SECTION 16

A Model for the Universe (6) -- The Neutron, Newton's Laws

In dealing with the atom and its description in terms of this Universal Physics there were existing atomic models with which to deal, models whose fundamental correctness was well established by experimental data. Principal among these was the planetary model conception of the atom and the Bohr model correlation of electron orbits and line spectra. Now, in the case of the atomic nucleus, there is much less in the way of a model. There are data and there are some observed patterns in the data. There are some hypothesized explanations for some of these. But, an overall nuclear model is lacking. To develop such a model in this Universal Physics requires, then, a detailed analysis of the data.

First, however, a brief survey of the subject in the terms of traditional 20th Century physics is needed.

SURVEY OF NUCLEAR DATA PATTERNS

In an ingredients or "cook book" sense, atomic nuclei are composed of some quantities of protons and neutrons. The proton is the $+U$ center-of-oscillation described in the section on Mass and Matter and with which the discussion has been dealing. It is the nucleus of the Hydrogen atom. Until now nothing has been said of the neutron. It will be developed shortly, but for the moment it is simply a particle, found primarily in atomic nuclei, having a mass slightly greater than that of the proton and having a neutral electric charge.

Atomic nuclei have a quantity of protons, Z, the atomic number, which corresponds to the type element the atom is and which is equal in number to the number of orbital electrons of that atom. The equal number of nuclear positive charges (protons) and orbital negative charges (electrons) yields an overall charge-neutral atom. (At times an atom may lose or gain one or more orbital electrons for a time. In that condition the atom is termed as being *ionized* and it has a corresponding net electric charge.) It is Z that primarily determines the chemical properties of the element -- what substances it participates in forming and how they behave.

Atomic nuclei also have a quantity of neutrons, which add to the overall nuclear mass, the number of neutrons being $(A-Z)$ where A is the atomic mass number. It is an integer near to the actual nuclear mass (in atomic mass units, see Table 16-1, below) and equal to the total number of protons plus neutrons in the nucleus.

A chart of some atomic nuclei and particles is given in Table 16-1, below.

Name	Symbol = $_{Z}Sym^{A}$	Mass (amu) *
Electron	$_{-1}e^{0}$	5.485,799,03 × 10-4
Proton	$_{1}p^{1}$	1.007,276,470
Neutron	$_{0}n^{1}$	1.008,664,904
Hydrogen	$_{1}H^{1}$	1.007,825,035
(deuterium)	$_{1}H^{2}$	2.014,101,779
(tritium)	$_{1}H^{3}$	3.016,048,27
Helium	$_{2}He^{3}$	3.016,029,31
	$_{2}He^{4}$	4.002,603,24
...	...	...

*For the first three entries the mass is the mass of the particle. For the atoms the mass is the overall atomic mass including the nucleus and the orbital electrons.

Masses are given in atomic mass units, a system of relative mass measurement in which the mass of $_{6}C^{12}$ is arbitrarily set at 12.000,000,000 amu.

One amu = 1.660,540,2 x 10^{-27} kg (CODATA Bulletin)

Table 16-1

The mass of a nucleus is somewhat less than the sum of the masses of the component protons and neutrons (excepting only Hydrogen having a nucleus composed of only one proton). For example, if the mass of a $_{1}H^{2}$ Hydrogen nucleus is calculated by subtracting the mass of its one orbital electron as

$$\begin{array}{lrl} & _{1}H^{2} \text{ mass} = & 2.014{,}101{,}779 \\ - & \text{electron mass} = - & 0.000{,}548{,}580 \\ \hline & _{1}H^{2} \text{ nucleus mass} = & 2.013{,}553{,}199 \end{array}$$

and the result compared to the sum of the masses of the components of the nucleus, one proton and one neutron, as

$$\begin{array}{lrl} & \text{proton mass} = & 1.007{,}276{,}470 \\ + & \text{neutron mass} = & 1.008{,}664{,}904 \\ \hline & _{1}H^{2} \text{ nucleus mass} = & 2.015{,}941{,}374 \end{array}$$

the mass of the components is *0.002,388,175 amu* greater than the actual nuclear mass. This missing mass, called *mass deficiency* represents energy lost when the nucleus was formed. Consequently, it is energy needed to be supplied to separate the nucleus back into its components. It is, therefore, energy, or rather lack of energy, binding the nuclear components together and is called *nuclear binding energy*. This would appear to be quite important since otherwise the strong repulsive forces of the multiple protons in the nucleus for $Z = 2$ or more should cause the nucleus to fly apart.

Not all combinations of quantities of neutrons and protons will successfully form a stable atomic nucleus. For any given number of protons, Z, only a small range of variation of the number of neutrons, $(A-Z)$, is possible in a stable atomic nucleus. With the sole exceptions of Hydrogen (no neutrons and one proton) and Helium 3 (one neutron and two protons) all stable nuclei have the number of neutrons equal to or a little greater than the number of protons. When the number of neutrons is outside of that stable range the nucleus tends to emit a particle or particles in a fashion that changes the ratio of neutrons to protons toward the stable range. See Figure 16-2, below.

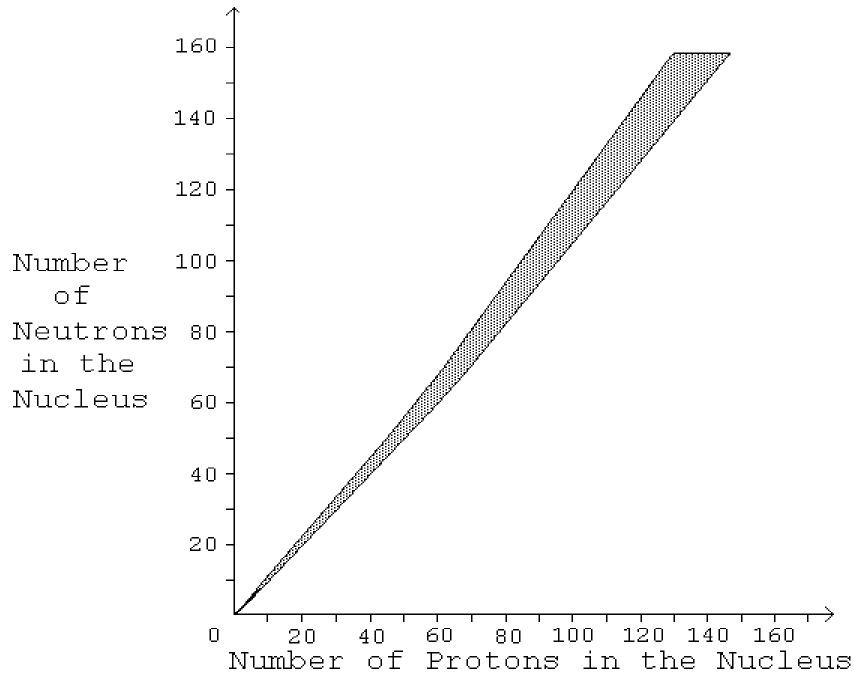

Figure 16-2
Stable Range of Nuclear Proton-Neutron Combinations

THE NEUTRON

The neutron gives substantial evidence of being some kind of combination of an electron and a proton. Unlike the case with atomic nuclei, where the presence of multiple protons and their mutual electrostatic repulsion makes the nucleus tend to fly apart except for the binding energy, an electron and a proton would tend to bind together in mutual electrostatic attraction. No binding energy - mass deficiency would be needed for an electron - proton combination.

This correlates with the neutron mass, which exceeds the sum of the masses of the hypothesized components, a proton and an electron, by $0.000,839,854$ *amu* (more than the mass of an electron). The neutron has in this sense a negative mass deficiency or binding energy, a mass excess. One might expect this since the act of combining a proton and an electron should also include at least some of the energy of their mutual attraction.

Because of the negative binding energy one would expect the neutron to be unstable, which it is. While the neutron is quite stable in a stable nucleus, where it is affected by its overall nuclear environment, it readily decays into a proton and an electron when in an unstable nucleus. Furthermore, when free of any nucleus the neutron naturally decays into a proton and an electron with a mean lifetime before decay of about *900* seconds. When this occurs some conserving momentum and energy are deemed carried off by a charge-less mass-less entity called an anti-neutrino in traditional 20th Century physics. (That particle is, in effect, defined by the necessity to conserve energy and momentum. The neutrino is treated in the later section *18 - A Model for the Universe (8) - Radioactivity.*)

The neutron decay is symbolized as

$${}_0n^1 \Rightarrow {}_1p^1 + {}_{-1}e^0 + \bar{\eta} \qquad \text{where: } \bar{\eta} = \text{anti-neutrino}, \; {}_{-1}e^0 = \text{electron}, \; {}_1p^1 = \text{proton}, \; {}_0n^1 = \text{neutron.}$$

There also exist anti-particles, particles identical to the above except for symmetrically opposite charge, composition and / or "spin". In anti-matter the anti-neutron decays into a negaproton and a positron as

$${}_0\bar{n}^1 \Rightarrow {}_{-1}p^1 + {}_1e^0 + \eta \qquad \text{where: } \eta = \text{neutrino}, \; {}_1e^0 = \text{positron}, \; {}_{-1}p^1 = \text{negaproton}, \; {}_0\bar{n}^1 = \text{anti-neutron.}$$

Data also indicate that, while there are a variety of possible combinations of various particles, when a particle and its anti-particle combine they mutually annihilate each other as, for example

$${}_1e^0 + {}_{-1}e^0 \Rightarrow \approx + \approx$$

$${}_1p^1 + {}_{-1}p^1 \Rightarrow \approx + \approx$$

$${}_1\bar{n}^0 + {}_1n^0 \Rightarrow \approx + \approx$$

where $\approx$ is a photon of gamma radiation, a very high frequency and high energy form of E-M radiation.

The $\approx$ carries off the conserving energy and momentum.

That a neutron when it decays always decays into a proton and an electron, and that an anti-neutron always decays into a negaproton and a positron, and that the neutron and anti-neutron mutually annihilate all strongly indicate that the neutron is some form of combination of electron and proton with analogous composition for the anti-neutron. Likewise, that model naturally yields the neutron's electrostatic neutrality and could tend toward the neutron mass being somewhat greater than that of a proton plus an electron.

The model is, then, that the neutron is some form of co-location of the proton frequency and wavelength type of center-of-oscillation with an electron frequency and wavelength type of center. The question is: how do the proton and electron centers-of-oscillation combine to produce this new kind of center, the neutron ?

The proton, a $+U$ spherical oscillation in space, has time varying pulsation, frequency and wavelength as already presented, which are as in equation 16-1 and Figure 16-3, below. Likewise, the electron, also a spherical oscillation in space but in $-U$, is as presented in equation 16-2 and Figure 16-3, below.

$$(16\text{-}1)\quad U({}_1p^1) = U_c\cdot\left[1 - \mathrm{Cos}[2\pi\cdot f_p\cdot t]\right]$$

$$(16\text{-}2)\quad U({}_{-1}e^0) = -U_c\cdot\left[1 - \mathrm{Cos}[2\pi\cdot f_e\cdot t]\right]$$

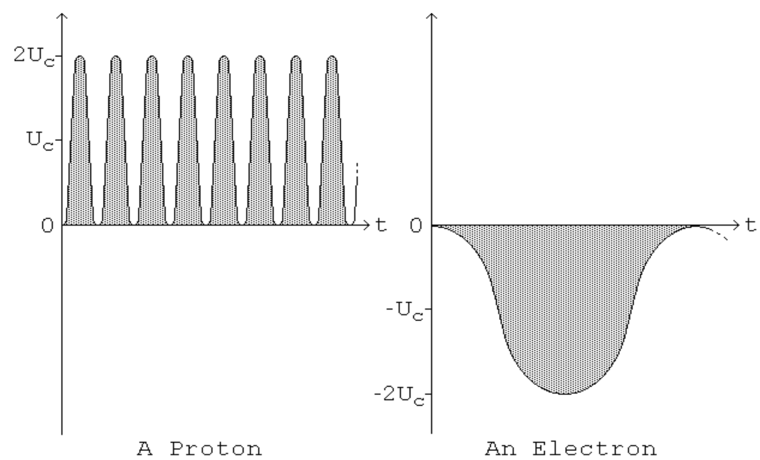

Figure 16-3
The Proton and Electron Oscillations
(Relative frequencies, f_p and f_e, are not to scale)

As a combination of a proton and an electron type center-of-oscillation in one new center, the neutron oscillation function would be the sum of the oscillation functions for the proton and the electron. On that basis

$$(16\text{-}3)\quad U({}_0n^1) = U_c\cdot\left[1 - \mathrm{Cos}[2\pi\cdot f_p\cdot t]\right] - \cdots$$
$$\cdots - U_c\cdot\left[1 - \mathrm{Cos}[2\pi\cdot f_e\cdot t]\right]$$
$$= U_c\cdot\left[\mathrm{Cos}[2\pi f_e t] - \mathrm{Cos}[2\pi f_p t]\right]$$

This form can be visualized as that of the proton except that the proton's constant average level of $U_c\cdot 1$ is replaced with the relatively slowly varying $U_c\cdot \mathrm{Cos}[2\pi\cdot f_e\cdot t]$ of the electron. See Figure 16-4, below. (The electron / proton frequency ratio, f_e/f_p is $1/1836.152701$, the same as the electron / proton mass ratio per the CODATA bulletin referenced in the preceding section). (A quite slight but necessary modification or adjustment of equation 16-3 will be developed in the calculation of the mass of the neutron toward the end of this section.)

The $+U_c$ average level of the proton cancels with the $-U_c$ average level of the electron leaving a zero average level corresponding to neutral electric charge. The neutron is neutral by virtue of alternating equally between positive and negative. (That a neutron can temporarily exhibit a positive or negative charge while neutral on the average could be of significance in neutron interactions with other particles, other neutrons, or nuclei.)

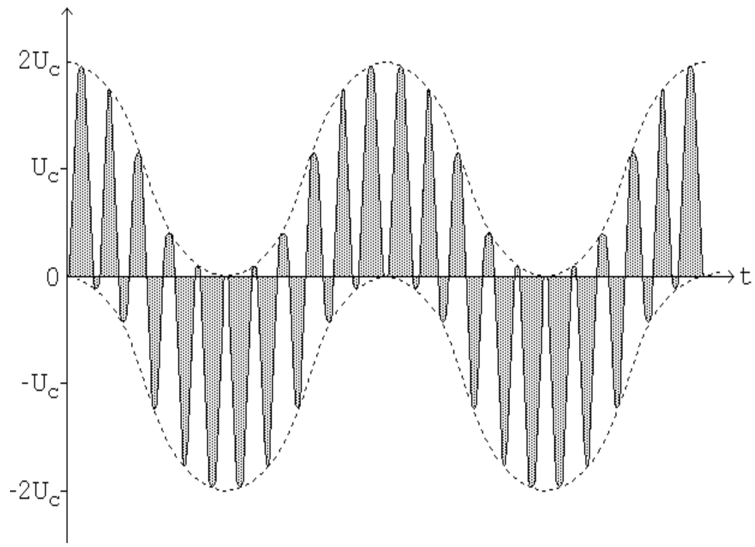

Figure 16-4
The Neutron Oscillation
(As in Figure 16-3, frequency is not to scale)

This configuration readily accounts for the neutral electric charge of the neutron. To be explained are:

- Why the proton $+U$ and electron $-U$ centers so co-located do not mutually annihilate and
- How the neutron mass is greater than the sum of its components' masses.

  (Actually, since responsiveness is proportional to wavelength, why does the electron responsiveness, which is much larger than that of the proton, not dominate the combination yielding a neutron responsiveness somewhat greater than that of the electron with a corresponding neutron mass less than that of the electron ?)

To address the question of the neutron's components not mutually annihilating as well as that of what actually happens in a mutual annihilation it is only necessary to compare a case of mutual annihilation with the above case of the neutron. A positron-electron mutual annihilation, for example, is

$$U({}_1e^0) + U({}_{-1}e^0) = \cdots \tag{16-4}$$

$$\cdots = U_c \cdot \left[1 - Cos[2\pi \cdot f_e \cdot t]\right] - U_c \cdot \left[1 - Cos[2\pi \cdot f_e \cdot t]\right]$$

$$= 0$$

The two oscillations literally cancel. The annihilation occurs because the two are point-by-point inverses of each other because their frequencies are the same. In the case of the neutron the two co-located particles are of different frequencies and consequently interact differently.

Such an annihilation is depicted in Figure 16-5 on the following page.

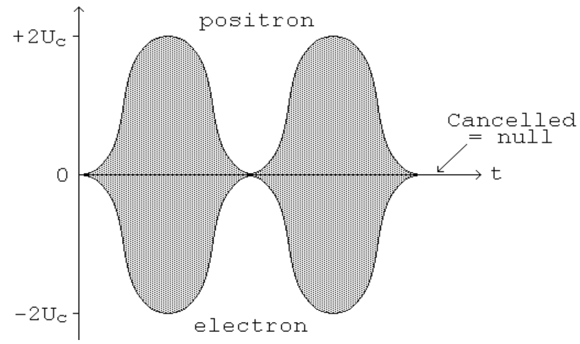

Figure 16-5
A Mutual Annihilation

In general for a particular particle and some particular anti-particle of it, their phases and frequencies will not be identical because of their different velocities and histories of relativistic frequency shifts. However, for them to mutually annihilate they must remain co-located for some brief moment sufficient for the event to occur. For the particles to be co-located for a brief moment their positions and velocities must be identical, which means that their frequencies and their phases will also be identical.

The mutual annihilation energy is the conversion into energy of the entire mass of the two particles involved. The mass of each of the particles is its oscillation as discussed in section *12 - A Model for the Universe (2) - Mass and Matter*. At annihilation the two particles' oscillations cease to exist by cancelling each other out. Since the center oscillations cease, the last U-waves propagated are followed by no U-waves at all from those centers. That is the greatest possible change in the U-wave propagation of a center.

Section *14 - A Model for the Universe (4) - Magnetic and Electromagnetic Field* showed that E-M radiation is the propagation of changes in the U-wave field, changes usually caused by velocity changes of charged particles. The ceasing at annihilation of the oscillations of the two particles involved causes a photon, as presented in the preceding section, to be propagated. Actually two photons result: one due to the $+U$ particle and one due to the $-U$ particle. The photons carry off conservation maintaining energy and momentum. The frequency of each photon is, in this case, the frequency of the oscillation that just ceased, which corresponds to the mass of the particle. In other words the photon energy, $W = h \cdot f$, is the energy equivalent of the entire mass of the particle annihilated.

In the neutron, however, the co-located proton and electron do not cancel to zero; they beat together and produce a new type of center-of-oscillation that oscillates equally in $+U$ and $-U$. From Figure 16-4 it is clear why the electron responsiveness, although much greater than that of the proton, does not dominate the neutron's responsiveness yielding a neutron mass less than that of the electron. While our vision perceives an electron frequency form in the figure, the actual oscillation is at or near the proton frequency only, with no overt component of oscillation at the electron frequency.

The precise determination of the neutron mass according to this model of the neutron is a complex procedure, however, and is developed later in this section after the following preparatory analyses.

FURTHER ANALYSIS OF CENTERS-OF-OSCILLATION

A center-of-oscillation has been defined and treated in this discussion as an on-going spherical oscillation of the *density* of the *medium*. The statement is now further clarified as follows.

- That the oscillation of the center is *spherical* means that it is radially outward in all directions from the center of the center-of-oscillation.

- The terminology *density* has been used to refer to the amplitude of the oscillation, a choice made to give a somewhat tangible feeling to the concept, the amount of medium in some sense. Every oscillation has its amplitude, but the term refers to the amplitude of something: air pressure for sound waves, E-M field for light, displacement distance for a pendulum or vibrating string, etc. The referral used for U-waves has been *medium density* in this work to this point.

  Now, however, it is necessary to be more precise and what had been referred to as "medium density" is hereafter referred to as "magnitude of the medium oscillation". This is necessary so that the term "density" can be made available for its traditional purpose, the amount-per-volume or -per-area of something. The magnitude of the oscillation now refers to its central behavior. The density refers to its concentration over two or three dimensions, surface density or volumetric density.

But, what is this center-of-oscillation ? To address this question requires going back again to the origin of the universe and its fundamental mechanics.

TIME

A *change* is one set of conditions being replaced by some different set of conditions. The direction of the change is inherent in the definition: the replac*ing* set comes after the replac*ed* set.

Duration is that which is until the next change. (Our human experience is that durations begin and end with change; however, for a duration to be it is only necessary that its terminating change has not occurred.) (A duration need not be measurable. Measurement is merely the comparison of something against a defined standard quantity with the drawing of a conclusion as to the relative amounts of the two.)

Time has already been defined as the potentiality (or capability) to exhibit duration, latent duration so to speak.

Realized time, the actualization instead of latency, is the exhibiting of duration.

Before the start of the universe there was no change. A duration was in process. A change was required to prevent that duration from being infinite. Time was realized, therefore, even before the start of the universe. Although it was unmeasurable, a duration was going on. Time has always been realized. The Origin only made time become measurable.

SPACE

Space has already been defined as the potentiality (or capability) to exhibit volume, latent volume so to speak.

For any volume to exist in the real sense (as compared to the imagining or visualizing of a volume) it must contain something. That is, something must fill the volume, something that is other than the nothing that existed before the start of the universe and exists outside of realized space.

Why volume, why three-dimensional space ? Because for something to be contained, to be within, a region of a space the something must not be solely on a boundary of the space. A boundary of a space is any location that is within the space and immediately adjacent to a location not within the space, not part of the space. In the absence of such a boundary, in the absence of any locations that are not part of the space, then the space is infinite, which cannot be.

One dimensional space, a line, appears to be bounded only by two end points. But, consider the example of one dimension space that is the line we would call a circle. It has no end points. Is it then infinitely long ? Certainly not. The apparent boundary of two dimensional space, a surface, would appear to be enclosing lines. But then consider the surface of a sphere. It has no enclosing lines yet it is not infinite. The boundary of a line is all points within the line. The boundary of a surface is all points within the surface. In both cases all of those points are adjacent to locations not within the line or surface.

As duration is bounded by change, so volume is bounded by surface. For an other than infinite volume there must be an enclosing surface on one side of which the volume is and on the other side of which the volume is not. Surface is to volume as change is to duration. Neither "exists" in the sense that surface has no volume (occupies no three dimensional space) and change has no duration. They are boundaries. But, there are locations within a volume that are not on the boundaries, that are not adjacent to locations not within the volume. Thus a volume is capable of containing something and three-dimensional space is the least number of dimensions having that capability.

Three dimensional space can be filled with something other than nothing, can be a change from the original nothing. Space of more than three dimensions can be conceived of and treated mathematically, but whether it is possible in reality is an open question and in any case it is less simple, less minimal.

It is medium that produces realized space by filling volume, by making volume able to be. But, volume and medium are not identical. Any non-zero amount of medium is enough to result in realized space. The realized space can be volume containing large or small concentrations, density, of medium.

Before the Origin no space was realized; there was no volume whatsoever. The Origin, the start of the original oscillation, started the realization of space, of volume.

A non-zero amount of volume could not suddenly leap into existence because that would require an infinite rate of change. The original realization of space was, then, the original introduction, injection, of medium; an introduction that had to occur progressively under the constraint of a *[1 - Cosine]* form of variation in order to avoid infinite rate of change, as presented in section *10 - The Probable Beginning* and its detail notes.

(As discussed in that section, this could have ceased after one cycle but it constituted less change for it to continue, once started, than to cease. Likewise, conservation was (and is) maintained by the introduction in the same fashion of equal un-, or anti-, or whatever-, medium in *-U*.)

We have at the Origin, then, medium, realizing space, being introduced continuously in a *[1 - Cosine]* form of rate, being introduced at the center of the oscillation. Why the center ? At the first instant of realized space the amount was infinitesimal, only a minute change from the set of conditions a moment before when there was no realized space at all. At that instant there was only one place that realized space, medium, could be introduced: the single point where it all started. Since medium was originally introduced at a point there is no reason that it could not so continue, and doing otherwise would be unnecessary additional change.

This is a difficult concept to accept. The key is that the process had to start from a single dimensionless point. That cannot be avoided. Given that, once that has happened, there is no reason to balk at what had to be at least once being on-going.

The introduced medium occupies, is, introduced volume. Because it is introduced, is continuously appearing at the center, it therefore moves, flows, radially outward from its source, pushed so to speak by the following increment of medium. It travels outward at the speed we call the speed of light, which, then, is a consequence of the on-going injection of medium. (As it flows outward it diffuses into ever-increasing volume resulting in a general inverse-square progressive reduction of the amplitude.)

The introduced medium is injected at a *[1 - Cosine]* form of rate. Therefore, the medium magnitude varies radially outward from the source. The outward flowing medium, carrying the magnitude variations, appears as, effectively is, an outward propagation of a wave, that which has been referred to here as U-waves, traveling outward at the speed of the flow of the medium, the speed of light.

The outward flowing waves are longitudinal waves, that is waves varying in the direction of travel (as compared to electromagnetic waves that are transverse, at right angles to the direction of travel). Since it is volume that is being introduced and forced to flow outward spherically, and since the volume is filled with medium, then the amplitude decreases as the volume ever increasingly expands while containing only the same amount of medium as was originally introduced in that increment of introduced volume.

The wave field consists of zero-to-peak-to-zero oscillatory variation of medium magnitude with the inverse-square reduction superimposed. It is the variation, the waves, that are significant. If the medium magnitude were merely the average value of the waves there would be no latent potential energy, there would only be an increasing volume of inactive realized space. But, the waves result from the *[1 - Cosine]* rate of medium introduction, which was necessary at the Origin to avoid an infinite rate of change.

Overall the propagation of these U-waves outward in all directions is latent, that is realizable, potential energy.

- The propagated field is the electrostatic field as already presented.

- An electrostatic field is latent potential energy. It becomes actual potential energy upon encountering another source of such waves.

The above described behavior of the original oscillation is also the behavior of all centers-of-oscillation. Section *20 - A Model for the Universe (10) - The "Cosmic Egg"* addresses how the original oscillation, the "Cosmic Egg" led to the universe of today.

This on-going, continuous, introduction of medium at the center of every center, with its consequent propagation of medium magnitude variation outward from the center is, nevertheless, a somewhat disturbing concept to we who function with so many implicit assumptions affecting our thinking and point of view, assumptions based on the macroscopic, tangible world present to us. The (only apparent) difficulty is rationalized by recognizing the following.

- The medium, what is being propagated, is minute amounts of *potential* impulse, *potential* momentum change, nothing more tangible, not even so tangible as energy.

- Continuous propagation of that medium is what we sense as a static, constant, unchanging, unmoving electric field. (It has already been shown that the transit time requirement caused by the speed limitation of the speed of light requires that electric field involve on-going something continuously traveling outward at the speed of light from the source electric charge.)

- Just as oscillating centers are our "hard" particles, and atoms consisting mostly of empty space but with orbital electrons whizzing around are our solid matter, so continuously propagated oscillatory medium magnitude is our static electric field.

It happens because of the continuous oscillatory introduction of medium, volume, realization of space, at the center of every center.

MOTION - NEWTON'S FIRST LAW

The words used above, "introduced" and "injected" are not really correct. They were used above to facilitate the discussion, but they are misleading in that they subtly convey the idea that the medium flowing outward from the center came from some other place, the place that did the introducing or injecting.

There is no such other place. There is no "place" at all except within the realized space of the medium propagation. The outward flowing medium does not come from elsewhere; it arises, or appears, and flows outward, the process being the center-of-oscillation. (Where the medium comes from is further addressed in section *21 - The Probable End*.) This seemingly non-conserving state of affairs was Originally resolved by the simultaneous outward flow of equal-and-opposite (in some sufficient sense) $-U$ medium behaving simultaneously identically. It continues to be resolved by the process in which the Original center led to the myriad centers of the universe as developed in section *20 - A Model for the Universe (10) - The "Cosmic Egg"*.

Except for the initial instant of the Origin, when the universe changed from having no existence at all to consisting of the first infinitesimal appearance of medium, all subsequent appearing of medium can be viewed as being "called" or "drawn" into appearance as a necessity. Since the immediately prior increment of medium flowed outward at speed c, the appearance of the next increment is essential to prevent a void, a "hole", a discontinuity of non-realized space in the midst of the expanding realized space. Of course, the process does not occur in increments but smoothly and continuously. Figure 16-6(a), below, illustrates the concept using increments.

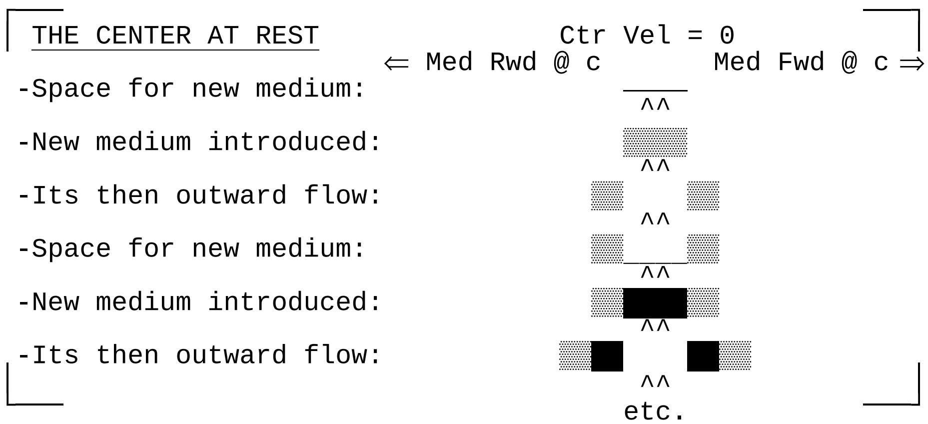

Figure 16-6(a)
The Center at Rest

Medium, then, appears at and flows outward:

- from any place within realized space which place is a center of outward-flowing, retreating, (and therefore potentially void-creating) medium, and
- in each direction at the necessary flow rate so as to maintain continuity and avoid a void.

Originally the flow rate was uniform in all directions and at the rate, that which we call c, the speed of light.

If, however, for whatever reason, the location of the center of outward flow is changing, is moving at a constant velocity, then the required pattern of the appearance and flow of new, replacement medium must be different. The rate of flow must be less in the forward direction by the amount of the speed of motion, because the outward flowing medium is retreating from the location of the source of new medium at the medium flow speed, c, less the location motion speed, v. Conversely the rate of flow must be greater in the rearward direction. Likewise, the three-dimensional rectangular components forward and rearward of the flow in any other direction are correspondingly modified.

The behavior is as was described in section *13 - A Model for the Universe (3) - Motion and Relativity*, and as is illustrated in Figure 16-6(b), below: propagation relative to the moving source at $c' = c - v$ forward and at $c'' = c + v$ rearward, the overall absolute medium flow rates being $c' + v = c$ forward and $c'' - v = c$ rearward.

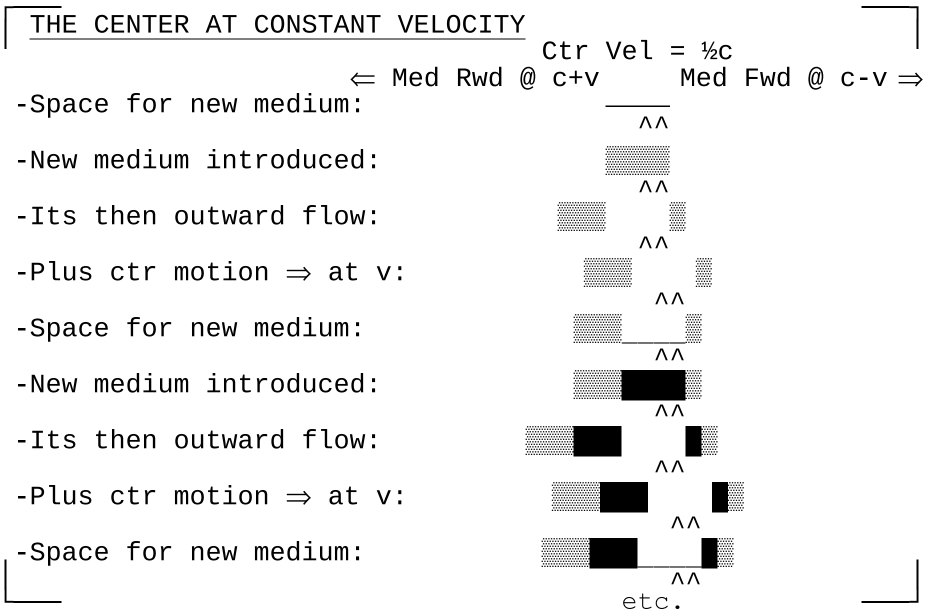

Figure 16-6(b)
The Center at Constant Velocity

Not only must the flow, the appearance of new medium, be so for a source of medium, a center-of-oscillation, if it is in motion at constant velocity; that is, not only must it be so to maintain the continuity of realized space; but, also, the fact of the medium flow being that way ($c' = c - v$ forward and $c'' = c + v$ rearward, etc.) causes the location of the center of flow for further new medium, the location required to avoid a void within realized space, to continuously change, change in the forward direction at that velocity v.

In other words, the center remains at rest or maintains its state of motion at constant velocity, Newton's First Law, because of the necessities of medium flow. The appearance and outward flow of medium, realized space, must match the need presented by the prior instant's propagation. The next instant of propagation must be such as to smoothly maintain the pattern of flow, avoiding the introduction of a discontinuity, which would be an infinity. If the center, the location of the appearance of new medium, is in motion then it must continue in that motion, if it is at rest then it must so continue, both subject to the condition that some other event does not occur to produce further change.

Such a further-change would be called, in Newtonian terms, a force, which must produce an acceleration. In the terms of this Universal Physics it is a wave from some other center now encountering the center being examined.

MOTION (CONTINUED) - NEWTON'S SECOND LAW

Newton's first law, that an object remains in its state of rest or constant velocity motion in the absence of being acted upon by a net force, results from the requirements inherent in the medium propagation action that takes place at the center of propagation of the center-of-oscillation as just presented above. Because the fact of motion is so a part of our macroscopic perception of the universe (and was of Newton's), we tend not to think that what motion is, how it happens, need be explained. We tend to feel that motion simply is, a "given", an axiom or postulate.

But, before the universe there was nothing. It is not necessarily reasonable nor correct to make any assumptions, contend any postulates, other than those that are applicable even before / without a universe. Such are the postulates that an infinity is impossible and that conservation must be maintained. The discussion of Newton's first law, above, is, then a discussion of what motion is and how motion occurs: *motion is the relocation of a center of propagation of U-waves, a relocation that is imperative because of the center's pattern of U-wave propagation at the time*.

Likewise, *acceleration is the changing of the pattern of U-wave propagation of a center so that a different velocity of the center becomes imperative*.

The change is caused by an "incoming" wave interacting with the "encountered center". The incoming wave changes the rearward propagation of the center in one way and changes the forward propagation of the center in another way. The overall effect is to change the center's propagation pattern in all directions. Consider a `+U` incoming wave encountering a `+U` center from the rear (traveling forward, see Figure 16-6(c), below).

```
 THE CENTER AT REST WITH AN INCOMING WAVE

  (1) Initial state:
                                 Ctr Vel = 0
                      ⇐ Med Rwd @ c       Med Fwd @ c ⇒
 -Space for new medium:                 ____
                                         ^^
 -Incoming wave increment:       ▒········⇒

 -Effect on rear free space:            ___
                                          ^
 -Effect on fwd free space:                _
                                           ^
 -Center relocation (velocity):          ____
                                           ^^
  (2) Resulting state:
                                Ctr Vel = ½c
                    ⇐ Med Rwd @ c+v     Med Fwd @ c-v ⇒
 -New free space as result:              ____
                                           ^^
 -New medium introduced:                 ▒▒▒█
                                           ^^
                                        etc.
```

Figure 16-6(c)
The Center at Rest and an Incoming Wave

See the next page for analysis of this Figure and also section *19 - A Model for the Universe (9) - Gravitation* for a minor modification to the above.

For the forward propagation, the incoming wave, arriving from the rear and traveling in the center's forward direction, appears to be "outgoing" as it passes the center of propagation of the center. The requirements of medium flow at that instant, calling for a certain level of medium flow in the forward direction, find some of that required amount being supplied by the incoming wave, now outgoing at that point. The center need only supply the difference between the total level of medium propagation called for and that supplied by the wave.

This means that a portion of the wave appears to have been absorbed (that portion of it is thereafter taken as being part of the center's propagation, not part of the wave), and it means that the amount of medium propagated by the center (called or drawn from the center) in the forward direction is reduced in consequence.

For the rearward propagation of the center the situation is analogous. The difference is that the incoming wave is, to the propagation from the center of the center, apparent anti-propagation. The center must not only propagate the amount of medium that would have been required in the absence of the incoming wave, it must also propagate an amount to cancel out the anti-propagation effect of the incoming wave. These effects of incoming wave encountering a center are illustrated in Figure 16-6(c), below. The pattern of propagation of the center is changed by the incoming wave from that of a center at rest to that of a center in motion at velocity v.

The preceding illustrations are all (subconsciously, implicitly) of a $+U$ wave encountering a $+U$ center. Analogous behavior, and with the effect in the correct direction (attractive or repulsive), results from the interaction between a $-U$ wave and $-U$ center or between a wave and a center of opposite $\pm U$ signs. Of course these illustrations are highly schematic. The process will be quantitatively developed shortly; however it is first necessary to address a preliminary matter.

It has been developed above that all of the propagation action of a center takes place at the center of the center; that is, at a point, a singularity, which is the source of the center's propagation of medium. The question then arises as to how some portion of the incoming wave is intercepted and caused to act upon that singularity. Clearly, more of the incoming wave front must be intercepted and caused to participate in the wave - center interaction than that portion which would be the projection of the singularity on the wave front. If the point singularity has no size, then it should intercept no wave.

U-WAVE PROPAGATION

At the end of section *14 - A Model for the Universe (4) - Magnetic and Electromagnetic Field,* in the discussion of the dielectric constant, it was stated that U-wave propagation is slowed in the presence of other U-waves. That effect is fully developed and analyzed several pages further on below. Consequently it can be taken as valid here for the moment and it can be taken as reasonable because it is evidenced as follows.

Both theory and observation demonstrate that light is deflected by a gravitational field. The theory is Einstein's general theory of gravitational field. The observation is of the deflection of light from very distant galaxies when the light is observed in circumstances such that it passes near to an intervening, less distant, galaxy. The observed light is E-M waves, of course. But E-M waves are merely a fixed imprint on the pattern of U-wave propagation. The E-M waves propagate because the U-waves on which they are imprinted are propagating. Since the deflection of light by a gravitational field is fact, it must be that the U-waves, themselves, are in fact deflected in the gravitational field.

Gravitational field has not yet been treated in this work; however, a few fundamental observations about it can be made. For exactly the same reasons as given for electric field, the gravitational field must consist of the propagation of something outward from the mass with which the gravitational field is associated. Unless matter is to propagate two different forms, one for electric field and a second one for gravitational field, the gravitational field must be an aspect, an effect, of U-wave propagation. That is certainly the more simple situation, and it is shown to be the case in the later discussion of gravitation in section *19 - A Model for the Universe (9) - Gravitation*.

The deflection of light in a gravitational field is, then, actually the deflection of U-waves in the presence of other U-waves. Such a deflection means that the propagation of U-waves is slowed by the presence of other U-waves. The amount of slowing must bear some proportionality to the amount of other wave present. That is, a U-wave propagation encountering no other U-waves is not slowed, but it is slowed if it does encounter other waves.

That cannot be a step change; such would be another form of an infinity. It must be a gradual variation with the amount of other U-wave encountered -- its local amplitude. That variation could conceivably be one of a number of different forms but the most likely is a simple linear variation. That is certainly the most simple and it is the most common form of variation found in nature. The detailed analysis of U-wave slowing, several pages further below, shows that the slowing is directly proportional to the wave amplitudes involved.

In a gravitational field the U-wave magnitude decreases radially outward from the source mass inversely as the square of the distance from that mass. Thus a U-wave front passing a mass in space, passing through a region of space with a decreasing gradient of U-wave magnitude across the wave front, experiences greater slowing of the portion of the wave front nearer the gravitating mass and less slowing farther away from the mass. In consequence the wave front turns, is deflected, somewhat toward the mass.

This is not a large effect. After all, the effect can only be observed as a quite small angular deflection in light passing through an immense gravitational field over a quite considerable distance of interaction. Nevertheless, this characteristic behavior of U-waves is fundamental to the wave - center interaction, Newton's second law, that of the acceleration of a mass when it is acted upon by a net force.

The U-wave field of the encountered center focuses some of the incoming waves from the source center onto itself.

In the case of an incoming wave interacting with the U-wave field of an encountered center all of the dimensions and quantities involved in the deflection of the U-wave front are at the other extreme of size from the galactic case. While deflection action continues to take place on any ray of wave front until it is heading directly toward the center of the encountered center (in which position there is no further deflecting action) the time and distance available to the interaction and the magnitude of the deflecting field are such that only a moderate portion of the incoming wave is fully deflected toward the center, focused upon the singularity which is the center of the center's propagation. Most of the waves have their paths bent slightly but not enough to focus them onto the center. They simply pass and go on their way.

It is only the portion of the incoming wave front that is successfully focused onto the encountered center that produces the Coulomb - Newton effect. The rays that miss the center of the encountered center effectively miss the encountered center of oscillation completely and do not enter into the interaction. The rays that take part in the wave-center interaction do so at, and by having been focused onto, the center of the center just as the propagation of the center arises from the center's center. It is the interaction of the two that results in Newton's second law. (The medium flow is not separate rays, of course, but a smooth continuum. The expression "ray" is used only to describe behavior.)

Only a moderate portion of the encountered center's U-wave field presents strong enough focusing action and need cause a minimal enough deflection so as to successfully deflect incoming rays fully toward the center of the center. This is as a region like a cone having its tip at the center of the center, its base toward the incoming waves and its axis centered on the direction of the incoming waves as in Figure 16-7, below.

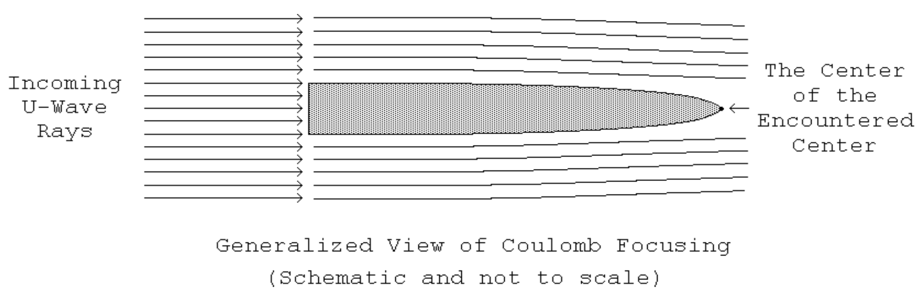

Figure 16-7

ANALYTICAL WAVE-CENTER INTERACTION

The derivation of Coulomb's law in section *12 - A Model for the Universe (2) - Mass and Matter* assumed the validity of Newton's laws of motion and used the second law, $F = m \cdot a$, as part of the derivation. That restriction or condition can now be removed and Newton's laws can now be derived in their own right. The complete derivation is as follows.

From the analytical development of Coulomb's Law in section *12*, the amount of medium propagated in one cycle of the propagated wave is

(12-24) $U \cdot \lambda = \text{amplitude} \cdot \text{wavelength}$

the amplitude of the oscillation times its wavelength.

An encountered center-of-oscillation at rest then propagates

(16-5a) $\Delta U_e = U_e \cdot \lambda_e$ [Medium per period, T_e, of its oscillation]

This is the amount of medium that "arises" or is "called" at the singularity, the source of propagation. It is the total amount propagated outward in all directions by the center

The amount propagated in any particular direction such as *forward* or *rearward* is $1/4\pi$ of the total, that is (at rest where all directions are the same)

(16-5b)
$$\Delta U_{e,fwd} = \Delta U_{e,rwd} = U_e \cdot \lambda_e \cdot \frac{1}{4\pi}$$

(This arises as follows. For a unit radius sphere each radial ray outward from the center is of length 1, representing 1 unit of amount of radial outward flow in the present case. The total of all such rays is the sphere's surface area times the single ray which is $[4\pi \cdot 1^2] \cdot [1] = 4\pi$. The fraction of the total propagating in any one individual direction is then the ratio: $1/4\pi$.)

Likewise the source center for the incoming waves propagates the corresponding amount, $U_s \cdot \lambda_s$ per period, T_s, of its oscillation. This, arriving as waves at the encountered center, has a density there over its spherical surface of

(16-6)
$$\begin{matrix}\Delta U_s \\ \text{per} \\ \text{unit area}\end{matrix} = \frac{U_s \cdot \lambda_s}{4\pi \cdot d^2}$$
[Medium per unit area per wave period, T_s, of the wave arriving at distance d from the source center.]

During the encountered center period, T_e, the number of wave periods, T_s, that occur is T_e/T_s so that the amount of arriving wave magnitude per unit area during a center period is as in equation 16-7, below. (Equation 16-7 is the average for a large number of instances and T_e/T_s is not necessarily nor usually an integer.)

(16-7)
$$\Delta U_w = \frac{T_e}{T_s} \cdot \Delta U_s$$
[Per unit area]

The amount of this incoming wave actually intercepted and used in the encounter is the magnitude of equation 16-7 times the effective area for collecting and focusing rays of the incoming wave onto the singularity, the center of the encountered center. At equation 12-5 that area was found to be

(12-5)
$$\text{Cross-section} \propto \pi \cdot \lambda_e^2 = K_{cs} \cdot \lambda_e^2$$

conceived simply as a target, the cross-sectional area of the volume in space occupied by the center, that volume having a radius proportional to the wavelength of the center's oscillation.

But, now it is found (and analytically derived below) that the process is not one of the source waves "running into" the center, but rather, one of their being focused onto the encountered center where the focusing effect is proportional to the encountered center's amplitude. That is:

- the encountered center can collect incoming rays that are not directly aimed at it but, rather, are aimed at a point displaced sideways from it by some distance,

- the maximum such distance, the displacement of the most mis-aimed ray that can be collected, the focusing power, is proportional to the encountered center wavelength and to its amplitude,

- that distance defines (is the radius of) a circular area all rays passing within which are collected.

(16-8) $$\text{Area} \propto \pi \cdot [\lambda_e \cdot U_e]^2 = K_{cs} \cdot \lambda_e^2 \cdot U_e^2$$

[Where K_{cs} is a constant characteristic of the situation / process]

(See detail notes *DN 10 - Analysis of Coulomb Focusing Details* at the end of section *19 - A Model for the Universe (9) - Gravitation* for further analysis of this target area.)

The total amount of incoming wave acting at the singularity per period of the encountered center is, then, the product of equations 16-6,7, and 8:

(16-9) $$\Delta U_w = \left[\frac{U_s \cdot \lambda_s}{4\pi \cdot d^2}\right] \cdot \left[\frac{T_e}{T_s}\right] \cdot \left[K_{cs} \cdot \lambda_e^2 \cdot U_e^2\right]$$

The overall effect of this in changing the center's propagation, the mechanism described in the preceding (Figure 16-6(c) and associated text) is as follows:

(16-10)

Forward

$$\Delta U_{e,fwd}' = \Delta U_{e,fwd} - \Delta U_w = \Delta U_{e,fwd} \cdot \left[1 - \frac{\Delta U_w}{\Delta U_{e,fwd}}\right]$$

[In the forward case the wave supplies some of the propagation needed to maintain continuity. The center can only supply the balance needed. More precisely, only the needed balance is "called" or "drawn" from the center.]

Rearward

$$\Delta U_{e,rwd}'' = \Delta U_{e,rwd} + \Delta U_w = \Delta U_{e,rwd} \cdot \left[1 + \frac{\Delta U_w}{\Delta U_{e,rwd}}\right]$$

[In the rearward case the center must not only propagate the amount that would have been needed in the absence of the wave but must also propagate an amount to offset the incoming wave.]

The magnitude of these changes relative to the center's behavior in the absence of the incoming wave, equation 16-5, is

(16-11) $$\text{Ratio} \equiv R_\Delta = \frac{\Delta U_w}{\Delta U_{e,fwd-rwd}}$$

For the center to be propagating medium at $(1 \pm R_\Delta)$ of its rest propagation rearward and forward respectively, it must be moving forward at a velocity, v, such that:

	Forward	Rearward
	(1) Propagation is at:	
(16-12)	$c' = c - v = c \cdot [1 - R_\Delta]$	$c'' = c + v = c \cdot [1 + R_\Delta]$
	(2) from which:	
(16-13)	$v = c \cdot R_\Delta \equiv \Delta v$	$v = c \cdot R_\Delta \equiv \Delta v$

That is, the overall effect is to change the center's velocity by the amount $\Delta v = c \cdot R_\Delta$ during one period of the center's oscillation, T_e, an acceleration of

(16-14) $$a = \frac{\Delta v}{T_e}$$

from which by substituting from the preceding equations:

(16-15)
$$a = \frac{c \cdot R_\Delta}{T_e} \qquad \text{[Substitute with 16-13]}$$
$$= \frac{c \cdot \Delta U_w}{T_e \cdot \Delta U_{e,fwd\text{-}rwd}} \qquad \text{[Substitute with 16-11]}$$
$$= \frac{c \cdot \left[\frac{U_s \cdot \lambda_s}{4\pi \cdot d^2}\right] \cdot \left[\frac{T_e}{T_s}\right] \cdot \left[K_{cs} \cdot \lambda_e{}^2 \cdot U_e{}^2\right]}{T_e \cdot [U_e \cdot \lambda_e \cdot {}^1/4\pi]} \qquad \text{[16-9, 16-5b]}$$
$$= \frac{c \cdot U_s \cdot U_e}{d^2} \cdot f_s \cdot \lambda_s \cdot K_{cs} \cdot \lambda_e \qquad [T_s = {}^1/f_s]$$
$$= \frac{U_s \cdot c}{d^2} \cdot K_{cs} \cdot \lambda_e \cdot U_e \cdot c \qquad [f_s \cdot \lambda_s = c]$$

which is identical to step (4) in the derivation of Coulomb's Law in section *12 - A Model for the Universe (2) - Mass and Matter* adjusted per equation 12-32. (The d here is identical to the R in section *12*).

It can now be reasoned as follows.

(16-16)
$$\text{Inertial Mass} = \frac{\text{Applied Force}}{\text{Resulting Acceleration}}$$
$$\text{Inertial Mass}_{\text{encountered center}} = \cdots$$
$$\cdots = \frac{\left[\frac{Q_s \cdot Q_e}{4\pi \cdot d^2}\right]}{\frac{U_s \cdot c}{d^2} \cdot K_{cs} \cdot \lambda_e \cdot U_e \cdot c} \qquad \text{[Coulomb's law in Universal Physics, equation 12-31, ... divided by equation 16-15]}$$
$$m_e = \frac{[U_s \cdot c] \cdot [U_e \cdot c] \cdot [{}^1/_{4\pi}]}{[U_s \cdot c] \cdot [K_{cs} \cdot \lambda_e \cdot U_e \cdot c]} \qquad \text{[Q = U·c, per equation 12-25]}$$
$$= \frac{h}{c \cdot \lambda_e} \qquad [K_{cs} = {}^c/4\pi \cdot h \text{ per equation 12-32]}$$
$$= \frac{h \cdot f_e}{c^2} \qquad [c/f_e = \lambda_e]$$

as must be the case, of course.

In section *12 - A Model for the Universe (2) - Mass and Matter* responsiveness was developed as expressed in equation 12-8, reproduced below.

$$(12\text{-}8)\quad \text{Responsiveness} = [\text{Cross-section}]\cdot[\text{Amplitude}]\cdot[\text{Frequency}]$$

$$= [\ K_{cs}\cdot\lambda_e^2\ ]\cdot[\ U_e\ ]\cdot[\ f_e\ ]$$

$$= [\ K_{cs}\cdot\lambda_e^2\ ]\cdot[\ U_e\ ]\cdot[\ c/\lambda_e\ ]$$

$$= K_{cs}\cdot\lambda_e\cdot U_e\cdot c$$

where: K_{cs} = a constant of the proportionality,
λ_e = the wavelength of the encountered center oscillation,
U_e = its amplitude, and
f_e = its frequency.

The last line of equation 16-15, above, which results in that same responsiveness, is a statement of equation 12-3, the opening of the discussion of mass, Coulomb's law, and the responsiveness concept, which itself was initially obtained from the inversion of Newton's Law that force equals mass times acceleration,

$$(12\text{-}3)\quad \text{Acceleration} = \text{Wave} \times \text{Responsiveness}$$

and its elaboration at Step (4) of the derivation of Coulomb's law in section *12*.

For equation 16-15 that same result was obtained from the expression of the physical action taking place: so much wave, so much wave per unit area, the physical area of wave collected by focusing, the effect on the encountered center's oscillation and propagation and motion of the focused-in medium, etc. The two analyses produce the same result.

Thus, as with Coulomb's Law and Ampere's Law in earlier sections of this work, now also, Newton's Laws become derived from fundamental considerations of the origin of the universe rather than being mere empirical observations

MEDIUM FLOW - THE "INVERSE SQUARE LAW"

The above investigation of the behavior of centers-of-oscillation, their propagation of U-waves from a singularity, and the focusing of incoming waves onto the center's singularity, raises a potentially troubling problem: what is the magnitude at the singularity; what happens where the r of $1/r^2$ is zero ?

The inverse square behavior is a density effect, that of amount-per-volume. The $1/r^2$ factor is the rate of change of density with respect to radial distance.

Let us imagine a quasi-one-dimensional universe, that is the medium being introduced into a pipe of constant cross-section. For this case there is no inverse square law behavior. The medium flows into constant volume, not ever increasing volume. The density at any location in the pipe at any instant of time is the amount of medium at that location at that instant divided by the volume at that location.

That very statement says that density cannot be considered at a specific location along the pipe, only over some length of the pipe so that there can be a volume. Since the medium magnitude at any instant of time varies continuously along the pipe, the most accurate result is obtained by choosing a very short length of pipe, so short that the amount of medium along the pipe, although varying, is essentially constant along that extremely short length.

Letting d represent distance along the pipe, the density at distance $d = D$ from the pipe entrance and over short length of pipe Δd at that location is determined as follows.

- The medium magnitude introduced at the pipe entrance (and then flowing along the pipe at speed c) is

$$(16\text{-}17) \quad U_c\left[1 - \mathrm{Cos}[2\pi\cdot f\cdot t]\right]$$

- and at any time t and location d along the pipe is

$$(16\text{-}18) \quad U_c\left[1 - \mathrm{Cos}[2\pi\cdot(f\cdot t - {}^{d}/_{\lambda})]\right]$$

[λ = wavelength of the medium wave in the pipe. $\lambda = {}^{c}/f$]

- The amount of medium in short pipe length Δd is equation 16-17 with the setting $d = D$ and times the short length Δd. The density there is that amount of medium divided by the volume of that section of the pipe, equation 16-19.

$$(16\text{-}19) \quad \frac{\text{Amount of Medium in the Volume} = U_c\cdot\left[1 - \mathrm{Cos}[2\pi\cdot(f\cdot t - {}^{D}/_{\lambda})]\right]\cdot\Delta d}{\text{Volume} = [\text{Pipe cross-section area}]\cdot\Delta d}$$

$$\text{Density Along Pipe} = \frac{U_c\left[1 - \mathrm{Cos}[2\pi\cdot(f\cdot t - {}^{D}/_{\lambda})]\right]}{[\text{Pipe cross-section = rate of change of volume per distance}]}$$

The three-dimensional case is as follows.

$$(16\text{-}20) \quad \text{Radial Density} = \frac{\text{The radial wave function}}{[\text{Rate of change of volume per distance from source}]}$$

If we apply this reasoning to the center-of-oscillation, where the medium is introduced radially outward in all directions into a space with the volume increasing as the medium flows outward rather than the constant volume of the pipe, the difference is the behavior of the volume and the description of the medium input. The amount of medium introduced is the same as for the pipe, but it expands into an increasing volume with the result of a decreasing density.

Considering the very first increment of medium, which flows a radial distance of Δr, it occupies a volume of

(16-21) $V_{total,1} = V_1 = {}^4/_3 \cdot \pi \cdot [\Delta r]^3$

After the second *Δr* the first increment has flowed out to distance *2·Δr* for a total volume of

(16-22) $V_{total,2} = V_1 + V_2 = {}^4/_3 \cdot \pi \cdot [2 \cdot \Delta r]^3 = 8 \cdot V_1$

$$V_2 = V_{total,2} - V_1 = 8 \cdot V_1 - V_1 = 7 \cdot V_1$$

Similarly

(16-23) $V_3 = V_{total,3} - V_2 = 27 \cdot V_1 - 8 \cdot V_1 = 19 \cdot V_1$

and, therefore, in general

(16-24)
$$\begin{aligned} V_n &= [n^3 - (n-1)^3] \cdot V_1 \\ &= [3n^2 - 3n + 1] \cdot {}^4/_3 \cdot \pi \cdot [\Delta r]^3 \\ &= 4\pi \cdot [n^2 - n + {}^1/_3] \cdot [\Delta r]^3 \end{aligned}$$

Since implicit in the description of this analysis is that

(16-25) $n = {}^r/_{\Delta r}$ and V_n is ΔV for the Δr

then Equation 16-24 can become

(16-26)
$$\begin{aligned} \Delta V &= 4\pi \cdot \left[\frac{r^2}{[\Delta r]^2} - \frac{r}{\Delta r} + \frac{1}{3}\right] \cdot [\Delta r]^3 \\ &= 4\pi \cdot \left[r^2 - r \cdot \Delta r + \frac{1}{3} \cdot [\Delta r]^2\right] \cdot \Delta r \end{aligned}$$

and the rate of change is

(16-27)
$$\begin{aligned} \text{Rate of Change of Volume per Distance from Source} &= \frac{\Delta V}{\Delta r} \\ &= 4\pi \cdot \left[r^2 - r \cdot \Delta r + \frac{1}{3} \cdot (\Delta r)^2\right] \end{aligned}$$

For example:

Δr	Rate of Change of Volume per Distance	
$\Delta r = r$	$4\pi \cdot \left[r^2 - r^2 + r^2/_3\right]$	$= 4\pi \cdot (0.333\cdots) \cdot r^2$
$\Delta r = {}^r/_{10}$	$4\pi \cdot \left[r^2 - \frac{r^2}{10} + \frac{r^2}{300}\right]$	$= 4\pi \cdot (0.90333\cdots) \cdot r^2$
$\Delta r = {}^r/_{100}$	$4\pi \cdot \left[r^2 - \frac{r^2}{100} + \frac{r^2}{30000}\right]$	$= 4\pi \cdot (0.990033\cdots) \cdot r^2$
	. . . .	
$\Delta r = {}^r/_\infty$	$4\pi \cdot \left[r^2 - \frac{r^2}{\infty} + \frac{r^2}{\infty}\right]$	$= 4\pi \cdot r^2$

Table 16-8

No matter how small Δr is made, the associated amount of medium and volume that occupy it are finite. No matter how closely the singularity is approached the density is finite.

Of course, the reason for there not being an infinite density at the singularity in the above analysis is that the problem is stated with a finite, not infinite, rate of introduction of medium at the singularity, as is the case with actual centers-of-oscillation. The density at $r = 0$ remains simply undefined.

It will be developed later (in sections *19* and *21*) that the case of $\Delta r = 0$ (or the case of $r = 0$) never occurs in reality, that the singularity, in spite of being a singularity, nevertheless functions as a minute volume having a minute radius, and that its propagation is from the surface of that volume.

ε, μ, AND THE SPEED OF PROPAGATION

At this point a brief consideration of an electrical analog to U-wave propagation is necessary to further develop the behavior of U-wave propagation and the medium. A transmission line is an electrical device for transmitting oscillatory electrical energy from one place to another. Examples are: the various coaxial cables and two-wire pairs found in radio, and video systems interconnecting equipment components; the longer length such lines to antennas; wave guides; and so forth. When electrical signals and energy are introduced at one end of such a line they do not appear at the far end instantaneously. Rather, there is a finite speed of travel of the electrical effects along the line.

Aside from the essential requirement that the speed could not be infinite in any case, the more proximate reason for the limited speed is that any such line inevitably has some electrical inductance and capacitance whether intentionally placed there or not. These limit the speed of propagation as will be described below.

A simple straight conducting wire has some self inductance and, since one must deal with such wires of various lengths it is best to deal in terms of the inductance per unit length of the wire, L_p. Likewise, any pair of electrical conductors, whether coaxial or not, have some capacitance between them. Again it is more convenient to deal in terms of the capacitance per unit length of the transmission line, C_p. Figure 16-9, below indicates the nature of the transmission line electrically, schematically.

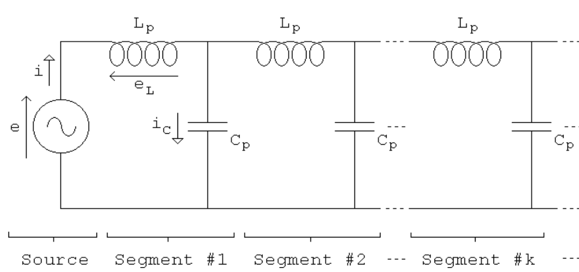

Figure 16-9

If an electrical potential source of some magnitude, e, is connected to one end of the line, an electric current, i, starts to flow in the line. If we consider one quite short segment of the line ("infinitesimally short") it consists (aside from its function as a pure conductor) of an inductance, L, and a capacitance, C. The amount of the inductance in the segment is

$$L = [\text{Inductance per length}]\cdot[\text{segment length}] \tag{16-28}$$
$$= [L_p]\cdot[v\cdot t]$$

where the length of the short segment, the [segment length] of equation 16-28, is the product of whatever the speed of travel, v, down the line is (its value not yet known) times a minute (infinitesimal) time segment, t. Similarly, the amount of the capacitance is

$$C = [C_p]\cdot[v\cdot t] \tag{16-29}$$

The potential produced in the inductance is

$$e_L = L\cdot\frac{di}{dt} \qquad \text{[The natural behavior of inductance, } L\text{, in general]} \tag{16-30}$$
$$= \left[L_p\cdot v\cdot t\right]\cdot\left[\frac{i}{t}\right]$$
$$= L_p\cdot v\cdot i$$

where $^{di}/_{dt} = {}^{i}/_{t}$ because t has been taken as infinitesimally small.

Similarly, the current through the capacitance is

$$i_C = C\cdot\frac{de}{dt} \qquad \text{[The natural behavior of capacitance, } C\text{, in general]} \tag{16-31}$$
$$= \left[C_p\cdot v\cdot t\right]\cdot\left[\frac{e}{t}\right]$$
$$= C_p\cdot v\cdot e$$

where, again, $^{de}/_{dt} = {}^{e}/_{t}$ because t has been taken as so small.

For any such infinitesimal segment of the line, when the electrical potential source, e, is first connected to it $e_L = e$, the source voltage, and $i_C = i$, the current in the inductance. That is, all of the voltage appears initially on the inductance and all of the current initially flows into the first segment of capacitance, which initially has no voltage on it. This is most easily visualized for the first instant of time and the first minute segment of the line, segment #1 in the above Figure 16-9, but as changes it is valid for all minute time segments and minute line segments if they are infinitesimal. Therefore

$$e = e_L \qquad \text{and} \qquad i = i_C \tag{16-32}$$
$$= L_p\cdot v\cdot i \qquad\qquad = C_p\cdot v\cdot e$$

which, multiplied together give

$$e\cdot i = \left[L_p\cdot v\cdot i\right]\cdot\left[C_p\cdot v\cdot e\right] \tag{16-33}$$
$$= L_p\cdot C_p\cdot v^2\cdot i\cdot e$$
$$v^2 = \frac{1}{L_p\cdot C_p} \qquad \text{[Solving for } v\text{]}$$

Thus 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 L_p and C_p is

(16-34) $$v = \frac{1}{\sqrt{L_p \cdot C_p}}$$ [Square root of equation 16-33]

This same result applies to light. Light is an electromagnetic propagation through space. The space in effect has inductance per unit length of μ_0 and capacitance per unit length of ε_0.

- The electrical inductance of a coil of wire is μ_0 times the dimensions of the coil, $N \cdot A/L$, where N is the number of turns in the coil, A is the cross-sectional area of the coil and L is the length of the coil. The N is a dimensionless number. Thus the inductance is, dimensionally, μ_0 times an area divided by a length, that is times a net length. The μ_0 must then be inductance-per-length.

- The electrical capacitance of a simple parallel plate capacitor is ε_0 times the dimensions of the capacitor, A/L, where A is the area of each of the two identical plates and L is the distance between them. Thus the capacitance is, dimensionally, ε_0 times an area divided by a length, that is times a net length. The ε_0 must then be capacitance-per-length.

Therefore, the speed of light is the already frequently presented

(16-35) $$c = \frac{1}{\sqrt{\mu_0 \cdot \varepsilon_0}}$$

However, the electromagnetic waves of light are merely an imprint, a modulation, on the flowing medium. It is medium that travels at the speed c. The speed of light is c only because light, static relative to the flowing medium on which it is imprinted, must travel at the speed of that medium flow. The flowing medium has both its flow and its potential just as does the electrical behavior in the transmission line.

The flowing medium is propagated by the oscillation of the center-of-oscillation. Every oscillation must consist of two aspects so that the oscillation energy is exchanged back and forth between them. Then the propagation of the center involves the propagation of the effect of the two aspects of the center's oscillation. For any oscillation those aspects are always in the form of potential and flow, for example: water pressure "head" and the flow, electrical voltage and current, or a pendulum's potential and kinetic energy. (This is developed further in section *21 - The Probable End*.)

But where do the μ_0 and ε_0 come from; how does empty "free space" have those characteristics ? It cannot and does not. Until medium appears the "free space" is absolute nothing, the non-existence (except as potentiality to receive medium) of before the origin of the universe. Clearly, it must be the medium itself, the only non-nothing material reality, that is the cause of μ_0 and ε_0.

Propagating medium, then, is like an electrical signal traveling along a transmission line where the electrical signal is the transmission line. Propagating U-waves are medium laying down its own transmission line as it propagates. (It is helpful to picture a humorous animated cartoon analogy of a train going along a railroad track that does not exist in front of the train, imagining a very busy man standing on the front of the locomotive furiously constructing new laid track just in time for the train to roll onto it.)

Three principal quantities are involved in electrical propagation along a transmission line and pertain to each location along the line: the amount of charge at the location, the electric potential and the electric current which is the flow of charge. There are three analogous quantities pertaining to each location in space involved in the propagation of medium: the amount of medium at the location, the medium potential and the medium flow. (This is an analogy and is not to say that medium amount corresponds to charge, and so forth. Rather, it has already been shown that medium flowing corresponds to static charge, that flowing medium produces the static Coulomb effect.)

It is the medium, the amount of medium at a particular location, that carries, and therefore determines, the value of μ_0 and ε_0 at that location. That quantity, the medium amount is a scalar quantity, one having magnitude but not an associated direction, just as is the case with electrical charge. The medium potential, the "head" in analogy to the corresponding water flow term, is a vector quantity, one having both magnitude and direction, and is the impetus, the "driving force" of the medium flow just as electrical potential impels electric charge flow, which is current. The medium flow is also a vector quantity, of course.

There is another difference between medium propagation and the transmission line analogy: medium propagates radially outward in all directions from its source whereas a transmission line is linear, does not spread out. The speed of propagation along the transmission line is constant because the inductance and capacitance per unit length are constant. But, if the medium is the source of the μ_0 and ε_0 then as the medium spreads out into ever greater spherical volume the local amount of medium becomes correspondingly diffused so that the values of μ_0 and ε_0 should decrease and the speed of the propagation increase. However, that does not happen, as follows.

The speed of propagation's dependency in a transmission line on the inductance and capacitance really means that the speed of propagation depends on the time that the electrical signal requires to build up its current through the inductance and to build up its voltage on the capacitance, both build-ups being accomplished in each incremental transmission line segment, sequentially segment-by-segment. Since the same identical current flow and charging-up must occur in each successive segment of the transmission line there is no change in the propagation factors, no change in the propagation velocity, from segment to segment.

In the transmission line the electrical input voltage and current are independent of the line's characteristic inductance and capacitance. Consequently a large input signal travels at the same speed in a transmission line as does a small signal. The transmission line, with its independent L_p and C_p, literally "just sits there" waiting for whatever input comes along.

But in propagating medium the "input signal", the medium potential and medium flow, are integral with and inseparable from the "line's characteristics", the μ_0 and ε_0 that determine the flow behavior. Medium propagation does not first "lay down its transmission line of μ_0 and ε_0" and then propagate medium flow and medium potential into them. Rather the medium propagation is the "laying down" of medium flow-in-μ_0 and medium potential-on-ε_0. Furthermore, the elements of the propagating medium are myriad infinitesimals of flow-in-μ_0 inextricably inter-mixed and inter-existing with myriad infinitesimals of potential-on-ε_0 in three dimensions.

For propagating medium the factor determining the speed of propagation is the time required to build up the medium's flow through the μ_0 and its potential on the ε_0. But, in radially outward propagating medium, the flow is inverse square spread out and the potential likewise in exactly the same ratio as the μ_0 and ε_0. The ratio of that U-wave propagation's medium flow to its μ_0 and of its medium potential to its ε_0 remains constant, and so likewise the speed, radially outward, of its propagation, c.

However, that behavior of propagating medium produces a major effect when medium propagating from one source passes through the same space as, medium from some other source. Depending on the orientation of the flows there can be a reducing of the speed of propagation, the c of both medium flows.

In general a medium's propagation speed depends on the magnitude of its medium flow (a vector quantity) relative to the amount of its μ_0 (a scalar quantity) and the magnitude of its medium potential (also vector) relative to the amount of its ε_0 (also scalar). Both of the quantities, medium flow and medium potential are proportional to the then, there, local amount of the medium, its amplitude as originally propagated and subsequently inverse-square reduced in its travel to its current location just, as also are the values of μ_0 and ε_0.

In speaking of the medium flow to be established through a μ_0 and the medium potential to be developed on an ε_0 one can just as readily speak of the medium amplitude involved in the process of propagating medium through a region of a given μ_0 and ε_0.

A given U-wave's vector medium flow and vector medium potential cannot interact with another U-wave's vector medium flow and vector medium potential unless both are directed in exactly the same direction, in which case they sum. That is because all U-wave flows are inverse-square radially outward spreading; they are vectors that cannot combine unless identically directed.

On the other hand μ_0 and ε_0 being scalar can accumulate regardless of the direction of the U-wave flow carrying them.

If two mutually encountering medium flows are traveling in the same direction their parameters all combine. The combined flow balances the combined μ_0. The combined potential balances the combined ε_0. Just as medium from a single source, diffusing into greater spherical volumes in space maintains constant speed of propagation, c, because the ratio of the medium amplitude to the μ_0 and ε_0 remains constant, so two medium flows in the exact same direction have, combined, the same ratio of amplitude to μ_0 and ε_0 as do their individual flows taken separately.

But if those two flows are not in exactly the same direction the scalar μ_0 and ε_0 of the individual flows combine to produce new somewhat greater values. But, the vector flows are spreading out in different directions. They cannot obtain a combining of their medium flows and medium potentials to compensate for the increased values of μ_0 and ε_0 present because they are inverse-square spreading in different directions and there is no valid net resultant.

This is always the case with vector quantities. Similar vectors can be resolved into a net combination or resultant vector. But if the vectors do not linearly respond to their environment in identical fashion such a combination is not valid.

For example electrical signals respond to inductance in proportion to the oscillation frequency of the signal and respond to capacitance inversely to the frequency. Two electrical signals of different frequencies in an inductive-capacitive environment respond each independently according to its frequency. One cannot take a vector resultant.

The independent behavior of the components of complex quantities appears in normal human experience. The overall sound of a symphony orchestra is a combination of many waves at many frequencies and would not at all "look" like a simple pure sinusoid if it could be viewed. But we distinctly and separately hear each of the different instruments, each different note and tone in spite of the sum.

Thus, for medium flows propagating in different directions through each other there is for each the now larger sum of the μ_0 and ε_0 of the two flows combined for which the flows have available only the same, now proportionally less sufficient, amplitude each of its own to drive itself. Each flow experiences a partially reduced value of c. Each is effectively slowed by the other.

For example if u_1 is the local medium flow #1 and u_2 flow #2 then:

(16-36) Same Direction — Opposite Directions

Each of the two flows separately

Same Direction:

$$c_1 = c\cdot\frac{u_1(\text{amplitude})}{u_1(\mu,\varepsilon\ \text{speed})} = c$$

$$c_2 = c\cdot\frac{u_2(\text{amplitude})}{u_2(\mu,\varepsilon\ \text{speed})} = c$$

Opposite Directions:

$$c_1 = c\cdot\frac{u_1(\text{amplitude})}{u_1(\mu,\varepsilon\ \text{speed})} = c$$

$$c_2 = c\cdot\frac{u_2(\text{amplitude})}{u_2(\mu,\varepsilon\ \text{speed})} = c$$

The two flows encountering each other

Same Direction:

$$c_{1,2} = c\cdot\frac{u_1(\text{amp}) + u_2(\text{amp})}{u_1(\mu,\varepsilon) + u_2(\mu,\varepsilon)} = c$$

Opposite Directions:

$$c_1 = c\cdot\frac{u_1(\text{amp})}{u_1(\mu,\varepsilon) + u_2(\mu,\varepsilon)} < \text{"c"}$$

$$c_2 = c\cdot\frac{u_2(\text{amp})}{u_1(\mu,\varepsilon) + u_2(\mu,\varepsilon)} < \text{"c"}$$

This behavior produces the observable bending of light rays by gravitational fields, as discussed above, and likewise produces the focusing of U-waves onto an encountered center as analyzed below, which action is central to the Coulomb effect. The behavior is also fundamental to the operation of gravitation as will be developed in section *19 - A Model for the Universe (9) - Gravitation*.

More specifically, for two flows not in exactly the same direction, one can be resolved into two components: one component in exactly the same direction as the other flow and the other component at a right angle relative to it. The right angle component acts to slow the other flow as just described while the component in the exact same direction as the other flow has no such effect.

The variation in the amount of slowing with the angle between the two flows varies as the Sine of that angle for angles 0 to 90° and for angles 90° to 180° is the value of the above equation 16-36 case for flows in "Opposite Directions".

Waves slowed by this effect resume their original natural speed based on their own propagating values of μ_0 and ε_0 once they have traveled beyond interacting with the flow that caused their slowing.

INERTIAL MASS - THE FOCUSING EFFECT

Considering the interaction between two simple centers-of-oscillation at some specific distance of separation, the greater the portion of the incoming wave front that is intercepted by, interacts with, the encountered center the greater the acceleration experienced by that center and, therefore, the less that the mass of that center must be.

Thus mass inversely depends on, is, the amount of interception, the focusing, the amount of an incoming U-wave front that is collected and directed onto the encountered center's singularity. That amount of focusing depends on the behavior of the medium as follows.

In the analysis of the detailed mechanics of a center-of-oscillation's focusing of incoming U-waves onto itself it is fortunate in reducing the complexity of the calculations that the inverse square falling off in amplitude of the <u>encountered</u> center's waves with distance need not be taken into account.

The encountered center's waves appear as in Figure 16-10, below.

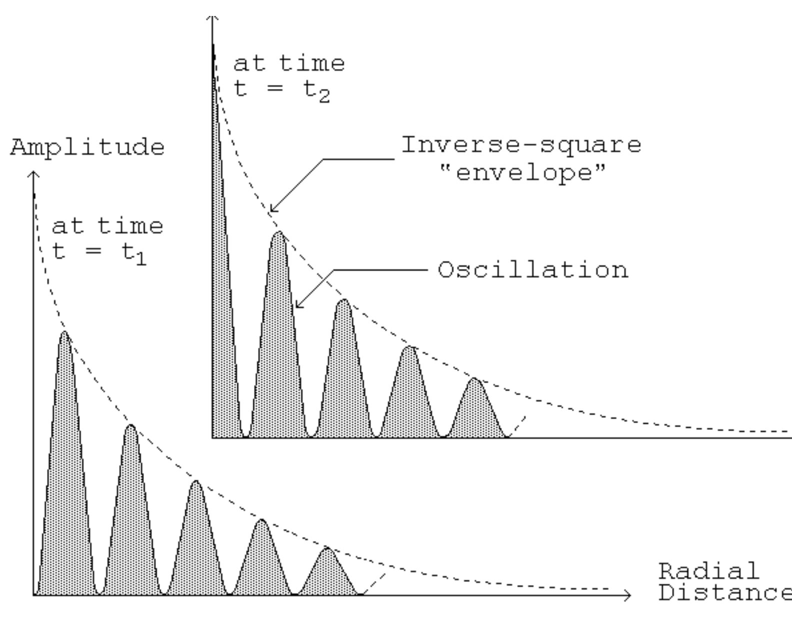

Figure 16-10
General Radial Variation of Medium Amplitude (Not to scale)