square of the center's oscillation frequency (for simple centers having only one single frequency).

The lower "cut-off" frequency, f_l, is minute, $8.3 \cdot 10^{-19}$ *Hz*. Therefore, the band width, the difference between the upper and lower "cut-off's" is simply the upper. If, in spite of the complex frequency content of the "Cosmic Egg", we apply equation 21-60 to compare the "Cosmic Egg" to a proton, the following is obtained.

(21-61)
$$\frac{f_{u,CE}}{f_{u,p}} = \left[\frac{[10^{105} \text{ to } 10^{109}]}{10^{65}}\right]^2 \quad \text{[Equation 21-59]} \quad \text{[Equation 21-53]}$$
$$= 10^{80} \text{ to } 10^{88}$$
$$\approx N_0 \quad [N_0 \text{ was calculated as } 10^{85}]$$

To the best that it would seem to be possible to estimate it then, the band width of the "Cosmic Egg" appears to have been the correct amount to produce a limiting of the number of Original oscillation envelopes (and, therefore, the number of Original particles) to $N_0 \approx 10^{82}$ to 10^{86}. The gradual cutting-off produced by the frequency dependent action of N and S (equation 21-52) was then greatly enhanced by the mathematical cutting-off developed in section *20 - A Model for the Universe (10) - The "Cosmic Egg"* (Figure 20-8 and related development).

THE "COSMIC EGG" CORE

The value of δ developed in section *19 - A Model for the Universe (9) - Gravitation* and the value for F developed above (equation 21-55) are for the case of the simple, fundamental centers-of-oscillation, those of a proton or an electron or their anti-particles, the cases of particles having a charge equal to the fundamental electric charge, not some multiple of that charge as in atomic nuclei. The question remains as to whether δ is always that amount or whether it is different for other particles, atomic nuclei and the "Cosmic Egg".

Because the only dimension of τ is time, which cannot decay, τ does not decay. (As already pointed out, time being the independent variable of material reality, whether it decays, varies, or is rigorously constant is beyond our ability to detect in any case. For us it cannot but appear constant.)

Since τ is universal, that is there is only one value of it for the universe as with c and h, and with τ constant, that is non-decaying, then from equation 21-28, $\tau = \delta \cdot F / 3 \cdot c$, the product $\delta \cdot F$ must be a constant except for its decay as δ decays, which is exactly matched by the decay of c in that expression.

(21-62)
$$\delta \cdot F = \delta_p \cdot F_p \quad \text{[proton]}$$
$$= \delta_e \cdot F_e \quad \text{[electron]}$$
$$= \delta_{CE} \cdot F_{CE} \quad \text{[Cosmic Egg]}$$

But, even though that product, $\delta \cdot F$, is always the same, are those $\delta's$ and those $F's$ all the same ? It is always the same δ and F for the basic simple centers of oscillation, the proton and electron and their anti-particles. But, was the radius of the "Cosmic Egg"'s singularity also equal to δ ? Did $\delta_{CE} = \delta_p = \delta_e$? And, if not, then what about atomic nuclei ?

The reasoning is as follows. Medium must be conserved. The Origin conserved medium by there coming into existence equal and opposite amounts of initial medium in $+U$ and $-U$. With the exception of subsequent mutual annihilations and the gradual decay by U-wave propagation, that same amount of medium must be present in the particles of the universe today.

Propagating medium corresponds directly to electric field and the total medium propagation from a center-of-oscillation corresponds to / is the electric charge. That propagation being determined only by τ and the amount of medium in the center's core, then the amount of medium in a center and in the universe corresponds to electric charge. As charge must be conserved so must medium; they are not two different things but merely different ways of expressing the same thing.

The amount of mass-volume supply in a proton core is

$$\text{(21-63)} \quad \text{amount(mass-volume)}_p = {}^4/_3 \cdot \pi \cdot \delta_p{}^3 \cdot F_p$$

From equation 21-55 this is equal to h/c and has the dimensions $[M \cdot L]$. That is, that quantity corresponds to the square of the charge, q, or the square of the amount of medium, $\upsilon = q \cdot \tau \cdot c$. Conservation of charge / medium, whether squared or not, is the same conservation. Because of its significance above squared will be used.

For conservation, the "Cosmic Egg"'s amount of $+U$ medium squared must have been N_0 times the amount in a single proton (N_0 = number of protons in the entire universe estimated earlier).

$$\text{(21-64)} \quad \begin{aligned} \text{amt}(\upsilon^2)_{CE} &= \text{amt}(\upsilon^2)_p \cdot N_0 \\ &= {}^4/_3 \cdot \pi \cdot \delta_p{}^3 \cdot F_p \cdot N_0 \qquad [N_0 \text{ protons of medium} \\ &= {}^4/_3 \cdot \pi \cdot \delta_{CE}{}^3 \cdot F_{CE} \qquad = \text{Cosmic egg medium}] \end{aligned}$$

so that

$$\text{(21-65)} \quad \delta_{CE}{}^3 \cdot F_{CE} = \delta_p{}^3 \cdot F_p \cdot N_0 \qquad [\text{The two right halves of 21-64 are equal.}]$$

Dividing equation 21-65 by equation 21-62

$$\text{(21-66)} \quad \frac{\delta_{CE}{}^3 \cdot F_{CE}}{\delta_{CE} \cdot F_{CE}} = \frac{\delta_p{}^3 \cdot F_p \cdot N_0}{\delta_p \cdot F_p}$$

$$\delta_{CE}{}^2 = \delta_p{}^2 \cdot N_0$$

$$\delta_{CE} = \delta_p \cdot \sqrt{N_0}$$

$$\begin{aligned} \delta_{\text{Cosmic Egg}} &= \delta \cdot \sqrt{N_0} \qquad [\delta_p = \delta] \\ &\approx 4 \cdot 10^7 \text{ meters} \end{aligned}$$

(That result can initially be disturbing. How can a single point, a singularity, have a radius of *forty million meters* ? But, if $\delta = 4.05084 \cdot 10^{-35}$ *meters*, which is non-zero, has already been acceptable to us as a singularity, which it has, then we cannot complain about the "Cosmic Egg"'s "radius" being $4 \cdot 10^7$ *meters*. It only seems large to us because of the sizes we have to compare it with. At the time of the "Cosmic Egg" there was nothing else to compare it with. It was neither large nor small. It simply was.

(And after all, $\delta_{Cosmic\ Egg}$, just as is the case with the particular δ of any core / particle, is merely a measure of the equivalent spatial effect outside of that core of the amount of medium within that non-space core singularity.)

Since all $\delta \cdot F$ products must be the same and δ varies directly as the square root of N_0 then F must vary inversely as the square root of N_0.

(21-67)
$$F_{Cosmic\ Egg} = F \cdot \frac{1}{\sqrt{N_0}} \qquad [F \text{ is } F_{proton} = F_{electron}]$$
$$\approx 8 \cdot 10^{18}$$

N_0 being the number of protons in the "Cosmic Egg", for an atomic nucleus it corresponds in the above formulation to the number of protons in the nucleus which is A, the atomic mass number (Z protons as such and $[A-Z]$ protons as neutron components). Therefore the δ of a nucleus or a particle is

(21-68)
$$\delta_{nucleus,\ particle} = \delta \cdot \sqrt{A}$$

Neither F nor δ is a fundamental constant, then, in that both have different values for different cores, different particles.

It is the product $F \cdot \delta$ that is a fundamental constant. It is the same for all cores, for all particles. What does that mean; what does $F \cdot \delta$ represent ? Per equation 21-55

(21-69)
$$\frac{h/c}{4/3\pi \cdot \delta^3} = F$$
$$\frac{h/c}{4\pi \cdot \delta^2} = \frac{1}{3} \cdot F \cdot \delta = \tau \cdot c$$

which can be interpreted as

"Propagation Pressure" = Universally Constant [Except for its gradual decay parallel to the decay of "c"]

In other words, for all cores that "propagation pressure" is, and must be, the same. That is essential for the decay τ to be the same throughout the universe. The value of δ of a core is according to the amount of medium, the amount of h/c within the core. The value of F varies inversely as the adjusted δ to maintain constant $F \cdot \delta$, constant "propagation pressure".

CONCLUSION

Because the proton and electron are so fundamental, and their common δ relates so directly to G, the Newtonian constant of gravitation, it is convenient for us to think of and to take, δ_p and δ_e as well as F_p and F_e as fundamental constants and to call them δ and F.

In summary, the fundamental "constants" of the universe appear to be as in Table 21-14 on the following page.

The Universal Constants

Constant	Significance	Value in MKSR=SI Units	Units	How Here Obtained
	Core Constants			
υ	Medium of a basic core(1)	$1.71730 \cdot 10^{7}$	$\sqrt{M \cdot L^3}$	$\upsilon = q \cdot \tau \cdot c$
δ	Radius of a basic core(1)	$4.05084 \cdot 10^{-35}$	L	$\delta = \left[\frac{G \cdot h}{c^3}\right]^{\frac{1}{2}}$ (2)
τ	Decay time constant	$3.57532 \cdot 10^{17}$	T	$\tau = {}^{\delta \cdot F}/_{3 \cdot c}$ (3)
N_p	Inertialance/ unit length	$2.38558 \cdot 10^{-57}$ (4)··(5)	$1/L^2$	$N_p = \frac{\mu_0}{2\pi \cdot \tau^2 \cdot \alpha \cdot c^2}$
S_p	Storeance/ unit length	$4.66407 \cdot 10^{39}$ (4)··(5)	T^2	$S_p = 2\pi \cdot \tau^2 \cdot \alpha \cdot c^2 \cdot \varepsilon_0$
h	Energy per cycle-per-sec	$6.6260755 \cdot 10^{-34}$	$M \cdot L^2/T$	[Well developed measurements]
	Oscillation Constants			
f_p	Proton frequency	$2.2687316 \cdot 10^{23}$	$1/T$	$m_p \cdot c^2/h$ (6)
f_e	Electron frequency	$1.2355898 \cdot 10^{20}$	$1/T$	$m_e \cdot c^2/h$ (6)
	Wave Field Constants			
q	Medium flow amplitude	$1.60217733 \cdot 10^{-19}$	$\sqrt{M \cdot L}$	[Well developed measurements]
c	Medium speed in free space	$2.99792458 \cdot 10^{8}$ (7)	L/T	[Well developed measurements]
μ_0	Permeability of free space	$4\pi \cdot 10^{-7}$	--	[Definition]
ε_0	Dielectric of free space	$8.85418782 \cdot 10^{-12}$	T^2/L^2	$\varepsilon_0 = \frac{1}{\mu_0 \cdot c^2}$

(1) The cores of those particles having the fundamental electric charge, q: the proton, electron, and their anti-particles.
(2) Better measurements of "G" are needed.
(3) $F = 7.93801 \cdot 10^{60}$ (numerically = ${}^{3 \cdot h}/_{4 \cdot \pi \cdot c \cdot \delta^3}$)
(4) "N" and "S" vary per type particle, N_p and S_p do not vary; therefore N_p and S_p are the "constants".
(5) α is the "fine structure constant" = $\frac{1}{2} \cdot \mu_0 \cdot c \cdot q^2/h$.
(6) Of course, m_p and m_e are well developed measurements.
(7) This best measured value of "c" is taken as exact.
(8) "Well developed measurements" means those reported in the already referenced CODATA Bulletin.

Table 21-14

One can wish that a fundamental relationship between that δ and the other universal constants could be developed such that the Newtonian constant of gravitation, G, could be determined to high accuracy from those other constants. G has been connected to the rest of physics in the overall above development, but it turns out that its value is unavoidably related to other constants whose values are even less able to be precisely measured than is that of G. That is

(21-70) $$G = \frac{c^3 \cdot \delta^2}{h} \qquad \text{and} \qquad \delta = \frac{3 \cdot c \cdot \tau}{F}$$

With the exception of those not having length, L, as part of their units of measurement (τ, S_p, f_p, f_e and μ_0) all of the constants of the above Table 21-14 have been shown to be gradually decaying. (This has not been overtly shown in the case of N_p, but must be so because of its units of measurement involving $[L]$, length, and so as to be consistent with the decay of c.) We refer to them as "constants" because over a human life time they so appear to be. The values given are the values that they appear to have to us at the present, their currently decayed values.

The values of the original quantities that came into existence at the start of the universe are termed "arbitrary" below because, there being nothing else existing, there was nothing to affect or determine their value and there was no standard, reference, or scale by means of which to measure them. For example δ simply happened: it was neither large nor small, it simply became at (arbitrarily) the value that subsequently decayed to that we now perceive.

The original oscillation arbitrarily determined the proton and electron relative masses by determining the original oscillation's wave and envelope frequencies. One can say that that act made time mensurable, that it essentially "created" time $[T]$.

The oscillation was of an arbitrary amount of medium (and un-medium) (which relate to the positive and negative charges that we are familiar with) and came into existence occupying a singularity of arbitrary radius $\delta_{Cosmic\ Egg}$. It was necessary for the medium to have a dimensionality involving both space $[L]$ and something else $[M]$ because $[L]$ alone is not "something", would not have been sufficient to interrupt the infinite duration of nothing that was then going on and that had to be interrupted to avoid an infinity. The realization of space required and requires that something occupy it for it to be.

The nature of that medium, so to speak the arbitrary amount of its $[M]$ aspect, arbitrarily determined the values of h, μ_0, ε_0, and, therefore, c. Likewise the nature of that medium determined the value of F.

And decay instantly started at the (at that point already determined in value) time constant $\tau = \delta \cdot F / 3 \cdot c$

. . . . . .

Is it not amazing ? Is it not wondrous ? Is it not exquisitely beautiful in its symmetry, harmony, simplicity, and purity that all this varied, complex and dynamic universe came from the so simple, so uncomplicated, so direct and straight-forward, inevitable, unavoidable origin ?

. . . . . .

THE ASTROPHYSICAL BASIS OF THE UNIVERSAL DECAY

There is general agreement among scientists who study such matters, that is cosmologists, that the universe began with and results from an essentially instantaneous appearance and outward "explosion" of the matter and energy of the universe, at a "singularity" -- the Big Bang. But their generally accepted concept of what the resulting on-going expansion is and how it operates has several problems of unanswered / unresolved considerations.

SPACE

The Hubble - Einstein theory, extensively elaborated in numerous books, texts, and scientific papers, is that the result of that beginning was the creation of space itself, and that it is space, itself, that is expanding, and in the process carrying the universe's matter and energy along with it. That expansion of space is considered to be such that the velocity, v, of recession from a distant observer of any object in that space is directly proportional to the object's distance from the observer so that the distance is v/H_0 where H_0 is the "Hubble Constant", the value of which has been not well determined beyond being in the range of $50 - 100\ ^{km}/_{sec}\ per\ megaparsec$, but is reported per analysis of a Hubble Space Telescope survey as $72\ ^{km}/_{sec}\ per\ megaparsec$.

[The *parsec* is a unit for measuring astronomical distances that is equal to $3.26\ light\ years$. A *light year* is the distance that light travels in one year at our present speed of light, $c = 3 \cdot 10^8\ ^{meters}/_{sec}$. Of course a *megaparsec* is a million *parsecs*.]

In spite of the past acceptance of the Hubble - Einstein concept there are fundamental questions about it that remain unanswered. The concept is a direct result of Einstein's General Theory of Relativity for which space, itself, is some kind of "substance" [not Einstein's terminology, but effectively the equivalent] capable of expanding and capable of being "curved" by the effect on it of gravitating masses in it. That concept leaves the problem, "... relative to what" ? If space is expanding then the expansion must be relative to some static, non-expanding reference. If space is curved than the curvature must be relative to some flat, uncurved reference. One cannot have relativity without relativity.

So, what should one call that "flat, uncurved reference"? It must be, and it is, space itself; and it is, and it must be, the framework that expansion of the universe is relative to. And, flat, uncurved rectilinear space is and must be, the framework that curved motion due to gravitation is relative to. And that space must have always existed unoccupied [and, therefore actually "nothing"] until the "Big Bang" introduced matter and energy into it.

Furthermore, were space itself expanding as in the Einstein - Hubble theory, then it would be expanding everywhere including the expansion of the space containing and within all of our instrumentation and measurement standards. But, an expanding ruler used to measure an expanding universe would report only a static state, not an expansion. The expansion would be undetectable by us if it were space, itself, that is expanding. Since we detect the expansion, then it must be, and is, the objects within space that are moving away from each other [away from the "Big Bang" location] and space itself is static.

In the Hubble - Einstein conception the universe that arose from the Big Bang has no "center" and no "edge" or boundary; rather, space -- the universe -- is a topologically "closed space" with nothing else beyond its "spatial limits". That concept results from Einsteins's insistence that there is no primary frame of

reference, that all is absolutely relative. Einstein took that position arbitrarily, there being at his time no way to prove or disprove it. Probably his position resulted from his, itself, correct thinking that all frames of reference must have the same physical laws and the same fundamental constants, that is they must be "invariant" [Einstein's terminology]. But, that does not preclude one of those frames being the primary reference while still having the same physical laws and the same fundamental constants, that is while still being "invariant".

Since Einstein's time measurement of Doppler Effect shifts, due to the Earth's orbital motion around the Sun, on our measurements of the cosmic microwave background "Big Bang" residual's wavelengths demonstrate that there is a primary reference and it is the location of the "Big Bang" and that the Earth's present absolute speed relative to it is $3.7 \cdot 10^5 \ meters/_{sec}$

[See page 106, ¶(2).] [The "Doppler Effect" is that waves propagated from a source moving away from us experience lengthening of their wavelength, and shortening for a source moving toward us. A common experience of the effect is the rising then falling tone of a whistle or siren as its source approaches us then passes and recedes from us.]

The Hubble - Einstein space having come into being from a singularity and having continuously expanded thereafter, it is difficult to justify the concept that the location of that original singularity is no where, and in particular that it is not somewhere within the expanding space of the universe that arose from it. Likewise, it is difficult to justify the concept of the expanding universe of space having no "edge" or boundary. Because it is expanding, at any moment the universe's "closed space" encloses a smaller "closed space" that it was a moment ago. Some distinction between the two is necessary else there would be no expansion. The enclosed smaller "closed space" must have a boundary or "spatial limits" that distinguish it from the total enclosing larger "closed space" with its larger "spatial limits".

Theorist mathematicians like to use analogies to justify their space-with-no-edge. They cite the surface of a sphere as a two-dimensional space having no edge, no boundary, as it exists in the three-dimensional space of the sphere whose surface it is, and they then ask that that example be extrapolated to a three-dimensional universe in a four-dimensional space. But the sphere surface is in three-dimensional space and it has two boundaries: *[1]* the boundary between the surface of the sphere and everything outside of the sphere, and *[2]* the boundary between the surface of the sphere and everything inside the sphere. Also, some theorists like to cite the Moebius Strip as an analogy, but that is only an example of quibbling with definitions, not an example of different space.

The Origin and Its Meaning conception of the cosmic topology is that space is a three-dimensional Euclidean metric which is nothing until something occupies it. It is now not nothing because part of it is occupied by the matter and energy of the universe. The metric extends infinitely in all directions, but only a finite portion is occupied by the universe. The unoccupied portion is nothing, only a metric.

THE UNIVERSAL DECAY AND SPACE

The exponential decay of the universe is just that; it is not a decay of the metric in which the universe resides. The decay is relative to the metric. Detection and measurement of the universal decay would appear to be extremely difficult if not impossible for two reasons. The first is that it would appear that

the rate of decay is quite slow relative to a human life time. That appears to be so because the decay would have been going on for the billions of years since the "Big Bang" and a human life time is at best only about a century.

But, in addition, all of our tools, equipment, scales, calibrated references and selves are composed of the same centers-of-oscillation and function in terms of the same medium as the universe. If the hypothesized decays occur and we attempt to detect or measure them with ourselves and our instrumentation, which are part of the same general decaying universe and are decaying in the same fashion, then most likely we would detect no decay at all and would be forced to conclude in favor of a non-decaying universe.

There is, however, a method by which today's instrumentation (the only instrumentation available to us) can be taken back in time to measure U-waves propagated by centers-of-oscillation billions of years ago. That method is, of course, that of dealing with the light from very distant stars which light has traveled for eons before now arriving and becoming available to us. The measurements that can be made on that light include measurement of its speed and its Planck's constant (are they our c and h or larger ?).

The Planck's constant measurements can be made by means of the photoelectric effect as explained in section *15 - A Model for the Universe (5) - Quanta and the Atom* relative to Figure 15-2, where the slope of the lines (which must be plotted from measurements data) is equal to Planck's constant. The speed of light can be measured by 20th Century versions of the Michaelson / Pease and Pearson experiments using the Foucault method. Of course, performing the measurements on the extremely weak light from greatly distant stars will most probably be much more difficult than ordinary laboratory measurements of c and h on "local" light.

The expected results of the experiments are given in Figure 21-15, below, which gives the multiples of our contemporary value of the constants c and h that are expected to be found in light that was emitted at various times in the past. The figure is calculated using the form of equation 21-19 with the time constant, τ, of equation 21-56, $\tau = 3.57532 \cdot 10^{17}\ sec$, ($\cong 11.3\ billion\ years$) and the relative decay rates of Table 21-7.

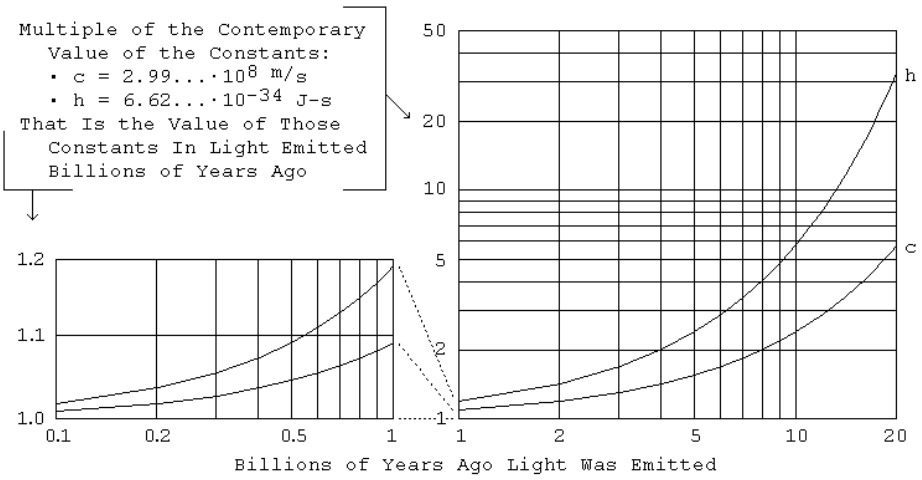

Figure 21-15

REDSHIFTS AND THE AGE OF THE UNIVERSE

Another analysis that can be, and regularly is, made of the light from distant stars is to obtain the spectrum and measure the wavelengths of the various lines in it. As already discussed in Section 15, pages 162-164, each atomic specie exhibits a characteristic line spectrum. The spectrum obtained from distant stars is already known to be different from that obtained from the same atomic specie on our own Earth (which, of course, are at rest relative to us, the observers).

In the Hubble - Einstein theory, the difference is attributed to the Doppler Effect [described above], that the observed astral source is traveling away from us at a velocity large enough to significantly shift the apparent wavelength of its light as we observe it. The amount that the wavelength is shifted is used to determine the speed of recession, v, of the star away from us, and that speed is then used with the Hubble constant as $distance = v/H_0$ to obtain the distance of the star from us.

The observed shift in the line spectra obtained from light from distant stars is called the redshift because the shift is toward the red end of the spectrum, toward longer or greater wavelengths. That is, the wavelengths of the lines in the specific spectra of distant stars is greater than the wavelengths of those same lines in spectra obtained locally at the present time.

The universal decay, being an exponential decay of the length $[L]$ aspect of all quantities, then the wavelengths of all light are so decaying and at the same rate of decay as for the speed of light, c. That is, for the same frequencies, decaying c would produce decaying wavelengths. Decaying spectral line wavelengths means that the wavelengths were longer at earlier times. The light that we observe from distant astral sources has traveled a long time up to our observing it, which means that it was emitted long ago when its wavelengths were less decayed, were longer. Thus, the universal decay naturally produces redshifts just as are observed.

There has to be some redshift due to the Doppler effect because the universe is expanding so that the astral sources whose light we observe are moving away from us. Consequently, the redshift that we now observe must be a combination of shifts due to the universal decay and the Doppler shift.

An estimate of the age of the universe can be made using the observed redshifts. The first problem is to separate the observed redshifts into the portion actually due to the Doppler effect of the velocity of the light source observed and the remaining portion, that due to the universal decay.

While the differential equation that governs the slowing down of the matter produced with an average initial velocity by the "Big Bang" is simple in form, namely

$$\frac{d^2s}{dt^2} \quad \frac{GM}{s^2}$$

[G = universal gravitation constant]
[M = effective mass acting]
[s = distance traveled]

its solution is quite awkward. The nature of the result is approximately, however, that

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

[where the A, B & c are constants]

In other words, the velocity falls off very rapidly [inverse exponentially] with distance.

Therefore, most of the velocity loss had to occur early after the "Big Bang". A very large part of the slowing must have taken place by the time the earliest galaxies formed, about *2 to 3 billion years* after the "Big Bang". It is likely, then, that the velocities of the earliest galaxies that we have been able to observe were no more than $c/10$.

The Doppler shift for non-relativistic speeds [$c/10$ or less] is

(21-72)
$$\lambda' = \frac{c + v}{c} \cdot \lambda$$

[λ' = shifted wavelength
λ = original wavelength
c = speed of light
v = velocity of light source away from the observer]

The redshift would be the difference of the two wavelengths, $[\lambda' - \lambda]$.

If we use the estimate that the most distant objects that have been observed were then moving at about $c/10$ $(3 \cdot 10^7$ *meters/sec* as compared to Earth's present speed of $3.7 \cdot 10^5$ *meters/sec)* then their redshift due to their speed alone would be

(21-73)
$$\lambda' = \frac{c + v}{c} \cdot \lambda = \frac{c + [c/10]}{c} \cdot \lambda = 1.10 \cdot \lambda$$

a redshift of *10%*. The universal decay redshift would then be that associated with the observed total redshift of such a most distant galaxy less the Doppler effect portion as just calculated.

In the science of astronomy redshifts are stated in terms of a variable, z, defined as

(21-74)
$$z \equiv \frac{\lambda_{v=actual} - \lambda_{v=0}}{\lambda_{v=0}}$$

$\lambda_{v=actual}$ being the larger due to the effect of the light source moving away at velocity v.

Equation 21-74 is based on the thinking that the emitted light was of shorter wavelength, $\lambda_{v=0}$, and that the wavelength was lengthened by the Doppler effect to $\lambda_{v=actual}$. On the other hand, taking the view that the light was emitted many years ago at the longer wavelength (and was only observed by us at that wavelength a few moments ago) whereas all of the local light currently present is emitted at a long-decayed wavelength that is significantly shorter, then the expression for z becomes

(21-75)
$$z \equiv \frac{\lambda_{time=ancient} - \lambda_{time=present}}{\lambda_{time=present}}$$

$$= \frac{\lambda_{time=ancient}}{\lambda_{time=present}} - 1$$

The earliest galactic sources that have been observed exhibit values of z of about 10. With the above estimate that on the order of 10% of the total redshifting might be due to Doppler effect then the remainder, that due to universal decay, would be on the order of 90% of the total and correspond to a z of about 9.0. Then, from equation 21-75,

$$(21\text{-}76) \qquad \frac{\lambda_{time=ancient} - \lambda_{time=present}}{\lambda_{time=present}} = z + 1 = 9 + 1 = 10$$

The decay expression is

$$(21\text{-}77) \qquad \frac{\lambda_{Age=present}}{\lambda_{Age=2\ to\ 3\ billion\ years}} = \varepsilon^{-t/\tau} = \frac{1}{10}$$

which means that

$$-\frac{t}{\tau} = \mathrm{Ln}\left[\frac{1}{10}\right] = -2.3$$

$$t = 2.3 \cdot \tau = \text{time since age was 2 to 3 billion years}$$

$$(21\text{-}78) \qquad \text{Total Age of Universe}$$

$$= 2.3 \cdot \tau + \text{2 to 3 billion years}$$

$$= \text{28 to 29 billion years}$$

For: τ = 11.3 billion years [equation 21-56]

Contemporary cosmologists' current estimates of the age of the universe, relying solely on the Hubble - Einstein concept of space, are of about 13.7 *billion years*, which is on the order of half the above calculated age. There are several problems with that estimate, however. First, validation of the universal exponential decay has now resulted from observations of the Pioneer 10 and 11 satellites, which exhibit what has come to be called the "Pioneer anomalous acceleration".

The details can be found at the scientific / technical paper archive site on the Internet World Wide Web at the URL *http://www.arxiv.org* in the paper *physics/9906031* titled *A Comprehensive Resolution of the Pioneer 10 and 11 "Anomalous Acceleration" Problem Presented in the Comprehensive Report "Study of the Anomalous Acceleration of Pioneer 10 and 11" and the Relationship of that Issue to "Dark Matter", "Dark Energy", and the Cosmological Model*.] The 13.7 *billion years* estimate entirely ignores the universal decay -- ignores the cause of on the order of 90% of the amount of shift in observed redshifts.

Furthermore, the recent progress in astronomical observation has pushed back to earlier and earlier times in the development of the universe the time when the first galaxies appeared. In current Hubble - Einstein analyses the first galaxies now are calculated to have appeared only a *few 100 million years* after the "Big Bang", that is at about 13.4 *billion years* ago in a universe calculated to be only 13.7 *billion years* old. That compares

poorly with the earlier estimates of the time required for the universe to get to the point of developing galaxies, *2 to 3 billion years*.

Further in favor of the Universal Decay theory, is that exponential decay is found essentially everywhere in physics, in nature. It would almost seem to be a requirement of a universe coming into existence with a sudden "bang". In addition, the useful Occam's Razor [the simplest explanation is most likely the correct one] is certainly against Hubble - Einstein. The Hubble - Einstein cosmological concept is in severe and increasing trouble.

Both the Hubble - Einstein and the *Origin and Its Meaning* analyses and calculations for the age of the universe and the related issue of how far back into the past we are able to observe are treated in depth in the next following detail notes *DN 13 - The Cosmos Now and Its Expansion From The Origin To The Present*.

The original conclusion of the science of astronomy that the universe is expanding was based entirely on the ubiquitous redshifts, that essentially all observed astronomical bodies exhibit a redshift to us. Not unreasonably, this was then interpreted to mean that they all have a component of their motion away from us, the observers. Almost all of the magnitude of those redshifts is actually due to universal decay not to relative motion, however. The deduced conclusion that the universe is expanding was a fortuitously correct conclusion but, not unreasonably, for the wrong reasons.

If it were possible to actually observe the decay with contemporary measurements it can be observed that the change in a universal "constant" such as q, c, or h over a period of 11.3 years would be on the order of one, two or four parts in 10^9, respectively, based upon their relative decay rates. But, those constants are presently measured to an estimated accuracy of in the range of 500 *parts in* 10^9 (*0.5 parts per million*) (per the already referenced CODATA Bulletin). Thus observation of the universal decay by direct measurement of the declining value of our universal constants, even over a period of a human life time, would appear to be beyond our capabilities at present even were it possible at all with the on-going decay of our instruments and ourselves meaning that no decay at all would be directly measured.

Indirect measurement of the universal decay by measurement of the c and h of light from distant stars is thus indicated in order to experimentally verify the universal decay and to obtain better data for the calculation of where we stand in that decay -- the age of the universe.

CONCLUSION

In conclusion, the universal decay leads to the expected fate of the universe: while it started with a "bang", it will nevertheless end not even with a "whimper", only an inevitable dispersion of its U-wave propagated medium in space and the on-going decay of values (c, q, δ, h, etc.) and of all physical size into nothingness, essentially dimensionless singularities doing essentially nothing.

[See the next following detail notes *DN 13 - The Cosmos Now and Its Expansion From The Origin To The Present*, which, in addition to developing the universe's expansion, also analyses its fate in detail.]