STRUCTURAL FUNDAMENTALS OF OUR PERCEIVED UNIVERSE
(AN ALTERNATIVE APPROACH)

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PREFACE

I bring to your attention, an introduction into a new way of looking at the foundations for the assumptions concerning the structure of our perceived universe. It confirms that our universe is a carefully crafted structure with an intense inverse feedback level to maintain the responses of matter and structures very close to the design parameters. The findings do not alter any facts, or experimental results, but only alters what we can read into them, while also broadening our concepts of the possible.

The approach is the result of more than twenty years of exploration of relationships. It was started as a hobby, without a specific aim or structure format other than the simple idea that the fundamental structure ought to permit a broader range of phenomena than our existing interpretation of structure would seem to permit. As a result of the lack of a specific structural focus, there was no identifiable logical path for where the exploration should start, or what was the best path to follow. As the first few pieces were discovered, they required changes in the conventional concept of structure to accommodate them. As more pieces were discovered, they required additional alterations to the concept of possible structure, until it finally evolved to the form presented in the text, and then it became a better fit to the various facts than the conventional approach. The new facts or results, however, are still valid under the existing concepts of structure, but reasons for their existence or descriptions of their connectivities to other data are lacking in that frame of reference.

The final form that the new approach settled into will seem quite natural to those with electronics backgrounds, as involving phase lags, phase advances, phase shifts, modulation, demodulation, and frequency spectra. There have been many pieces of information scattered about that could have directed us into the new approach long ago, had we seriously considered their implications. A particularly obvious case is the perfection of the fit of hyperbolic angle increments as parametric representations of the increments in the ratio of velocities relative to the radiation velocity c. This at least should have been a clue to the fact that we needed either complex functions or added dimensions, or possibly both. Looked at from a different perspective, the new approach can be considered as a derivative from some fundamental dimensional considerations developed in Sir Arthur Eddington's "Fundamental Theory", supplemented with some general background and findings along the way. The result is a theoretical foundation for a cyclic universe structure that is also a universal field theory.

Because of the changes in concepts, and the expression of these changes in several hundred equations, it may facilitate comprehension if the material is approached by way of selective scanning. A suggested path is to read Section 1. to page 9, then the insert in Section 1.2 marked off by ----- beginning page 13. This insert relates to the partial geometrical concept that guided some of the exploratory paths. Follow then with Section 2. up to the start of 2.5., then to Section 3. through 3.4.. Section 4. through 4.5. contains relationships among fundamental constants that are important to the new approach. At this point it is optional whether to read the discussion section 6.7., or to proceed with the whole report.

The differences, between the conventional approach and the proposed approach, show most clearly in extreme situations where we have little no observational data. Universe emergence by the standard "Big Bang" starts at a point of near infinite density, expands rapidly, and forms elementary matter particles in the cooling process. In contrast, by the new approach, matter emergence starts as Neutrons, as space becomes available, and continues relatively slowly. It requires close to 5953 seconds at 0 ^{o}K, with the last 1 1/2 seconds involved with heating up to the starting temperature of 5.267 x 10^{9} ^{o}K for the high temperature phase, with the temperature continuing to rise slowly with Neutron decay to just below the Electron - Positron threshold temperature. At another point where we lack adequate observational data, the conventional theory indicates a possibility for large neutron stars to undergo catastrophic gravitational collapse with the formation of "Black Holes". In contrast, the new approach permits gravitational collapse of excess mass in large Neutron stars, with this matter being relocated to other regions of the universe without "Black Hole" formation. I believe that the simplified approach contained in the present work represents the starting point for a new paradigm for both Cosmology and Nuclear Physics. I submit my material as an introductory elementary text for an improved way of looking at the potential structure of our perceived universe. I do this with the full expectation that many persons, with good theoretical backgrounds in Electronics and Physics or Astrophysics, will shortly understand the material far better than I do, and can guide the wide range of new research projects that should open up as a result of the broader scope of the new foundations.

An important secondary aspect of this report is the implication that the structural fundamentals in the proposed new approach are a part of the same set of fundamentals of universe structure as were utilized by the ancient culture responsible for the building of the great pyramid in Egypt. The proposed new material represents the re-emergence of this ancient knowledge.

August, 1999 Henry F. Myers

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TABLES

1. MATTER, UNIVERSE, AND UNIVERSAL FIELD

The subject matter to be discussed represents the fundamentals of a system for describing what we perceive of our specific universe. It is expressed in the form of elementary concepts that, taken together, make up a universal field theory. The theory has been derived from a study of gravitation. The study began with a simple analog-model approach to computing the Newtonian gravitation constant G, and a recognition that some higher dimensional aspects than our ordinary four dimensional spacetime must be involved, plus some alteration in our concept of time and its dimensionality. This has been a long process of discovering new aspects or requirements, incorporating them, and then going back over the whole theory. This process was repeated many times over the years, until the form that I present now was evolved. This may not be the final form, but it goes sufficiently far to establish the validity of many of the conclusions, and can serve as a foundation upon which others can build. One of the important aspects of the findings is that our perceived universe is a subsystem in a larger and more complex system, where space has a structure that is dimensionally at least as complex as elementary mass-units.

1.1. Basic Elements

At the most fundamental level that we can currently handle, there are at least three components involved: a mathematical group, a universal field, and a mind effecting creative selection decisions. There are obviously things or factors that are more fundamental than the three components that I have identified. These are factors such as the assumptions under which a mathematical group can exist, the fundamentals under which the universal field can exist and operate, and those elements which permit a decision making mind to exist and function outside of the physical structure of our particular perceived universe. We obviously have to stop somewhere in the process of trying to approach "first cause". Whatever the stopping place, it must be somewhere that we can comprehend, and yet be something that can also provide a minimally sufficient foundation upon which to try to construct a physical universe similar to what we perceive. This is the most that the above three selected fundamental elements of structure can represent. The present approach to the structure of the universe is not a mathematical derivation based upon the three proposed fundamental components. Rather, it represents a structuring of the understanding of the modified or different approach to some fundamental factors developed in Sections 2 & 3, based upon the observed behavior of matter and electromagnetic radiation, followed by fitting the observed perceptions together with some factors developed in Arthur Eddington's (1949) Fundamental Theory. This does not furnish a clear cut mathematical basis. As a result, I have used some mathematical terms more in their looser common sense aspects rather than in a rigorous mathematical format. The complete algebra of the suggested group has not been explored: it may not be the exactly proper group, but it does seem to fit the requirements established by the consideration of the observations about matter and radiation. The process of selecting a potential fundamental mathematical group for a basis only came about after many of the new aspects in sections 2 & 3 had been discovered. An expression relating a fundamental mass-unit volume to the inverse of the total universe mass-energy complement at the current universe age, Equation (2-41), was developed. When converted to an expression for the situation at full universe emergence, this became:

$$[(4/3)\pi\, r_0^3]^2 = 1/(\beta\, M_0\, c^2), \qquad (1\text{-}1)$$

where M_0 = total initial matter mass-energy complement (+ or - region),

r_0 = fundamental mass-unit radius at emergence,

β = a factor to relate values in un-measurables to measurable defined by Eq. (2-55) as

$$\beta = (3/4)(e/\pi)2^{5/8} = 1.000\ 805\ 353\ 672\ 043 \qquad (1\text{-}2)$$

Along the way in development of Eq. (2-41), an expression for the total number of mass-units at the present universe age was developed as Eq. (2-34). When this was first evaluated using the then current age value of Avogadro's number (CODATA 1973) and the present mass-unit radius determined from Eq. (2-29) using the 1973 value of Planck's constant, β and the mass of a Carbon 12 based mass-unit as $1/N_A$ and later adjusted for the presence of β, it yielded :

$$N_u = [\beta\, m_\mu\, c^2(4\,\pi\, r_1^3/3)^2]^{-1} = 1.369\ 757 \times 10^{79} \text{ mass-units}, \qquad (1\text{-}3)$$

where m_μ is the mass of an atomic mass-unit in grams,

c is the radiation velocity in cm sec^{-1}.

In the appendix of Eddington's Fundamental Theory, his Equation (23) gives the total number of potential electrons plus protons in the universe. The number of wave-function state neutral carriers would be half that value, or,

$$N_w = (3/4)\ 2^{256}\ 136 = 1.181\ 079\ 31 \ldots \times 10^{79}. \qquad (1\text{-}4)$$

This equation is treated as a first approximation to the number of wave function potential carriers at the current universe age. A more precise number determined after a more thorough dimensional analysis is given as Equation (1-18), where $N_w = 1.363\ 237\ 686\ 182\ 259 \ldots \times 10^{79}$ for the state of initial emergence at local cosmic rest and implying the initial total universe masses as computed.

The closeness of the two independent estimates for the number of neutral carriers, at the present age, (mass-units in one case and hydrogen atoms in the other) suggested that the Eddington estimate for the number of degrees of freedom was probably quite close and should be considered in selecting the best value indicated by the new approach.

Equations (2-41) and (1-1) above provide some structural information that must be considered in group structure: three-space unit volume squared, an inversion relationship, and an internal six-space are all involved. In addition, interaction with the universal field is a basic aspect. Ordinary experience with position of matter particles in spacetime first suggested that the squared volume aspect was a combined effect of direct space volume, an inversion effect, and inverse volume. The inversion effect is connected with matter having structure that extends into normal space together with structure contained in the inverse region with boundary crossing causing inversions in the universal field components. (In the full universe manifestation, there are two space regions and two matter regions containing interior inverse regions, with universal field flow components circulating in opposite directions, as described later.) The universal field flow is hypothesized to contain rotations both clockwise and counter-clockwise, as well as time flow in both a positive and negative sense. Then considering the six-space aspect in the interior region and the fact that Eddington indicated that his 16 component E number system was equivalent to the set of rotations in a six-space, I elected to treat the rotation aspects of the universal field as being 16 components in one time direction, and possibly being the source of complex time.

Considering the foregoing, it appears that we have a volume, an inversion, an inverse volume and something more needed to accommodate the universal field. In addition, it appears that the components in both matter volumes may be paired as a normal and an inverse for each unit vector element. Eddington indicated that closed groups are required in the basic structure at the fundamental particle level. Cyclic groups of the form ($a^1, a^2, a^3 .... a^n$), where $a^0 = 1$, $a^n = 1$, are closed and commutative. In this form, n is also the number of elements in the group. The number of elements in the four-space groups is four in each. Then solely as a shorthand notation, as an aid in estimating total group size, I use the notation $(Q \,\&\, 1/Q)^4$ for the volume aspects with (Q) representing a single element or unit vector. The total fundamental group is then assumed to be of the form $(Q \,\&\, 1/Q)^4 \, \sigma^n$, with n to be determined.

To have a clean-cut group free of redundancies, there must be some limits imposed on n. The integral divisors 2, 4, & 8 should be avoided. Also, the number 16 should both be avoided as a divisor, and yet be contained within n.

Then, there are situations where 5 degrees of freedom may be involved, such as a case where complex time effectively represents 8 elements in a volume determining group, but uniform velocity in all three-space directions, such as at the state of local-cosmic-rest, collapses freedom utilized to 5. Also, when we have four independent length vectors, with time involved in each, we have effectively five degrees of freedom at the external perceived volume level, and an additional five in the inverse aspects. The fit of Kaluza's (1921) five dimensional approach seems to verify that four length dimensions and an unidentified fifth element in the system handles relationships at the level of General Relativity theory. In fact, it is an improvement, in that it brings Gravitation and Electromagnetics into closer relationship than General Relativity, in terms of form of expression. Considering these conditions, it appears that only prime numbers can satisfy the restrictions. The smallest prime number that can serve is 17. On this basis, n = 17 was selected as a likely candidate. The proposed form for the basic group is $(Q \,\&\, 1/Q)^4 \, \sigma^{17} = 1$. There are several different levels of perception or manifestation possible, resulting in different numbers of effective product elements active. The group as described above has 8 x 17 = 136 product elements. Where the external and internal volumes plus the inversion yields a single volume perceived as a kind of an L^2 space then there are only 4 x 17 = 68 effective elements. At the level of complex time affecting all elements, or when the first portion becomes 4 x 4, the total becomes 16 x 17 = 272. In order to be treated as proper mathematical groups, each of the above three product element groupings needs to be increased by one to include the zero vector element, which is a part of every true group. Note: At the perceived structural-unit level where both the direct and inverse volumes participate, we have squaring of the time effect, so that both positive and negative time appear as squared quantities, or positive time. Positive time is defined as that of universal field flow outward into normal space from matter units, while inward flow from normal space into matter interiors is considered negative time direction. The squaring effect at the matter-unit level, plus the unidirectional flow of the normal matter inversion boundary with cosmic age, accounts for our normal experience being confined to positive time flow.

The second basic component is the universal field. With our present limited knowledge, it can only be described by some of its properties. As indicated earlier, it appears to contain sixteen components in the set of rotations, and additionally, it may be a source for complex time. It is the source for energy, mass, time units, length units, forces, etc., and is the medium for conducting the interactions between separate particles in our perceived universe. The field contains a series of harmonically related wavelengths (or frequencies), the maximum wavelength of which is probably less than π times a mass-unit diameter. The field flow maintains coherence while containing rotations both clockwise and counterclockwise in both negative and positive time sense. It is the carrier and source of electromagnetic effects and gravitation. The phase velocity in the universal field is what we measure as the radiation velocity c. When we measure electromagnetic effects, what we measure are properties of the universal field with modulation, but we attribute the effects to the modulation rather than to the whole field. Gravitation appears to be the effect of a small inverse angle phase shift in field leaving matter units.

The evolution and expansion of the universe appears to be a cyclic process. Cosmic time then is related to this cycle, and is defined as the age angle (ϕ) in radians measured from the start of emergence, with a value of π at the instant of full collapse. The universal field is complex, and will probably remain for some time as the most difficult to conceptualize.

The third fundamental element is a design intent that is manifest in decisions such as the mathematical group selection, and in selection of which probabilities are to be actualized in our universe. This creative intent is made evident by the inclusion of an information factor that I have called "the probability actualization factor". In relative terms, an increment of one bit of information represents an increased multiplicative ratio factor of two; while an increment of zero additional information represents a multiplicative factor of only one. In binary terms, $\log_2$(ratio) is the increment of information in bits added. A state selected to be made actual, has its information content increased by one bit. This represents a numerical ratio of 2 relative to the base potentiality. Then, with each of (N) contributing dimension (or parameter) being equivalent, each parameter acquires a ratio share of $2^{1/N}$ over what its value would otherwise be. This actualization factor then appears as $2^{1/4}$, $2^{1/16}$, $2^{1/69}$, etc. for each factor, depending upon the number of elements (N) in the full selected structure or event. For example, where a structure is dependent upon 8 components, but only five are independent, then the resultant factor is $2^{5/8}$. This is a very important element in the new theory, and is a direct piece of evidence of information added, to otherwise random possibilities, to make actual what we perceive. <u>This is one of the two special-factor concepts required in the new theory.</u> This is not an entirely new concept. Frederick W. Kantor, 1977, in <u>Information Mechanics</u>, suggested that some differences in states could be considered as being relative information content dependent.

1.2. Fundamental Relationships

CAUTION: In interpreting the results of equations in this section, extreme care must be exercised concerning dimensionality of the answers when expressed in centimeters. Because of the way that the analysis is formulated, length dimensions are assumed to be normal linear three-space components at early universe ages, however space and matter are more complicated, and even at the simplified perception level, we must treat some dimensions as ordinary three-space units of length, while for other purposes the same units must be considered equivalent to abstract cm^2, because an ordinary fundamental unit of length cannot exist without a fundamental unit of time, and both refer to the same segment of Universal Field flow. See Section 1.5., and watch carefully for the places where I have shifted from ordinary cm to cm^2 in text explanations etc.

The structure of the mathematical group limits the possible number of relationships, but just exploring possible mathematical relationships alone, as a path to understanding our universe, could lead far outside the universe of our perceptions. What is necessary, is to explore what we perceive and then relate this to the proposed mathematical group and its interactions with the universal field, and then explore what is necessary to bring about some agreement. The proposed basic group form $(Q \,\&\, 1/Q)^4 (\sigma)^{17} = 1$, is not in the shape that we normally utilize. The above expression implies that a unit four space vector element is multiplied by one of the σ elements to generate a new element in the larger group. Every element in the final group is a product of this multiplication process. As a result the total group field contains some sub-groups. One of these sub-groups can be formed by treating the four-space elements each as being operated on by the whole range of the σ elements, or $((\sigma)^{17}= 1)$. I believe that this kind of a reduced complexity by averaging together the σ effects upon each elementary four-space unit vector, forms our perception basis. The effect of σ^{17} being unity is not the whole answer, because matter and space etc. are only generated by interactions with the universal field, and the field rotation aspects are only a 16 element group, leaving a residue of one element to be satisfied. This remaining unit is the time aspect, which determines the length of a time unit and by interaction also determines the unit length, with unit time and unit length both representing the same identical portion of a fundamental cycle in the universal field. As a result, then we can replace the composite unit vector by a new composite unit Qt in our perceptions. Expressed in the conventional four-space general vector form, we would have t perform the functions that we perceive as ordinary time,(t) but in a different degree as

$$lt + jt + kt - cwt \,. \qquad (1\text{-}5)$$

An implication of the above form is that both the time unit and the length unit are formed, for each composite unit vector individually, in the whole process of interaction with the universal field. Then if a structure is in motion relative to the universal field in one three-space direction, this will produce a phase difference which will affect the perceived length unit and time unit in that direction, when compared with the values in the standard reference frame of the other two directions. This kind of effect is what we recognize as the result of application of the Lorentz transform. That transform can handle the effect of relative motion in one direction at a given location, and that is all that is usually encountered in perceived three-space. The actual situation in our expanding universe is that there is motion at a constant velocity in the fourth (*w*) direction, and velocities in the three-space directions that vary with universe age, but which may be the same in all three-space directions. As a result, with increasing age there is a changing velocity with respect to the point of origin, and possibly to the universal field that generates the basic macro-space local reference frame. This state is what , I identify as the state of local-cosmic-rest. Later, it is indicated that the extent (thickness) in the(*w*) direction, for fundamental particles, is limited to a single length and time unit, and that we do not have any perception of change in location in that direction. In other words, in the fourth physical direction, we perceive no change in position, but perceive only change in time as a count of elapsed normal time units.

There are some subtleties in conversion to what we perceive at a macro space level. Volume is a product of all four individual direction component vectors with their numerical coefficients and any special shape factor for the particular volumetric form. Volume exists fundamentally in a single time unit, Then using Eq. (1-5) as a basis, together with coefficients, we would have

$$V = -(A\mathit{l}t\ B\mathit{j}t\ C\mathit{k}t\ D\mathit{w}t)\ . \tag{1-6}$$

The product (*ljkw*) as unit volume is a scalar, the product (ABCD) is a pure number, a question then is what about (tttt); it must equate to (t), with the implication that unit time is idempotent (its square is equal to itself). We have one more consideration in that *w* is limited to a fixed single unit value that we cannot perceive in structures. Now, in considering matter structures, since we don't perceive anything in the fourth space direction, structures are limited to a three-space in our perceptions, and the fourth component is recognized only as existence of the structure being considered. The product (*ljkw*) has dimension length^4, which we treat as unit volume, or a scalar under addition to similar volumes. In unit length that is manifest, there is a universe size scaling factor which is the same in all directions, at the state of lcr (local-cosmic-rest). It is assumed that the source of this scale factor is associated with the time component in the universal field, and separate from the rotation group contribution.

We can utilize the vector form in Eq. (1-5) when dealing with single fundamental units of structure, but not exactly in dealing with macro-space structures and positions. The source of time at the fundamental particle level is the inversion boundary and the particle's extension into perceived space. Eddington recognized that the time boundary, or time-source connection with fundamental particles, could not be continuously changing position relative to the particle. He assumed that this was taken care of by a reflection image or some similar mechanism. In the present approach, this need is taken care of by all fundamental units being in continuous contact with the inversion boundary. The other three components are unit vectors in the perceived space containing and surrounding the fundamental particles. They must be considered in a coordinate free approach as the incremental lengths appropriate to the specific particle under consideration. When we shift to consideration of macro structures, we are no longer dealing with a homogeneous region, and whole particles of matter, or even locations in space, may become the zero of the reference frame. The meaning of the time coordinate becomes different from its meaning at the fundamental particle level. Instead of being a length in a specific direction coupled with a unit of time, in macro-space it becomes a count of units of ordinary time or a general radius from the reference point as ct. At the level of the inversion boundary, there is both positive and negative time, but the existence of the two four-space aspects results in squaring the time units, so that only squared units appear in the existence aspect of the fundamental matter particles. As a result, ordinary perceived time units, as squared entities, appear as positive time. At the inversion boundary level, positive time is defined as that of universal field flow outward into space and negative time as that of universal field flow from space inward into fundamental particles in the *w*t direction. The direction of expansion of the universe is that of outward flow of universal field from matter structures. As a result of the particular choices, the universe expansion is a positive time phenomenon by definition, and parallels our experience in macro spacetime. On this basis, we are unlikely to encounter any negative time atomic or nuclear scale phenomena that exist for more than a single time unit.

Matter exists everywhere in our perceived universe in the same instant of time "Now", so that the concept of simultaneity has meaning. Cosmic time represents a count of instants of time from the start of universe emergence (in the form of the age angle). Separate locations in the universe at the same count of cosmic time are in the same instant of "Now", but our perception of events at locations remote from our sensing equipment is delayed by the radiation transit time from the source to the sensors. Since we do not perceive any space direction to time, for spacetime use, it becomes a scalar quantity that is either a time count or an equivalent radiation travel distance unit count. As a result, in spacetime we must shift from the vector form of expression of Eq. (1-5) to a four-space form that treats the time component as a scalar, but modified by a rotator component (w), which is equal to (-1) when squared, to keep it separate from the other three components. This has been accomplished by introduction of the Minkowski vector form for macro spacetime as

$$Ax + By + Cz - wct\ . \tag{1-7}$$

Then, the distance-interval (ΔS) represented by

$$(\Delta x)^2 + (\Delta y)^2 + (\Delta z)^2 - (\Delta ct)^2 = (\Delta s)^2, \tag{1-8}$$

makes it possible to relate the initiation time of the particular event at its source to the observers time system, or cosmic age. Once again: the symbol (w) used in macro space and *w* at the fundamental particle level are different. At the fundamental level, it represents a unit vector with a fixed magnitude and direction, with direction not perceived, while the macro usage is that of a three-space radial distance from a particular reference point expressed as a time function.

Returning now to fundamental particle structure, there is a need to consider interactions with the universal field. The neutral structures are symmetric about the inversion boundary, which means that they interact with the universal field on both sides of the boundary. The effect of the rotation group applied twice, as a whole, is the same as applied once.

Interaction effects between universal field flows do not appear to occur in space, but only at interfaces or in bounded internal regions. Inside of fundamental particle interiors, the opposite flows can interact to form standing wave patterns. The energy of the interaction product is proportional to the volume and to the product of the cosines of the four phase angle differences involved. The standing wave patterns filling the volumes at any given fixed velocity phase angle represent fixed quantities of energy, which in turn are the foundation for the characteristic that we measure as mass. Then, the energy required to change the velocity of the particle, with respect to any one of the four direction components of either of the two universal field flows, is simply proportional to the change in the cosine of the particular direction phase angle involved between the two universal field flows. Mass-units are specified to have an extent in the (*w*t) direction of only one time unit.

The universal field flow is postulated to be made up of a series of harmonically related wavelengths (or frequencies) (See Section 3.5.). As a result, there exists some minimum unit of flow that contains effective representations of all the component contributions in their normal relationship, so that larger extents are simple repeats of the fundamental unit pattern. This fundamental unit appears to our perceptions as the fundamental length unit and likewise the fundamental time unit. A neutral unit of structure based upon the fundamental length and time units is called a mass-unit. This unit turns out to be quite close to the ordinary mass-unit physical that has been set as equal to one twelfth of a Carbon 12 atom. The relationship found is that a Carbon 12 mass-unit is equal to 1.000 000 248 new fundamental mass-units at the state of local-cosmic-rest (See Sections 3.3. & 4.2.). In the process of arriving at the above, the concept of mass has been defined as the quantity of energy perceived in unit time in the normal space aspect of the fundamental particles involved. Later in the study, a mass-unit was defined to remain a fixed quantity of energy throughout the life cycle of the perceived universe.

The concept of space and its relation to matter now needs to be explored. Space is a concept that is dimensionally at least as complex as matter, and its maximum quantity is limited by interactions of the maximum number of potential normal and negative mass matter units as limited by the number of potential units in the pre-emergence structure of the universe. To talk quantitatively about space, we need to know the potential maximum number of abstract structural units in the pre-emergence region. The selected mathematical group size should contain some clue to the required number. The minimum number of degrees of freedom in neutral pre-emergence particles of perceived matter seems to be eight, as derived from the range of structures in the periodic table, and in some of the nuclear particle studies. Accepting this, and considering the pairing (Q & 1/Q) and the effect of element squaring as effectively reducing the pre-emergence aspect to a four-space, requires only group size as 4 x 17 = 68. To this we add the zero element for a group as 69. Then, if we subtract 8 elements for a potential structure, the remainder is 61. The requirements for a unit of structure are potentially 8!. Both positive energy and negative energy units of structure are required, so the pairing effect requires the number of potential units to be determined from the total group after deduction of the elements required in one type of unit (either negative or positive). As a first approximation we might expect the potential number of units of structures to be

$$N = 61!/8! = 1.258\ 879\ 499... \times 10^{79}\ , \qquad (1\text{-}9)$$

however, the new "probability actualization factor" needs to be considered. This factor is determined by the ratio of the required elements in the specific structure to the total for all the elements involved. This is a ratio of 8/69. Including the probability factor, then, the possible number becomes

$$N_p = 2^{8/69}\ (61!/8!) = 1.364\ 225\ 582\ 852... \times 10^{79} \text{ Structure Units.} \qquad (1\text{-}10)$$

This is the number of potential (either positive or negative) neutral pre-emergence structural units, which are specified to be equivalent to Neutrons. When multiplied by the theoretical mass of a Neutron at the state of local-cosmic-rest, this also provides an initial estimate for the total perceivable matter portion of the mass-energy of the emerging universe in grams.

$$M_0 = N_p\ (1.008\ 661\ 950\ 291...)/N_z = 2.284\ 973\ 198\ 597 \times 10^{55}, \qquad (1\text{-}11)$$

where N_Z is the new equivalent of Avogadro's number expressed in new mass-units and theoretical grams, as N_A(CODATA) x 1.000000248, and 1.008 661 950 292 ... is the number of theoretical new mass-units in a Neutron at the state of local-cosmic-rest, as determined by Eq.(4-15).

As our universe ages, things change. It is not simply an effect of cooling, there seems to be something that drives changes in structure toward lower energy forms. The simplest method to accomplish this is to have one of the structural probability factors change with universe age. After testing the magnitudes of several different possibilities, the factor settled upon was the probability actualization component of one element in the pre-emergence group. Then have this factor decline uniformly with cosmic age in radians. One factor has a probability actualization information content of 1/69 bit, or an effect at maximum of $2^{1/69}$ at age $\phi=\pi$. This would yield an effect proportional to $2^{1/69}$ and to (ϕ/π). Converted to a simplified form that changes linearly with age angle in radians, this is shown as Equation (1-12) below.

Total mass of the universe is a fundamental determinant factor in the value of some of the fundamental characteristics of the universe, such as Planck's constant (h), the universal gravitation constant (G), as well as the relative magnitudes of the length and time units at various different universe ages.. The potential mass is a function of the number of potential structures, which is probability dependent. To keep track of the effect of the probability change with universe age it has been assigned to total mass-energy. At maximum effect, mass would become initial mass divided by the factor $2^{1/69}$. When expressed in the form of the initial mass multiplied by a factor that changes uniformly with change in the age angle, the total effective mass, which I call the gravitational mass $\left(M_g\right)$ becomes

$$M_g = M_0\{1- [1- (1/2^{1/69})](\phi/\pi)\}, \text{ or,} \tag{1-12}$$

$$M_g = M_0 (1 - \alpha\phi/\pi), \tag{1-13}$$

where,

$$\alpha = [1- (1/2^{1/69})] = 9.995\ 322\ 693\ 322\ 665... \times 10^{-3}. \tag{1-14}$$

It is now necessary to examine the properties of the four principle regions in the universe structure. Perceived matter units have structure that extends an external boundary into perceived space and have portions of their structure that contacts the adjacent negative space through an inversion boundary, with some of the inversion boundary being an integral part of the unit's structure. Likewise for negative matter structures, they extend an external boundary into negative space and contact perceived space through their interiors contacting an inversion boundary with perceived space. Universal field flow circulates in both fourth physical space (*wt*) directions and in both positive and negative time sense, and with both clockwise and counter-clockwise rotations for each direction. With these several flows, there are intersect nodes in every fundamental cycle interval. The fundamental cycle is one that contains a full wavelength of the longest wavelength component of the universal field pattern, as formed in perceived space. Because of the number of components and directions in the flow, it is anticipated that the interval or separation between adjacent intersect nodes would be one fourth of a fundamental cycle in extent. This separation is the fundamental length unit, and the time extent is the fundamental time unit. The time and length units are both equivalent measures of the same portions of the universal field pattern. It is obvious that we cannot have a unit of time without some accompanying length, and we cannot have a unit of length without some time elapsing.

In crossing an inversion boundary, there is an inversion in size relationships in the universal field with respect to some standard that constitutes a macro-length standard determining unit. With four inversion boundaries, the four inversions returns the universal field size relationships back to their starting points in completing a circuit and returning to a given region. It requires some time to make a transit from one boundary to the next in a given direction. If this effect is also to return universal field phase to its initial phase in making a circuit of all four regions, then the transit time must be a multiple of the whole field cycle. The smallest value would normally be expected to be only one cycle, or four fundamental time units. Due to the fact that we have universal field flow in both positive and negative time, the net result of completing a circuit could be zero net time, with a net effect that, for perceived time, we are starting from zero time for each perceived time unit of existence.

In addition, when electromagnetic flows encounter interfaces where the difference in propagation velocity on the two sides is large, there is a phase shift across the interface, and modulation or demodulation. What passes through the interface or is reflected depends upon the bandpass characteristics on the two sides. Where the interface has a small radius of curvature, this may also limit the transmission across the interface to components with a wavelength comparable to the diameter or smaller. If we treat the interface as having conductive properties similar to a metallic sphere, the ITTC Handbook (1956) indicates the resonance value of the interior of the sphere as an antenna to be 2.28 times the radius. Wavelengths longer than this resonance value would tend to be rejected and reflected from the interface, and since we are talking about mass-units, the critical radius is the mass-unit radius. Modulation, of wavelengths longer than the above implied wavelengths, would tend to be demodulated from the universal field flows and confined to the space region of origin. This is the basis for energy conservation laws in both the positive and the negative perceived universe systems.

The fundamental universal field carrier wavelengths are smaller than the critical resonance values, so they pass unobstructed through the interfaces. Because of the inversion characteristics of the inter-region boundaries, the velocity ratio on the two sides is large, but not infinite, so the phase shift is close to, but slightly less than $\pi/2$. This results in a phase lag in the outgoing flow which is responsible for the gravitational field effect. In the case of this effect, in making a circuit there are two sets of a phase shift and of its opposite, which cancel out to a net zero phase shift effect in making a total circuit of the four regions.

A note in passing, this zero time effect could be the answer to the statement occasionally heard from mystics or psychics to the effect that our universe exists in a region of no time!

If the universal field phases of the two opposite direction flows start out being in phase in the interior of matter-units, they can interact to generate standing wave patterns that represent energy contained within the inversion boundary of these units. Moving out to the perceived space portion, the two flows shift in field phase in opposite directions by a full time phase of $\pi/2$ for each, or π between them. The interaction result then is zero over a time-unit average, except for the small residual that constitutes the gravitational field. Because of the symmetry, the two universal field flows are in the equivalent states in any given region, so that they can interact. Moving to the next region, there would be an additional phase shift of $\pi/2$ in opposite directions for the two flows. This would bring us to the interiors of negative matter-units, where the two flows would be 2π apart, or effectively in phases again. The physical state here is different than in perceived matter, because each of the two flows is in opposite phase to its state in perceived matter, which makes each of the flows be the negative of its perceived matter amplitude state. Coupled with the phase shift in field time aspect of π this makes the matter-energy content be the negative of that of the perceived matter units. Then, likewise, the small residual (uncanceled) field flow in negative space is the gravitational field between negative matter units. The universal field flow loop in the wt direction is symmetric in either direction. In connection with the above field flows, the definition of mass-units and all matter as having an extent (or depth) of one time unit, requires that the total quantity of universal field energy leaving a matter unit in unit time is exactly equal to the energy equivalent content of the mass-energy, Also, each of the two universal field flows from the structure unit is energy potential and each represent the square root of the mass-unit energy content per unit time.

An important consequence is that the total quantity of matter-energy in the sum of our perceived universe and its negative companion, in a unit of time, is zero, except for short time fluctuations in either, the duration of which I would expect to be less than a full field cycle or four fundamental time units.

The guiding concept of structure geometry is important to the whole new concept, but it is something I have not been able to indicate in the form of sketches. The figures 1-1 through 1-3 each illustrate some simplistic aspect of the whole, but lacking an understanding of higher dimensional geometry, it is difficult to put together a picture of the composite whole. I have a mental image of some of the characteristics that serves to guide my exploration of properties. I visualize our perceived universe as a "Three-D" shell on the surface of a hypersphere, with the perceived matter shell having a thickness in the fourth direction of a single unit, and being one of four shells in contact that are separated by inversion boundaries, generating a closed universal field circulation path through the four shells in the fourth direction. In essence then, the whole perceived universe from any one time point of view has an extent of one time unit, with perception connection to adjacent and remote three-space locations via modulation on the universal field transmitted through perceived space. The continuous duration of matter units is a single time-length unit, that is continuously changing in fourth direction location with time. Thus, what we perceive is the instant "Now" at the point of perception plus instants in the past when ordinary three-space radiation at the point of perception is received and demodulated.

As a result of this point of view, the universe is considered in terms of the mass and energy content in a single unit of time. This approach would be expected to yield different values depending upon the distance to the presumed boundaries, as limited by the normal radiation velocity c. This severe limiting effect is circumvented by the existence of inverse regions, between the positive and negative matter shells, where the universal field velocity and unit sizes are inverted, with the result that the universe is tied into a connected whole within no more than a time unit cycle of four perceived time units. What exists in a single time unit in any one matter shell is actually the equivalent of the total mass-energy of the universe. What we perceive via our usual senses is a sampling mix stretched out over a wide time range of source emissions into our conventional-time past. In effect, if there were to be a sudden change of large magnitude in the total mass-energy of our universe, its effect upon many factors would appear locally almost simultaneously with the major change; even if the physical source location of the change was separated by millions of light years, in the conventional space-time sense, from the local sensing point. Considering this, the total quantity of mass in a unit of perceived time is a proper unit for measurement of our perceived universe.

The following Figure 1-1 is a simplistic representation, treating connectivities in a unit of atomic time, but excluding any aspects of the motion of the total system of four regions in the *w*t direction. The two matter regions are treated as though they were three-space volumes as layers on the surface of a hypersphere and were of one wt unit in the radial *w*t direction. With our lack of perception of any physical extent in the fourth direction, then the matter portion of the universe, seen from the location of any individual matter unit, appears to be a spherical distribution in space with the observer at the center of the universe.

The simplistic presentation in Figure 1-1 is an aid to thinking about structures and relationships, but only in a limited way. The actual connections and relationships are much more complex, and will require an understanding of higher

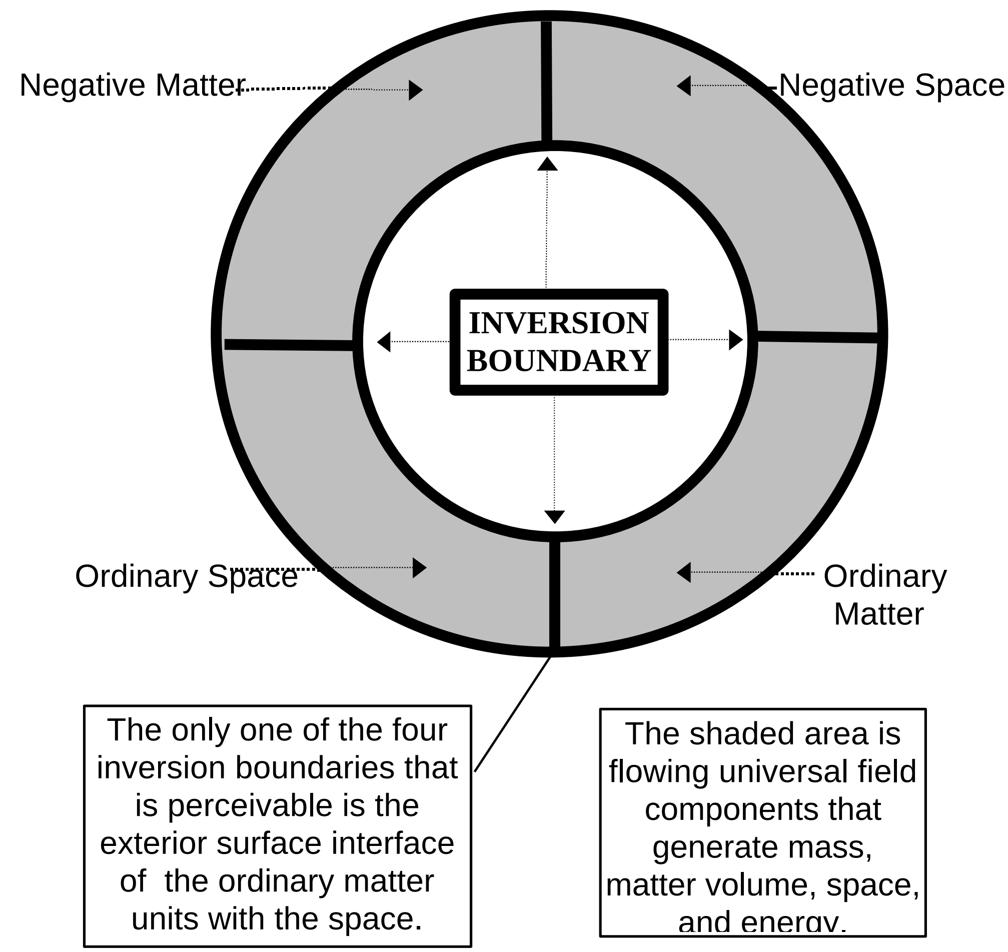

Figure 1-1
The four principal regions

This figure is an over simplified approximation that is dimensionally inadequate. It is constructed to illustrate the separation of each of the four major regions and to show the boundaries separating them in the direction of flow of the universal field that connects them. The universal field flows across the inversion boundaries in both directions. The positive time direction is defined as motion outward from the surface of matter particles into space and continuation in the same direction in circuit of the four regions. Negative time is flow in the opposite sense. The universal field contains internal rotation aspects about the flow axis, both clockwise and counter-clockwise in each time direction. There is another flow aspect that cannot be shown, and that is the flow in the universe expansion process, which involves motion in a fourth physical direction, involving the w direction that we do not perceive, but only sense as elapsed time.

dimensional geometry. There are some things, however, that are determinable from some of the postulates governing the structures and from relationships found in some of the derived equations. The volumes of the space regions are determined by the interaction of matter unit volumes, universal field, and cosmic age phase angle as in Equation (1-22). Relationships within the matter regions are implied from the relationships in Equation (2-41), which indicates that the square of the perceived three-space volume of a mass unit is equal to the inverse of the total-matter mass-energy of the perceived one fourth portion of the total universe. Each and every individual mass-unit involves this same relationship, which then couples each perceived mass-unit to every other mass-unit in the existence time of a single time unit. Thus, two matter units, that have some special strong coupling within the interior of the space region between their structures, can continue their relationship despite a change in their three-space proximity. This coupling may have a time duration that is affected by some probability relationships, but while it endures for the pair, a forced change in a complementary property of one unit can cause a change in the coupled property in the other unit regardless of the particular three-space separation of the two units. This change should occur in the same cosmic time unit as in the interior coupling in the matter region. The result being that exterior three-space observations would seem to indicate a velocity of propagation of a three-space coupling effect with a propagation velocity much greater than the standard velocity c normally encountered. Obviously a similar situation holds within the negative matter region also. This is the structural foundation for the “non locality” encountered at the quantum level.

We are ordinarily accustomed to thinking of a closed volume in three-space as being bounded by the exterior surface. In the new approach of a higher dimension volume, a closed volume is bounded by two three-space volumes separated by a unit in the wt direction. One of the volume bounds is the exterior three-space volume, while the other is the interior three-space volume seen from negative space, with both having relationship to the region between the two bounding volumes indicated by Equation (2-41). What we perceive of the true mass-unit volume is only a three-space projection of the mass-unit exterior. This is generated by the interaction of the exterior boundary with outgoing universal field, as made manifest by modulation of the outgoing field picked up at the inversion boundary of matter units and space.

Considering the demodulation effects of the inversion boundaries, it can easily be seen that any energy generated in either the perceived matter and space region or in the negative set remains in the region of origin. This is true for any kind of energy that appears as amplitude modulation on the universal field. This is the foundation for energy conservation in either of the two matter-space regions, when considered individually. The gravitational field in perceived space is a result of a less than $\pi/2$ phase shift in the universal field crossing from the interior inverse region of perceived matter units through the inside volume of the matter units and the outer boundary of that structure into perceived space. This effect is a very small phase lag effect, such that interaction of the outward flowing field in space with the incoming universal field from the negative matter inverse region does not yield complete cancellation in the perceived space. The net result is that a small portion of the incoming field remains active as a result of the presence of other matter units in perceived space and is able to alter the phase of the interior energy content of the matter unit. The effect of this difference in phase, caused by the presence of other matter units, is the gravitational field effect. The difference between the gravitational modulation of the universal field and that due to ordinary energy modulation of the field is that the ordinary energy modulation is in the form of amplitude modulation, while the gravitational effect is only a small shift in phase of the universal field as a whole, so that it passes through the inversion boundaries and other interfaces exactly the same as the universal field. In other words, the inversion boundaries are as transparent to gravitational modulation as they are to the fundamental universal field components.

One additional aspect about mass, since mass is perceived by the inertial effect of resistance to change in phase (change in relative velocity) or in its response to a gravitational field, and it is the quantity of mass-energy inside the inversion boundary that responds, there is an implication that only structures that have an inversion boundary as part of their intrinsic structure can have rest-mass. Photons, or like patterns of modulation on the universal field cannot have rest mass even though they have energy of modulation content. Yet, by being contained between the two boundaries to perceived space, they can contribute to the total perceivable mass of the universe.

Based upon what has been discussed, it is obvious that once a process of universe emergence has been initiated, a series of changes in other relationships occurs. Both cosmic time and perceivable time start to change. It is necessary that we relate these two factors together in order to place events into consistent relationships. Also, because of its ties to Eddington's earlier work, it was natural to base the work upon the "Centimeter, Gram, Second" set of fundamental units. This has been advantageous in that if other scales of units had been used, some important relationships might have been concealed by reason of large-number scale factors.

Expansion of the universe is responsible for the change in many cosmic factors. The process is initiated by some unknown impulse which disturbs the initial unstable equilibrium of the pre-emergence potentialities. Once initiated, the process follows a sequence through expansion, and collapse, then enters a second phase where perceivable matter and negative matter interchange (as a result of sine ϕ becoming negative): it then starts emergence with the direction of entropy reversed, and proceeds on to a second collapse, and then it can stop in the metastable state and remains there until another initiating pulse starts the system into operation again.

Once the expansion process starts, it continues as though driven by some external function, or the change in total energy of the positive matter. The process continues on to an age phase angle that is some integral multiple of 2π that permits it to stop at the metastable starting point. For our purposes, I propose to explore only the first half phase from $\phi = 0$ to $\phi = \pi/2$. The second half phase is something with which we have no experience. It is doubtful if life processes, as we know them, exist in the second cycle from $\phi = \pi$ to $\phi = 2\pi$.

One of the primary hypotheses in this study of our perceived universe is that for perceived matter to exist, there first must be perceived space to contain it. By implication, where there is no perceived space there can be no perceived matter, and no flowing universal field to act upon the matter units:. Our perceived matter and space are different than the pre-emergence matter, but are derived from this earlier substance under the set of design rules for our particular perceived universe. I call our particular perceived space "Wave-Function" space, in keeping with the designation in Eddington's practice, with matter being contained within it as our conventional wave-function based units of structure.

The volume of perceived space is defined as the outer cross product of the potential volume of pre-emergence matter units (positive with negative) treated as three-space spheres, together with a partial degree of freedom associated with the unperceived fourth dimension, under the influence of the universal field and the age phase angle ϕ. The perceived space volume is considered to be the outer product of every positive-energy matter unit exterior with the inverse of the interior of each and every negative-energy pre-emergence unit, and including the sine of the age phase angle in each product, plus a contribution of the fourth dimension degree of freedom factor, (which item is also a function of the cosmic age in radians). (See Appendix 7.4.) This makes perceived space be something a little more than a plain six-space or a squared three-space by reason of the fourth degree of freedom factor contribution. A similar kind of effect is also involved in the volume of companion negative space.

The quantity (volume) of perceived wave-function matter is limited by two factors: the quantity of potential pre-emergence matter structures, and by the rules for the existence of wave-function matter units. The first of these conditions governs the potential of wave-function space, and the second governs the potential number of wave-function structural units.

One other assumption is necessary for our starting conditions; to the effect that the energy density of the universal field for both types of matter structural units is the same, and that the total energy associated with the matter of the pre-emergence state is the upper limit to the matter energy of the perceived wave-function matter units. This is exclusive of the "space stress" that is the source of gravitational potential energy in any collection of matter-units. As a uniform starting point, a mass-unit in one system is the same as a mass-unit in the other system.

In connection with providing a number for the total mass of the universe in grams, there are a number of other things that need to be mentioned regarding the whole project. The value of the total mass of the universe is fundamental to the determination of many of the universe's constants. The two computed values N_p and N_w for the number of pre-emergence structural units and the number of wave-function probable structural units are exact, and can be computed to as many places as necessary. To compute the mass, we need to know the masses of the respective structural units. For the theoretical mass we have a precise value of a Neutron mass. As a fundamental assumption we equate the neutral carriers to Neutrons both in the pre-emergence state and in wave function state at the instant of full emergence before the wave-function units can start to decay. In addition, in wave-function space, we need to take into account the fact that a free Neutron's mass is affected by the fourth power of the cosine of the velocity phase angle (θ) between earth based wave function space and the state of local-cosmic-rest. (See Section 4.2. Eq. [4-22] for the determination of $\cos^8\theta_v$ from experimental data.) Then, when the numbers of mass-units is converted to grams by dividing the number by N_z, we have our first value for the matter mass of the universe:

Theoretical $M_0 = N_p(m_n)/N_z$, or

$M_0 = 1.364\ 225\ 582\ 852 \times 10^{79}(1.008\ 661\ 950\ 2916)/N_z$,

$M_0 = 2.284\ 973\ 198\ 597 \times 10^{55}$ (Theoretical grams). (1-15)

The actual mass of the universe at emergence is what it is, independently of the method of calculation. Differences in computed values reflect errors in measurement, errors in input factors, or errors in the equations. We have a means for computing the number of pre-emergence units of structure N_p but no independent method of computing the number of pre-emergence units of structure that is derived directly from the CODATA system. As a result, the theoretical value for N_p is utilized for computing the universe emergent mass for all systems, and the theoretical value M_0 is used as the basis for calculations of all fundamental factors in both systems.

In the process of computing numerical values in this project three sets of fundamental physical constants, other than the universe emergent mass, are involved. The first of these is the CODATA 1973 set which was used as a basis of comparison in some of the earlier work. Some of the comparisons are included. After the CODATA 1986 set became available, this was the basis for standards to compare with the computed theoretical values. The third set is composed of theoretical values computed on the basis of the theoretical initial universe mass and relationships discovered along the way. <u>The theoretical structure is based upon the theoretical fundamental constants</u>, even though some of the CODATA 1986 based factors are shown along the way for comparison.

By now you should have noted that I have adopted the standard SI system for reporting numbers with more than four places to the right of the decimal point. The results based upon the CODATA systems, may be reported to a maximum of 10 places, while the theoretical system results are generally reported at 10 to 13 places (except for N_p, N_w, m_n and a few others which may be reported to 16 figures, with the implication that the results could be carried farther with an adequate calculator).

The theoretical values are generally computed for the state of local-cosmic-rest. The CODATA are earth reference frame values and generally imply the current universe age, including an implied assumption that the fundamental physical constants do not vary with age, or that any variation is too small to be significant. In contrast, in the theoretical approach, it is shown that constants that are dependent upon the mass of perceived wave-function matter vary with universe age: this includes length units, time units, Planck's constant, and the universal gravitation constant G. For precise comparisons, the age difference between emergence and the current universe age must be taken into account, when comparing theoretical values with the CODATA derived values. In converting emergent cycle times to years, I have used the SI value of $3.155\ 693 \times 10^7$ atomic seconds per tropical year, and assumed that it is exact. It cannot be, because the length of our year changes with cosmic age and the length of a current second at any age differs from the length of an emergent second. This is something that will eventually have to be straightened out, or some new designation invented for the year involved. (Note: Some other limited precision factors have been assumed exact for the purposes of theoretical calculations, such as light year, parsec, megaparsec etc.)

At this point, we need to back up and compute the number of wave-function potential units of structure by taking into account some of the differences in structure from the values assumed in Eddington's structure. The first of these is that Eddington assumed that at the level of perceptions, mass-units or fundamental structures had the dimensions of points. In our case at the perception level we require a minimum of five degrees of freedom. As a result Eddington assumed that the degrees of freedom factor was reduced from 137 to 136. In our case we must reduce the freedom factor by 5 to 132. At our level of perception, matter seems four dimensional in a unit of time, and we are concerned with matter units in only one of the four space regions, which implies a new probability actualization factor of $2^{4/16}$, or simply $2^{1/4}$. Eddington assumed that the pure binary probability was 136 + 120, or 256, which is the square of his "E" number system. In the present case we have 16 x 17 for a total of 272 elements, but for any one matter element to exist, the rotational aspects of the universal field tie up 16 elements, which reduces the available binary probability number to 256, the same as Eddington's number. On the basis of these differences, we construct a modified form of Eddington's wave-function probability equation for the number of neutral carriers (Neutrons):

$$N_W = (3/4)\ 132\ (2^{1/4})\ 2^{256} = 1.363\ 237\ 686\ 182\ 259 \ldots \times 10^{79}. \qquad (1\text{-}16)$$

These are units equivalent to the pre-emergence structural units, or Neutrons, with a mass at local-cosmic-rest that is equal to the mass of a pre-emergence structural unit. There are fewer of these units permitted than for the pre-emergence structural units. As a result, there are pre-emergence units that cannot appear as matter, but only as the energy equivalent of the extra units. The amount of energy involved is

$$E_0 = (N_p - N_w)\ (m_n/N_z)\ c^2 = 1.487\ 126\ 279\ 835 \times 10^{73}\ \text{ergs}. \qquad (1\text{-}17)$$

This supplies only sufficient energy to raise all the emerged perceived Neutrons to a thermodynamic temperature of $5.2674 \times 10^9\ {}^{o}K$. Perceived matter requires space in which to exist, so, as space is produced, it immediately is filled with emerging structural units. Since there is no extra space in which the Neutrons can move or decompose, they must remain motionless except for spin, or at a state of 0 ^oK, until after sufficient space to contain all the permitted perceived space units has emerged. After that, the pre-emergence structural units that cannot emerge as matter units must appear as the equivalent energy. This energy is coming in rapidly and raises the perceived matter units from 0 ^oK to the indicated maximum temperature in 1.437 seconds. This emergence process and the timing are totally different than any of the standard "Big Bang" models.

To get to the above conclusions, the principal data were the number of pre-emergence potential structural units and the number of potential permitted wave-function state neutral carriers. With these two numbers being so fundamental, we might expect other combinations of these numbers to have significant impact upon the total structure of our perceived universe. There are at least two more significant relationships that are dependent upon these numbers, or functions of them. The pre-emergence units of structure are 8 dimensional: the units of wave function structure as we perceive them are 5 dimensional functions. We might expect some relation between the 1/8 root of a pre-emergence element of structure and the 1/5 root of an element of structure of wave-function units. What we find is a relationship that is apparently coupled to the lowest energy structural units, which are contained in the Iron 56 atoms, and at the other end of the spectrum, a coupling to Electrons in the form of the Landé g/2 factor. (All expressed in the new mass-units at local-cosmic-rest.)

$$\text{(Iron 56)/56} = (N_w/N_p)^{8/5} = 0.998\ 841\ 620\ 274\ 317 \text{ (theoretical)}, \qquad (1\text{-}18)$$

$$\text{Landé g/2 factor} = 1/(N_w/N_p)^{8/5} = 1.001\ 159\ 723\ 125\ 439\ . \qquad (1\text{-}19)$$

(Both in the new units. See Section 4. for the first, and Section 3. for the second.)

Now, back to the problem of space volume and the relation with cosmic time and ordinary time. To do this effectively, we need to consider some of the various radii of space at different ages. The most important radius is what I call "the radius of curvature generator". This value is identified as R_{u0}, and participates in determining all other space radii. R_{u0} is based upon the emergent mass of the universe and the volume of space corresponding to that mass, assuming the interaction angle sine is 1.

The volume of perceived space in the general case is:

$$V_{sp} = N_p^2\ m_n^2\ V_0^2\ [(1-\alpha\phi/\pi)(\sin^3\phi)(p^{\sin^2 f})^3], \qquad (1\text{-}20)$$

however, at very small values of ϕ (close to emergence) the square bracket term would approach zero because of the sine term. We are interested in the potential maximum driving radius, which would correspond to a state of $\sin\phi = 1$, and where V_0 is the emergent volume of a mass-unit. Thus we set the maximum <u>starting potential</u> for a purely three-space volume for space as

$$V_{sp0} = N_p^2\ m_n^2\ V_0^2. \qquad (1\text{-}21)$$

This then yields an estimate for the maximum radius driving force, which I call the "Radius of Curvature Generator". The value for $\sin^3\phi = 1$ only occurs at age, $\phi = \pi/2$, but it does represent the potential maximum interaction involved in the basic concept for R_{u0}:

$$R_{u0} = (V_0^2\ N_p^2\ m_n^2[3/4\pi])^{1/3}. \qquad (1\text{-}22)$$

Recalling that the total matter-energy mass M_0 in grams is the total mass of structural units divided by N_z, or $(N_p\ m_n)/N_z$ and the volume of a mass-unit is given by Eq.(1-1), a re-arrangement yields

$$R_{u0} = [M_0\,N_z^2\ (3/4\pi)(\beta\ c^2)^{-1}]^{1/3}, \qquad (1\text{-}23)$$

$$R_{u0} = 1.300\ 471\ 892\ 102 \times 10^{27}\ \text{Emergent units, or abstract cm}^2. \qquad (1\text{-}24)$$

At any appreciable age ϕ it is necessary to take into account the effect of the interaction factor in the volume, $(\sin^3\phi)$, and the effect of $(1-\alpha\phi/\pi)$ on M_g in V_1^2 as a factor. On the radius, this age effect upon current mass has an effect as $(1-\alpha\phi/\pi)^{1/3}$ in generating the radius of curvature factor in proper units at the given age. Since the radius effect is being expressed in the cms related to ordinary perceived units (abstract cm^2), the effect applies to the perceived three-dimensional aspect, but not to the fourth dimensional rotational freedom contribution factor. The radius factor R_u is given by

$$R_u = R_{u0}\ (1-\ \alpha\phi/\pi)^{1/3}, \qquad (1\text{-}25)$$

as the effect of the radius of curvature generator at the given age ϕ due to the change in universe mass with age (M_g) at the given age ϕ. This is not the actual three-space radius, which must take into account $\sin\phi$, and the fourth dimension rotational freedom contribution $\left(p^{\sin^2 f}\right)$ to the effective three-space radius (R), given by the following equation:

$$R = R_u\ (\sin\phi)\left(p^{\sin^2 f}\right), \text{ or} \qquad (1\text{-}26)$$

$$R = R_{u0}\ (\sin\phi)\left(p^{\sin^2 f}\right)(1-\ \alpha\phi/\pi)^{1/3}. \qquad (1\text{-}27)$$

The fourth space radius does not partake of any of the fourth dimensional rotational freedom. The radius of curvature adjusted to the particular current universe mass (M_g) is the potential driving force for all radii at the given age ϕ.

For some situations, it is advantageous in comparing two ages to convert the number of length units from the specific age value to its equivalent in terms of emergent size length units. Making this conversion is based upon the radius being proportional to the inverse of the sixth root of the mass (M_g) at the given age as indicated in Equation (1-1). However, we must be very careful about dimensionality. In some situations we are dealing with ordinary centimeters as used in our common three-space. We must recognize that these cms are actually composite units of a length and a time unit. As a result the common cm has a dimensionality contribution proportional to an abstract fundamental cm squared. This results in an emergent cm being smaller than a cm at the given age in the ratio of $(1- \alpha\phi/\pi)^{1/3}$, or the number of emergent size cms being the specific age number of units derived from M_g and then divided by $(1- \alpha\phi/\pi)^{1/3}$. This effect enters in many different places and must be given individual consideration in comparing factors at different ages. The difference between the effects of the three-space radius and the fourth dimension radius is illustrated in Figures 1-2 and 1-3 .

Before getting too far away from the equations where the fourth dimension rotational freedom is first utilized, a little explanation is necessary. The total rotational freedom introduced by an additional dimension is proportional to 2π . The contribution of the number 2 is absorbed into the actualization probability factor as an existence contribution. The angular portion represents a changing contribution with cosmic age. At maximum, for a full dimension, it would be π. In the present situation, at small age angles, only a small fraction of a dimension is involved. The function must be something that varies with the age angle. In topology where a partial dimension is encountered it has been shown that the partial dimension effect can be represented by $\sin^2 \varphi$, where φ is the angle for which the sine times a normal dimension would be of magnitude equal to the partial dimension, and the partial dimension can be replaced by $\sin^2\varphi$. Then, for a full dimension, the added rotation factor would be π^1; while for a fractional effect, the exponent 1 is replaced by $\sin^2 \phi$ in the universe three-space radius, to adjust for the partial dimension effect of *w*. (Muse's, Charles 1990, 1991).

For small age angles, the three-space radius and the fourth space radius are equal, but by the age $\phi = \pi/2$, the three space radius exceeds the fourth radius by a factor of π.

Using these fundamental relationships, we can now proceed on to determining more of the specific characteristics of our particular perceived universe.

1.3. Space, Ordinary Time (t), and Cosmic Time (ϕ)

Ordinary time (t) is the time of our perceptions of change, yet, from a cosmic standpoint, it is the cosmic-age phase angle (ϕ) that governs the flow of cosmic events. It is, therefore, necessary to relate ordinary time (t) to cosmic-age phase angle (ϕ) to be able to put cosmic events into ordinary time units.

Fundamental structural units do not all remain in exactly the same form in which they emerged, but some of them change into other types. To cause extensive changes, there must be some driving force that represents a change in probable energy level. The simplest mechanism, to cause a complex probable structure to rearrange, is a change in the probability of one of the component elements. In our perceived universe, this is accomplished through a rotation that is coupled to the age phase angle ϕ. Since matter units are derived from universal field interaction with a group field composed of 69 elements, a change of actualization probability of one element of structure would represent a fractional probability of $2^{1/69}$. This is postulated to affect total universe mass (and energy), and to take place at a uniform rate with respect to the phase angle ϕ . This was discussed in the prior subsection (1.2.), resulting in Equations (1-12) to (1-14).

Equations (1-12) to (1-14) are very important fundamental relations. They imply that any factors or dimensions in our universe, that are functions of the total universe mass, will change with universe age. A couple of examples are the general gravitation coefficient G and Planck's constant h.

In the problem of handling variability with age, we need something constant as a reference point. It was earlier pointed out that the characteristics of the fundamental mass-unit were such that it appeared to tend toward constancy. We have elected to specify that a mass-unit remains a constant fixed quantity of energy throughout a cosmic life cycle from emergence to collapse. For other factors, such as time and length units, an arbitrary reference standard is employed. This is the value of the length and time units at the instant of full emergence. The current-age values of various variable units can then be computed from the particular age phase angle (ϕ) and the relationship of the particular factor to the total universe mass.

We still have not related ϕ to ordinary time, but we can now move closer. As a reference point for measurements of space and time, we select the emergence of the first bit of space, which is soon filled with the first unit of matter. Then, consider this our reference point zero for space, cosmic age angle ϕ and for ordinary time t in our perceived universe.

As a model of the way that the universe emerges and expands, we select a limited slice containing the fourth direction *w* and one of the ordinary three-space directions. We start with the perimeter of a point at the origin, this expands to a one dimension circle, and that circle continues to expand and move away from the origin point. At mid cycle it reaches a maximum size and then starts to decrease in size as it moves farther away, eventually collapsing back to a point at the end of the cycle. In the process, the circle sweeps out the surface of a sphere of changing radius, with one pole at the point of origin and the other at the point of collapse. Consider the ring size at a given location to represent the perimeter of the three-space universe at that age, at least in the early stages of the expansion. (This assumption is not true in the later stages of expansion.) Distance along the surface from a pole to the ring, in a great circle path, is related to the fourth physical distance, which we do not perceive, and which changes uniformly with cosmic age phase ϕ. See Figures 1-2, & 1-3, which were constructed to illustrate parts of the complex age and radius relationships. Even taken as a whole, they are inadequate to illustrate the relationship of perceived space as being an expanding closed three-space L^2 shell with a small fixed thickness in the fourth physical direction in a unit of time.

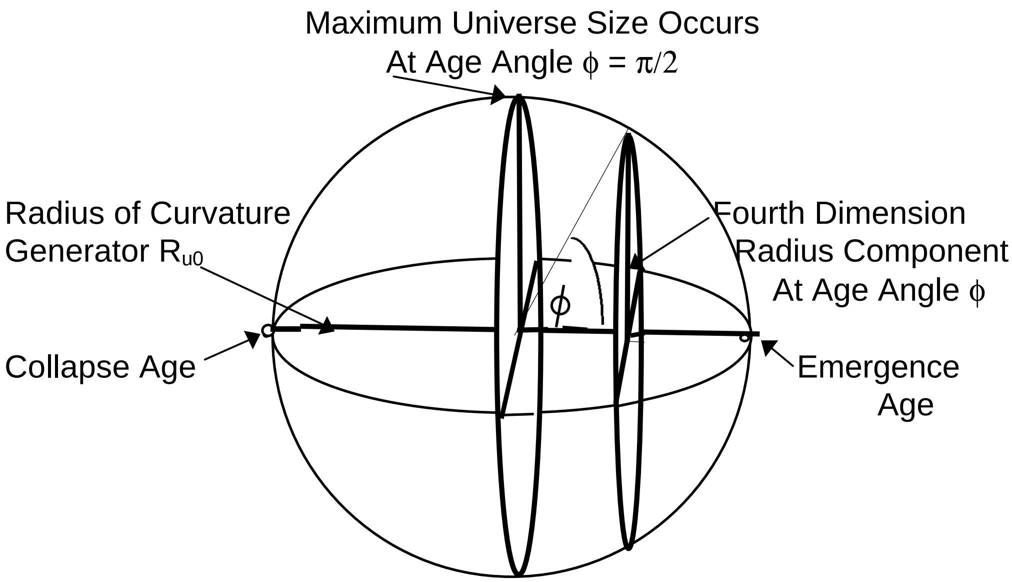

Figure 1-2
Fourth dimension aspects of a cycle

Note: Time flows uniformly along great circle paths from emergence to collapse for the fourth dimension aspect. The perceived spacetime is a thin shell on the surface of a higher dimensional structure, with the shell only being required to have a thickness in the fourth direction of a single universal field minimum cycle unit, which contributes to the unperceivability of this motion.

Cosmic age progresses uniformly with angle in radians: $d\phi/dt = 3.668\ 933\ 706 \times 10^{-18}$ radian sec^{-1}, in emergence size units.

Perceived universe radius is a function of the radius of a three-sphere similar to the fourth space sphere indicated above plus a contribution of the additional degrees of freedom contributed by the fourth physical direction as:

$$R_u = R_{u0}[(\sin\phi)\left(p^{\sin^2 f}\right)(1-\alpha\phi/\pi)^{1/3}],$$

and $(1-\alpha\phi/\pi)$ is a small factor governing the rate of decline of effective universe mass with age: α being only $9.995\ 322\ 693 \times 10^{-3}$.

At the point of initial full emergence the perceived universe is considered to be a three-space sphere. If we construct a line from pole to pole (emergence to collapse), and then a line from the center of curvature of the great sphere, in the fourth space aspect, to the location of the ring on the surface, this generates an angle ϕ with respect to the line from origin to collapse. This angle, measured on the origin side, is what is defined as the universe cosmic-age phase angle ϕ. The angle to the circle defining the universe size at initial full emergence is ϕ_e. The radius of the circle at any age is a fourth dimension aspect and is designated R_4. It can be described at small age angles as:

$$R_4 = R_{u0} \sin\phi, \text{ .in emergent size units.} \tag{1-28}$$

R_{u0} is what I call the emergent "Radius of Curvature Generator" [Eq. (1-22)], which is the fourth dimension radius of the great sphere, and is constant in emergent size units. This is a constant determinant factor involved in the actual radius of the universe in all four physical directions. The rate of change of ϕ is fixed, but we have not yet related it to ordinary time.

In subsection (1.2.) it was assumed that the change in universe mass was linear with cosmic age angle and that this then resulted in a first estimate of <u>potential</u> maximum space volume at emergence as in Equation (1-21):

$$V_{sp} = N_p^2 m_n^2 V_0^2. \tag{1-29}$$

Using the value for the three-space radius that includes the contribution of the age angle and the additional rotational freedom, we find the adjusted total space volume to be

$$V_{sp} = N_p^2 m_n^2 V_0^2\left(p^{3\sin^2 f}\right)(\sin^3\phi)(1-\alpha\phi/\pi). \tag{1-30}$$

There is one particular time between the start of emergence and end of collapse for which we know, from other sources, the exact value of V_{sp}, and that is at the instant of initial full emergence. This is when V_{sp}, treated as a three-space volume, is exactly equal to the total three-space volume of all permitted wave function mass-units (Vol_{Mw}). The volume of all these mass-units at a given age ϕ is

$$Vol_{Mw} = N_p\, m_n\, V_0\, (1- \alpha\phi/\pi)^{1/2}. \qquad (1\text{-}31)$$

Replacing V_{sp} in Equation (1-30) by this factor, and then dividing both sides by it, yields

$$1 = N_p\, m_n\, V_0 \left(p^{\,3\sin^2 f}\right)(\sin^3\phi)(1- \alpha\phi/\pi)^{1/2}. \qquad (1\text{-}32)$$

At this point we need to recognize that Vsp, in terms of perceived space mass-unit radii, is actually of dimension cm^6 in abstract cm units and we divided out by a quantity that is dimensioned cm^3. Therefore, while the numerical resultant 1 is correct, it must be dimensioned cm^3, and adjusted by a factor $(1- \alpha\phi/\pi)^{-3/6}$ to adjust abstract cms for age. Taking this into account, we then have

$$cm^3 = N_p\, m_n\, V_0\left(p^{\,3\sin^2 f}\right)(\sin^3\phi), \text{ or} \qquad (1\text{-}33)$$

$$cm^3/\sin^3\phi = N_p\, m_n\, V_0\left(p^{\,3\sin^2 f}\right), \text{ or} \qquad (1\text{-}34)$$

$$cm/\sin\phi = (N_p\, m_n\, V_0)^{1/3}\left(p^{\,\sin^2 f}\right), \text{ or} \qquad (1\text{-}35)$$

$$1/\sin\phi_e = (N_p\, m_n\, V_0/cm^3)^{1/3}\left(p^{\,\sin^2 f}\right). \qquad (1\text{-}36)$$

Later on, in Section 2., a relationship between a single mass-unit volume and total universe energy at a given age is developed as Equation (2-41). This is of the form

$$V_1^{\,2} = 1/(\beta\, M_g\, c^2), \text{ or} \qquad (1\text{-}37)$$

$$V_0^{\,2} = 1/(\beta\, M_0\, c^2). \qquad (1\text{-}38)$$

Also, the initial universe mass is derived from the total number of mass-units as

$$M_0 = N_p\, m_n/N_z, \qquad (1\text{-}39)$$

where N_z is the number of theoretical mass-units in a theoretical gram at the state of local-cosmic-rest. Using the above, and substituting for V_0 in Equation (1-36), its value in Eq. (1-38), yields an expression for the sine of the angle of full cosmic emergence (ϕ_e) as

$$1/\sin\phi_e = [N_p\, m_n\, N_z/(\beta\, c^2\, cm^6)]^{1/6}\left(p^{\,\sin^2 f}\right), \text{ or} \qquad (1\text{-}40)$$

$$\sin\phi_e = [\beta\, c^2\, cm^6/\,(N_p\, m_n\, N_z)]^{1/6}\left[1\Big/\left(p^{\,\sin^2 f}\right)\right], \qquad (1\text{-}41)$$

at the abstract cm level. N_z is of dimension 1/mass, or cm^6 in the new approach. This makes the above expression for sin ϕ_e be dimensionless.

The factor β is derived in Section 2.4. as Equation (2-55), which is

$\beta = (3/4)\ (e/\pi)\ 2^{5/8}$, or (1-42)

$\beta = 1.000\ 805\ 353\ 672\ 043$ (1-43)

Where c^2 is used in the above, it implies the number for c without any net dimensions, on the basis that at the fundamental level, length and time units represent the same section of universal field flow hence their ratio is only a dimensionless number representing the ratio of the scale factors between the units and the normal length or time forms in the cgs system of units in use. Now, with the value for β , we have sufficient data to calculate a value for sin ϕ_e. Using the CODATA mass of Neutrons (m_n) in mass-units, and the CODATA value for N_A and assuming the second bracket term [ ] in Equation (1-41) equal to unity, we compute a value, which is

$\sin \phi_e = 2.184\ 076\ 662\ 736 \times 10^{-14}$ (CODATA based) (1-44)

At this magnitude, the sine of an angle is equal to the angle in radians to better than ten places, so we can replace sin ϕ_e with ϕ_e, as

$\phi_e = 2.184\ 076\ 662\ 736 \times 10^{-14}$ radians. (CODATA) (1-45)

It is obvious from the magnitude of ϕ_e, that we can properly consider at emergence, that

$1/(p^{\sin^2 f}) = 1,$ (1-46)

with no loss in precision in estimating the value of ϕ_e.

As an alternate to using the CODATA 1986 values, we can also compute the value of ϕ_e using the lcr values for N_z and m_n derived in the study. This yields

$\phi_e = \underline{2.184\ 077\ 677\ 402 \times 10^{-14} \text{ radians.}}$ (Theoretical) (1-47)

The theoretically derived values are preferred for generating a consistent set of relationships.

The foregoing derivation of a value for ϕ_e still only takes us part way along the path for relating ϕ_e with ordinary time (t). At the instant of full emergence, the value of $(p^{\sin^2 f})$ is so close to 1 that we can treat the total space volume as spherical (in L^2 space). The perimeter of the sphere that contains all the matter is determined by R_u:

$S_p = 2\ \pi\ R_u \sin \phi_e$, or (1-48)

$S_p = 2\ \pi\ R_{u0}\ (1 - \alpha\phi/\pi)(\sin \phi_e)(p^{\sin^2 f}).$ (1-49)

With the small value of ϕ_e, this simplifies to

$S_p = 2\ \pi\ R_{u0}\ \sin \phi_e$. (1-50)

The rate of change of the perimeter with change in ϕ_e is

$d(S_p) = 2\ \pi\ R_{u0}\ (\cos \phi)\ d\phi$. (1-51)

The velocity of radiation c is the limiting three-space velocity of separation of matter units in a single dimension. If this limit is applied also as the maximum rate of perimeter increase for space, then we can determine the value for $d\phi/dt$ at full emergence. Applying this limit,

$dS/dt = c$, or $dS = c\ dt$. (1-52)

Then, equating $d(S_p)$ to dS, we have

$c\ dt = 2\ \pi\ R_{u0} \cos \phi_e\ d\phi$, or (1-53)

$d\phi/dt = c/(2\ \pi\ R_{u0} \cos \phi_e)$. (1-54)

The value of ϕ_e calculated by Equation (1-41) is so small that we can treat $\cos \phi_e$ as equal to 1 to more than ten places. Now, back to Equations (1-20) to (1-22) for the volume of space, and then compute the value for R_{u0} as

$R_{u0} = [3N_p^2\ m_n^2\ V_0^2/(4\pi)]^{1/3} = [3\ N_z\ N_{u0}/(4\ \pi\ \beta\ c^2)]^{1/3}$. (1-55)

In this form the effects of the age phase angle ϕ are excluded so as to yield the maximum value for the radius of curvature generator $_{Ru0}$. This is the value based upon the total number of pre-emergence structural units.

Evaluating the above using the CODATA 1986 values for N_A and m_n ,but not adjusting for the mass change when free Neutrons are slowed down to lcr, yields

$R_{u0} = 1.300\ 473\ 100 \times 10^{27}$ (CODATA based). (1-56)

Using the values for N_z and theoretical m_n yields the preferred value as

$R_{u0} =$ $\underline{1.300\ 471\ 8921 \times 10^{27}\ \text{cm}^2\ \text{(emergent theoretical),}}$ (1-57)

where cm^2 is a unit of length in an L^2 space representation of a sphere.

Then, using the computed value for R_{u0} we can calculate the value for $d\phi/dt$ by Equation (1-54) as

$d\phi/dt = 3.668\ 930\ 297 \times 10^{-18}$ rad sec^{-1}, (CODATA) (1-58)

using the CODATA 1986 values for N_A and m_n. Also, then, using the theoretical lcr values for N_Z and m_n , <u>which are adopted as the preferred values;</u>

$\underline{d\phi/dt = 3.668\ 933\ 706\ 46 \times 10^{-18}\ \text{rad sec}^{-1}.\ \text{(theoretical)}}$ (1-59)

Both above values are in terms of emergent size units for length or time. In the process of evaluating $(d\phi/dt)$, we encounter one of the dimensionality problems in the new approach. We either have to treat R_{u0} as a measure in ordinary perceived space of dimension cm, or consider the true dimensionality of ordinary cms as involving both length and time elements and being equivalent to cm^2 in this relationship. The full new approach dimensional exponents need to be carefully considered in all calculations of changes in unit size due to universe age. (See Section 1.5.) The velocity of the end of the Radius of Curvature Generator, away from the origin point, is R_{u0} times $d\phi/dt$. This is the velocity of the ring and points of matter, in the space associated with that perimeter, away from the origin in the unperceived *w* direction. This velocity at full emergence is given by

$$Vel = R_{u0}\, d\phi/dt = c/(2\pi). \tag{1-60}$$

It is postulated that $d\phi/dt$ and R_{u0} both remain constant in terms of emergent size units throughout the universe life cycle. This means that the velocity in the *w* direction is a constant $c/(2\,\pi)$ throughout the life cycle.

Using this constant fourth-direction velocity, we can compute the length of a cycle (T) from start of emergence to end of collapse. The period (T) given by using the CODATA 1986 standards is:

$$T = \pi/(d\phi/dt), \text{ or} \tag{1-61}$$

$$T = 8.562\,693\,7528 \times 10^{17} \text{ emergent seconds, or} \tag{1-62}$$

$$T = 27.134\,115\,241 \times 10^{9} \text{ emergent SI years.} \tag{1-63}$$

Also, then, using the preferred theoretical values for N_z and m_n:

$$\underline{T = 8.562\,685\,796\,31 \times 10^{17}} \text{ emergent seconds, or} \tag{1-64}$$

$$\underline{T = 27.134\,090\,028\,12 \times 10^{9}} \text{ emergent SI years.} \tag{1-65}$$

In converting seconds to years, the SI value of $3.155\,693 \times 10^7$ is assumed fixed and exact for a tropical year. This is something that will have to be corrected later, because year length changes with cosmic time, and the relative length of a current age sec to an emergent sec changes slightly with universe age. An alternative is to use Nominal years, where $T = 27.088\,761\,5636 \times 10^9$ Nominal years. (See Section 4.6.)

The age to maximum universe size is T/2. The current age of the universe can be derived by calculation if we have a precise measure of total current universe mass (M_g), or of some factor dependent upon universe mass, such as Planck's constant or the universal gravitation coefficient G.

As we advance in our technology, we find increasing understanding of many ancient artifacts and writings. As a case in point, if we divide T by the factor $2\,\pi$, we obtain the distance from emergence to collapse in the *w* direction, in light-transit units of distance. If we do this for T in years, we obtain the cycle distance in light years. This distance is

$$\text{cycle distance} = 4.318\,524\,553 \times 10^{9} \text{ light years, or} \tag{1-66}$$

rounded off to three figures, this becomes

$$\text{cycle distance} = 4.320 \times 10^{9} \text{ light years.} \tag{1-67}$$

This is the same number that is contained in the ancient Hindu literature (Blavatsky 1888) for cycle distance in years; and this is quoted by some cosmologists in the mistaken notion that this was the Hindu's estimate of a cosmic cycle in years. When the Eastern numbers related to cosmic cycles first became available to Western science, very little credence was given to their possible value, and few people thought of distances in light years or mega light years. Another factor that might have been involved in the particular numbers for the various cycles is the frequent practice in occult writings of altering important values by some factor that only an initiate would know. In the present case of cycles, the natural factor would be 2π.

Now, we can go back and examine some of the emergent universe conditions more closely and estimate how rapidly the universe heated up. First, a Neutron, as a neutral structural unit, represents the emerged equivalent of a pre-emergence probable structural unit. As space is generated, Neutrons emerge. They are packed tightly together, so that they cannot move relative to adjacent units. As a result, they are at a temperature of 0 ^{o}K. They cannot start any decay process either, because there is no space for increase in volume associated with decay. The whole volume does achieve a velocity relative to the emergence point that is consistent with the general velocity of motion in the fourth space direction, which puts them at the state of local-cosmic-rest.

Second, as mentioned in subsection (1.2.), there are fewer permitted structural units in wave-function space than in the abstract pre-emergence region, Equation (1-16) vs Equation (1-10) This means that there are probable structural units that can only emerge into wave-function space in the form of the equivalent energy of motion or Neutron temperature. This difference, or excess energy, was computed as Equation (1-17), and is

$$\text{Excess energy} = 1.487\ 126\ 279\ 835 \times 10^{73} \text{ ergs.} \tag{1-68}$$

This is only sufficient energy to raise the emergent Neutrons to a temperature of 5.267×10^9 ^{o}K. This thermodynamic temperature is attained in the short time between emergence of all the permitted Neutrons, and at the time that space has expanded sufficiently to contain the total matter mass-energy of the universe.

The phase angle for emergence of only the permitted Neutrons (ϕ_{en}) is calculated using Equation (1-41) modified by an additional factor of $(N_W/N_p)^{1/3}$ to reflect the smaller volume required.

$$\sin \phi_{en} = (N_{w/}N_p)^{1/3}[\beta\ c^2\ cm^6/(N_p\ m_n\ N_z)]^{1/6}, \tag{1-69}$$

$$\phi_{en} = 2.183\ 550\ 354\ 034 \times 10^{-14} \text{ rad, and} \tag{1-70}$$

$$t_{en} = \phi_{en}/(d\phi/dt) = 5951.458 \text{ sec.} \tag{1-71}$$

Subtracting the above time from ϕ_e converted to seconds, yields a difference, which is the heat-up time.

$$\Delta t = 1.437\ 266 \text{ seconds.} \qquad (1\text{-}72)$$

The heating of the universe from 0 ^oK to 5.267 x 10^9 ^oK occurs in this short interval Δt.

Because of the higher density and slower rate of expansion, and slower rate of temperature decline (after full Neutron emergence) in the early stages by the present approach than assumed in some of the conventional "Big Bang" theories, Neutron decay can play a larger part in the early universe evolution than is conventionally assumed. The cold expansion period before heat-up, slows down initiation of the early high-temperature phase in the new approach. As a result, I suggest calling the new approach a "Slow Bang" in contrast to the conventional "Big Bang" approach. In addition, the emergence temperature is below the threshold temperature of 5.930 x 10^9 ^oK required for electron-positron pair formation, so this process plays a very minor part in the early universe. As a result, there may be a lot fewer free Neutrinos in the universe than assumed by the existing conventional "Big Bang" theories.

1.4. Effects of Motion

The proposed new theory of the structure of perceived matter and space represents a change in the conceptual framework by means of which we interpret perceptions or measurements. It does not alter any of our perceptions or measurements, however it does alter what we read into them. Some of the existing mathematical devices, such as the Lorentz transform and the apparent mass increase with velocity predicted by Special Relativity, remain unchanged in the numerical values, <u>but the interpretations that we can apply to the results that they yield,</u> <u>are altered and expanded.</u>

Special Relativity implies that positions and velocities are all relative, but, by the new approach, we recognize the existence of two basic reference frames for position and velocity. The first of these is based upon location and velocity relative to the reference point of emergence time at the location of the initial emergence point of the universe in its present cycle. This frame has its usefulness in connection with some of the characteristics and properties of matter and space in the very early stages of a universe cycle, but it is inconvenient for ordinary usage because of its remoteness from current matter and space, as well as being confounded with our three-space perceptions. For example, the direction to the emergence point appears to be the same as any three-space direction, but this direction line is actually curving away, in a direction orthogonal to the assumed straight line of the optical line of sight, in a fourth physical direction that we do not perceive. This optical line of sight does go back to the origin by reason of its path curvature in the unperceived direction.

The second basic reference frame is that of the universal field flow at a given instant. The expanding space of the universe is filled with flowing universal field that is our basic local reference frame everywhere in the instant "now" of existence of our perceived universe. In different regions of the universe this space-field flow is moving away from the point of origin at a constant velocity of $c/2\pi$ in the unperceived *w*t direction, but, because of the geometry of the universe, the relative velocities of two separate local-cosmic-rest locations vary as a function of both their radiation path separation and the age of the universe at the instants of comparison.

The local-cosmic-rest reference frame is fundamental to the properties of matter as experienced, because a matter unit's dimensions and mass are determined by universal field interactions. The matter units, to remain in our perceived universe, must remain in the space of our perceived universe. This space is simultaneously expanding and moving away from the cosmic emergence point in the present phase of the universe cycle. Average matter units, then, must be moving at the same linear rate as the space containing the universal field flow. This flowing field becomes the local reference frame for each and every unit of matter in its own particular location at any one instant. This fundamental motion is in the unperceived wt direction, but, in turn, it has effects in the perceived three-space directions.

We need to examine this motion, relative to the cosmic reference frame origin point, for its effect upon both perceived local-cosmic-rest frame motion and three-space motion. Motion in the *w*t direction at a constant rate, in the expansion direction, results in increasing radius of the circle on the hyper-surface that represents a single dimension line. See Figure (1-2). This occurs for all three-space directions. This generates a rate of increase in separation of two points that are co-moving with their local space, this motion in turn matches the motion that is assumed to generate the Hubble Factor. The Hubble factor (H) is a measure of the separation rate, at a given universe age. It is proportional to the physical separation of the points in radiation path distance (this is proportional to the cosmic age angle between the source at emission and the observer at detection), and to the relative rate of change in radius of the assumed spherical distribution of matter. The expression for this factor as a function of universe age (ϕ) is derived in Section 5. as Equation (5-14). At a given location and total age (ϕ) the local value of H is given by

$$H = [(\ln \pi) \sin 2\phi + \cot\!an\, \phi]\, d\phi/dt, \tag{1-73}$$

with dimensions time^{-1}, or seconds^{-1} in the cgs system of units, and ϕ as the cosmic age in radians.

The perceived space, that contains the perceivable matter units in our universe, is the product of interaction, in the pre-emergence region, of the universal field with the potential exterior volume of perceived matter units and the inverse of the potential interior volume of negative matter units in a unit of time. The interaction product then is modified by the $\sin^3$ of the cosmic age phase angle ϕ. As a consequence of this close coupling to matter units, the perceived matter units each tend to remain associated with the space quantity for which they are responsible. This generates a tendency toward maintaining uniform matter distribution as the universe expands. This further implies that, on the average, matter units are at rest relative to the space for which they are responsible, at least in the vicinity of the matter unit's boundaries.

The measure of this tendency to uniform distribution is the Hubble factor shown in Equation (1-73). This results in a relative velocity that increases uniformly with the separation distance (for any relatively short distance span). This, then, can be represented as a constant acceleration force at any given universe age. The magnitude of this force can be estimated if we equate the separation distance to the time required for the effect to traverse the separation distance (d); this is

$$t = d/c. \qquad (1\text{-}74)$$

Velocity of separation is the product H d, and, if we insert these items in the standard expression for velocity in terms of acceleration and time, we then have

$$H\,d = a\,t = a\,d/c, \qquad (1\text{-}76)$$

and then the acceleration (a) becomes

$$a = H\,c,\ \text{in cm sec}^{-2}. \qquad (1\text{-}76)$$

The equivalent expansion separation force in dynes for a given particle is then:

$$F = H\,c\,m, \qquad (1\text{-}77)$$

where m is the particle mass in grams, and H is in sec^{-1}.

This force can be likened to an outward expansion pressure, expressed in dynes per gram, operating in perceived three-space. The perceived direction of the force is outward, away from any restraint. The force as a measurable effect comes into play in a situation where expansion is restrained, such as for a particle in a gravitational field. The direction of the force is away from the source of restraint. This can be considered a fifth fundamental force, which I call a "Space Stress" force, that tends toward the uniform distribution of matter particles. This is a force that acts in opposition to gravitation, in the expansion phase of a cosmic cycle, and must be taken into account in computing the range of the cosmic gravitational effects that are responsible for condensations and for affecting motion of remote masses. This generates a gravitational limit, beyond which a particular source of gravitation is insufficient to attract free particles in space to the gravitational source object over the universe expansion trend. This is discussed further in Sections 5. & 6. in connection with the Hubble factor and early universe conditions.

The outward motion represented by the current Hubble factor is the result of motion of the local-cosmic-rest reference frames of the remote source objects with respect to the observer's local-cosmic-rest frame. The resultant effect has no particular vector direction, but refers to whatever reference point to which it is compared. In a sense, it has magnitude without direction. This is a scalar property, so we can consider this scalar motion. This designation, as scalar motion, was also arrived at by a somewhat different approach to the Hubble factor that is contained in the works of Larson (1979, 1984, 1988). A specific comparison of the magnitudes of the scalar-motion force, as computed by Larson and by the present approach, is explored in Section 5. .

Now, ignoring the relatively small local contribution of the Hubble factor at the present universe age, we can explore the effects of local motion relative to the state of local-cosmic-rest. First, motion in any three-space direction is a motion relative to local-cosmic-rest, if it is measured with respect to a reference point or matter particle at rest with respect to the local universal field. The problem here is to find something that we know to be at the state of local-cosmic-rest, and which can be used as a reference standard. As a first guess, the only approach we have is to determine the net velocity of our local solar system with respect to all the remote reaches of the universe by means of the anisotropy in the microwave background radiation from the early universe. This radiation is seen equally well in all of the three-space directions. Measurements of this kind have been made, and have yielded an estimated velocity of the solar system with respect to the cosmic microwave background as 390 ± 60 km sec^{-1}, in the general direction of the Virgo cluster (Wilson 1979); and more recently as 360 km sec^{-1} $\pm$ 5% in the direction of the constellation Leo (Wilkinson 1986), or 370 ± 10 km sec^{-1} (Peebles 1993 Eq. 6.29). The above are obviously inconvenient values for use in establishing a laboratory reference frame on the earth's surface for local measurements, so to get around this, we will make a theoretical analysis on the basis that we have adjusted the laboratory frame to zero velocity relative to lcr and then will furnish any necessary corrections later. According to Special Relativity, this laboratory frame is an appropriate starting reference frame, provided that we are consistent in applying it.

In examining the concept of relative motion under conditions of the new approach, we must recognize both the new dimensionality aspects and the collapsed dimensionality set that provides our conventional perceptions and interpretations. The important velocity effects must be related to relative velocities with respect to the state of local-cosmic-rest, but when the lcr related value is not known, we must deal with the purely relative velocities. As a start, we assume that the local rest with respect to the earth's surface represents lcr in the laboratory frame of reference. By the new approach, matter units are eight dimensional in interaction with the opposite flowing universal field flows within their interiors. If they are eight dimensional, there are eight 90^o rotations (720^o) in the minimum rotational path that includes each dimension only once. At the level where we perceive spin in the electron, for example, it requires two 360^o rotations to return spin to its initial orientation. Thus, some of our observational results are consistent with the possibility of there being eight dimensions, even though the degrees of freedom have been reduced from eight to five by the specification that the ratio of the real to imaginary coefficients in the (t) component in a given structural unit be the same for all, at the state of local-cosmic-rest.

The available degrees of freedom are five, in the form of four physical dimensions (axis directions) and the ratio of the real to the imaginary aspects. This can be equated to an angle between the real axis and the complex number in the Argand plane. This in turn can be related to a phase angle displacement in an interaction with a regular rotating function such as implied for the universal field. The universal field, having two time flow directions and two rotation directions, can have several intersect patterns, depending upon relative phases of the four flows. Our ordinary perceptions are limited to three physical dimensions and time, because all matter is moving uniformly and synchronously in the fourth physical direction, thus eliminating any possible physical reference points for measurement of change in fourth-direction physical position. Time is implicit in each of the three physical directions, in addition to the length or distance, yielding a dual quantity product. This implies constancy for the length aspect in the fourth direction, and leaves the time component being the same in this direction as its involvement in the other three directions, and this is what we sense as the fourth dimension. To it, there corresponds a distance in the *w* direction that we do not directly sense or measure. In our ordinary perceptions of spacetime there is thus a potential degree of freedom in addition to the four that we can sense. This cannot be in the form of a length, since we don't seem to be equipped to sense four orthogonal lengths, but it can be in the form of an angle not included in ordinary spacetime, and which appears as a time-phase relationship that can affect some of our normal perceptions.

When matter-units are at rest relative to local-cosmic-rest, there is no change in relative phase displacement between surfaces in corresponding directions, and the interaction nodes between inflowing and outflowing universal field are uniformly distributed in all directions relative to a given structural unit. When matter is in motion relative to lcr, it encounters the given incoming phase in the direction of motion sooner than it would at rest. This represents a phase advance in the direction of motion relative to lcr. The phase advance angle is the relative phase angle between the axis of motion in the rest state and the corresponding axis in the moving unit, and this angle is not in the three-space system. This is the angle for projection of either axis upon the other in the direction of motion. In effect, velocity (v) divided by the radiation velocity (c) is dimensionless, and can be considered the sine of a phase angle θ_p between the direction of motion in the rest system and the corresponding axis in the moving system. This angle is not in the three-space reference frame system. This is a single degree of freedom aspect, or a single dimension effect, which can be treated as a rotation of a spacetime reference frame out of the normal three-space in a direction normal to the direction of motion axis. The Lorentz transform accomplishes numerically the same magnitude of effect for the appearance of one system sensed from the other by radiation means.

Even though the moving system has been rotated with respect to lcr in one direction, it still encounters the full range of universal field phase cycling. Thus, ordinary matter in the rotated system should still have the same characteristics in the new orientation relative to a whole universal field cycle as it had in the lcr orientation. Size, mass, time duration, charge etc. in the moving frame should be unchanged when measured in the new reference frame units. Cosmic time is a count of cycles in the universal field flow, and this should be identical in lcr and in the rotated reference frame. There may be a difference in time in one system sensed from another rotated with respect to it, when using radiation based sensing techniques, but cosmic time flows the same in each. This is a necessity for systems to remain in the same universe that we perceive, which is a thin shell in the *w*t direction.

It is possible to rotate and translate any ordinary three-space reference frame so that any given uniform straight line motion coincides with one of the reference axes. In considering uniform unaccelerated motion, we assume this has been done. If motion is in the positive X axis direction as perceived, then the X axis of the moving frame will appear in the rest frame as the projection on that axis. This will be

$$X_1 = X_2 \cos \theta_p, \tag{1-78}$$

where θ_p is the phase angle due to the velocity, and

$$\cos \theta_p = (1 - v^2/c^2)^{1/2}. \tag{1-79}$$

Time and length are intimately associated at the fundamental level: unit time and unit length are each equivalent measures of the same universal field element flow. Time in the moving frame maintains its relationship with length in the moving frame. As a result, time measured in the rest frame for motion in the X direction, when sensed by radiation techniques behaves the same as length. Thus

$$\Delta t_1 = \Delta t_2 \cos \theta_p. \tag{1-80}$$

In the other two axis directions, however, the moving frame axes remain parallel to the rest frame axes. The rotation effect of velocity in the X direction is a single dimension effect, so that

$$\Delta\,(X_1\,Y_1) = \Delta(X_2\,Y_2)\cos\theta_p, \text{ and} \tag{1-81}$$

$$\Delta\,(X_1\,Y_1\,Z_1) = \Delta(X_2\,Y_2\,Z_2)\cos\theta_p. \tag{1-82}$$

With the perceived effect being assigned to the X axis in Equation (1-78), then there can be no effect upon the other two coordinate axes. This is essentially the same thing that the Lorentz transform tells us.

Since it does not admit the existence of other dimensions, the Lorentz transform forces the interpretation of Equation (1-78) to be that the sensed lengths in the direction of motion (measured from the rest reference frame) represent an actual physical contraction. In contrast, the new approach recognizes these shortened lengths as the result of measuring the projection of the phase shifted lengths upon the rest frame axis. A second consequence is that the Lorentz transform interprets the decreased time measures for the moving system distances, in the direction of motion, as a slowing down of the rate of time flow to match a fixed time-length ratio c to the shortened distances measured. In the new approach we sense the times in the direction of motion in the moving system as their projections on the reference frame axis, with the projection of both time and length being reduced in the same ratio, implying a uniform fixed value for c in the moving frame in its units. Then the value of c is the same in the moving frame in all directions, and identical to its value in the rest frame, and the numerical values of dimensions of a moving structure in the moving frame unit are the same as its numerical values of the dimensions at rest in the local-cosmic-rest frame.

Mass is of dimension representing a product of universal field flow interaction and inverse volume, or inverse cms, so, in the direction of motion the constant mass of a structure is sensed from the rest frame as

$$M = M_0/\cos\theta_p. \tag{1-83}$$

Within its own frame, in all three-space directions, it is sensed as its rest mass, yet relative to the rest frame it has more potential energy than the energy equivalent of the rest mass. When we measure mass, we do so by sensing the resistance of the mass to a change of phase orientation. When we sense the mass of a moving structure, we sense the resistance of the initial rest mass to further phase shifting plus the resistance to further change in phase of the energy added to produce the velocity phase rotation. The initial rest value of mass-energy has not increased, but the phase angle energy of the mass relative to the measurement system participates at the same rate as energy in the form of mass. For ordinary matter, mass is unchanged by velocity relative to local-cosmic-rest, but sensing of the mass includes the initial mass plus the mass-equivalent of the phase rotation energy. Expressed in energy terms we would have

$\Delta E = M_0 c^2 [(1/\cos \theta_p)-1]$, or (1-84

replacing $[(1/\cos \theta_p)-1]$ by its infinite series equivalent

$$\Delta E = M_0 c^2 [(\theta_p^2/2!) + (5\, \theta_p^4/4!) + (61\, \theta_p^6/6!) + ...], \quad (1\text{-}85)$$

for θ_p^2 less than $\pi^2/4$.

For small angles in radians; $\theta = \sin \theta$, and for θ_p, $\sin \theta_p = v/c$. Under these conditions, the expression:

$$\Delta E = 1/2\, M_0 v^2 + M_0 (5 v^4/4!\, c^2) + ... , \quad (1\text{-}86)$$

reduces to the conventional Newtonian value for small v/c as:

$$\Delta E = 1/2\, M_0 v^2. \quad (1\text{-}87)$$

The phase angle effect from linear unaccelerated motion is a single dimension effect, or rather acts upon a single perceived dimension component. As a result dimensionless aspects should have the same value measured from the rest frame as they would have in the moving frame system. At the fundamental axis level, time and length are equivalent measures, so the number c is a dimensionless ratio of length and time scale factors, likewise any velocity v is a length-time ratio and is also dimensionless, but implies a scale ratio number. The velocity of either system measured from the other will have the same numerical value (in consistent units). The magnitude of the velocity relative to lcr determines the magnitude of the phase shift effect and the three-space direction of motion determines the direction of the maximum phase shift effect.

There are four physical directions, so the question naturally arises as to the possibility of a situation in which all four dimensions were involved at some phase angle or rotation that affected all; either seen from local-cosmic-rest, or within the altered or rotated frame. The gravitational field affects all three physical directions and time, but it does so one direction at a time, so it does not fit the requirements. What we are looking for is something that affects all four together to produce a possible effect such as

$$M = M_0 \cos^4 (\theta_x), \text{ or} \quad (1\text{-}88)$$

$$M = M_0/\cos^4 (\theta_x). \quad (1\text{-}89)$$

A response of this complexity is completely outside the scope of the Lorentz transform to handle as a single phenomenon, particularly where (θ_x) represents an angle of shift for some unknown reason.

We have already encountered a case of three dimensional interaction involving an age phase angle ϕ, in the form of the equation for the volume of space as a function of universe age. In those equations (Eq. 1-29) and (1-30) two sets of three-space volumes interact with an angle ϕ between corresponding axes at the same instant of time and universal field phase. The result involves $\sin^3 \phi$. This is a different kind of interaction than implied by Equations (1-88) and (1-89).

If we let θ_x be a velocity phase angle, then we do encounter physical situations that correspond to Equations (1-88) and (1-89). In particular, two substances show responses of the above type in relating mass sensed in the moving frame, with the values at rest in the lcr frame, using the moving frame velocity phase angle θ_p. The two substances are Iron 56 and free Neutrons outside of any nucleus. These two substances, one with the lowest energy per structural unit (Iron 56), and one with the highest energy per structural unit (Free Neutrons), must have some special relationships with the universal field to make their velocity responses differ from ordinary matter units.

To have the effect be readily physically detectable, we must know the true local-cosmic-rest masses of the two species. The derivations of the theoretical rest-mass of these two species at the state of lcr are discussed in Section 4.2. . Iron 56 appears to have its structure stabilized by a resonance effect such that its mass at lcr is determined (in the new mass-units) by

$$^{56}Fe/56 = (N_w/N_p)^{8/5} = 0.998\ 841\ 620\ 274\ 317\ ... \qquad (1\text{-}90)$$

The free Neutron is the fundamental original structure form in which the matter of the universe emerges. Its mass is governed by some different structural resonance relationships plus a contribution of the velocity of expansion ($c/2\pi$) in the fourth space (*w*t) direction relative to the universe emergence point as Eq. (4-14):

$$m_n = (N_p/N_w)^{1/10}/[1-1/(2\pi)^2]^{1/3}, \text{ or} \qquad (1\text{-}91)$$

$$m_n = 1.008\ 661\ 950\ 291\ 587\ ... \text{ New mass-units.} \qquad (1\text{-}92)$$

<u>Measured in the moving frame</u>, at a velocity corresponding to $\theta_p = \sin^{-1}(v/c)$ for velocity relative to lcr, the mass of Iron 56 appears to vary as

$$M = M_o \cos^4 \theta_p. \qquad (1\text{-}93)$$

This could be accounted for by the resonance effect holding the structure in alignment with the state of lcr, while the moving reference frame shifts with respect to the fundamental universal field incoming flow by θ_p uniformly (i.e. involving a shift relative to the coherent field phase in all directions). The effect is as though the strong resonance holds all structural dimensions in a fixed alignment so that when one dimension is affected by a rotation effect, all four are forced to exhibit a similar shift. Then in the moving system the structure would have a 4-space volume intercept as

$$V = V_0 \cos^4 \theta_p. \qquad (1\text{-}94)$$

Since mass is proportional to the volume of field flow interaction held up within the structure volume, in unit time, then the sensed mass in the moving frame decreases proportionately.

In the case of the Neutron, a resonance factor is contained in the mass determining relationship in an inverse way to its participation in the Iron 56 structure. We assume that the resonance factor interacts with the components coming from the negative universe and phase shifts the response of all four of these components. In the moving frame then the intensity aspect becomes

$$I = I_0 \cos^4 . \theta_p \quad (1\text{-}95)$$

However, mass is the exterior sensed response, which is proportional to the inverse of the interior space interaction, and hence the sensed mass measured in the moving frame becomes

$$m_n = m_{n0}/\cos^4 \theta_p. \quad (1\text{-}96)$$

Experimental measurements of Iron 56 and free Neutron masses in our laboratory reference frame confirm the above, and also yield a measure of the laboratory frame of reference velocity with respect to local-cosmic-rest. (See Section 4.2.). In ordinary matter these two special effects either do not appear, or both occur and cancel each other out.

In the case of the two substances, Iron 56 and free Neutrons, it appears that we are destroying or creating energy at some fractional cost in a reversible situation. This appearance is only because we do not recognize the full system involved, which includes space and "space-stress" energy. In the case of Iron 56 the internal resonance action is apparently transferring energy from the atomic structure into "space-stress" energy in a reversible manner. For free Neutrons, it appears that the structural resonance here moves in the inverse situation to Iron 56 and picks up energy from the "space-stress" accumulation, and adds it as effective mass to the Neutron. "Space-Stress Energy" exists. It is the source for the energy released in gravitational condensations of scattered matter particles into dense objects. "Space-Stress" energy is also manifested in the form of small changes in wavelength of free radiation in space with universe age. (See Sections 5.7. and 6.4.).

As a result of the special behavior of these two species, when mass is measured within their moving frames, there is also a deviation of these two materials from the behavior of ordinary matter when mass is sensed from the local cosmic rest frame. For ordinary matter, the phase shift angle (θ_p) of the moving frame, in the direction of motion, affects time and length as projections on the corresponding three space direction at lcr in accordance with cos θ_p, and mass as 1/cos θ_p. For these two special substances, the two effects may combine. For Iron 56, sensing mass in the moving frame from the lcr frame in the direction of motion could yield:

$$M_{Fe} = M_{Fe0} \cos^4 \theta_p / \cos \theta_p = M_{Fe0} \cos^3 \theta_p. \quad (1\text{-}97)$$

For free Neutrons outside any nucleus, the mass sensed from the lcr frame, in the direction of motion, could yield:

$$m_n = (m_{n0}/\cos^4 \theta_p)/\cos \theta_p = m_{n0}/\cos^5 \theta_p. \quad (1\text{-}98)$$

Remembering of course, that in any experimental setup, the difference between the laboratory rest frame and the local-cosmic-rest frame will need to be considered in making a final evaluation of test results.

In the above, I have indicated that the responses of these two substances, when sensed from the lcr state, may combine their individual special responses with the standard response of ordinary matter. This would be the case if we could consider the two effects to be independent and additive. If so, experimental results should confirm Equations (1-97) and (1-98). If not, then we will need to consider the implications of any deviation of the experimental results from the values expected.

In all the above discussion of the effects of relative velocity, it has been velocity relative to local-cosmic-rest that was the basic reference frame and which determines the total velocity phase shift angle. Also, it has been assumed that gravitational fields and other accelerations were either absent, or the reference frame was compensated by free response to the acceleration. We must now give some consideration to the presence of a gravitational field.

A gravitational field acts as a local negative energy region in the universal field caused by a phase lag in the outgoing universal field from the source matter mass. The gravitational field intensity falls off in the usual inverse square rate with distance. At any point in the field, the force is directed toward the source mass. The equivalent field energy level per unit gram mass at the given point in the field of a mass M is a function of radial distance (d) as

$$\Delta E = -G M/d, \qquad (1\text{-}99)$$

relative to the center of mass.

If an incoming mass entering a gravitational field ends up in a stable orbit, it contributes its independent initial momentum to that of the gravitational system. Depending upon its mass relative to the gravitational system mass, this may slightly alter the total system momentum and its velocity relative to local-cosmic-rest. The mass in orbit then shares the system velocity, and then acquires an orbital velocity relative to the center of mass in accordance with its position in the field. As a result, then, the velocity phase angle equivalent to its velocity with respect to the center of mass, will represent an energy increment that exactly cancels the potential energy residual represented by its radial position in the field. (See Section 2.5.).

The orbital velocity phase angle relative to the center of mass, plus the velocity effect of the center of mass, plus the negative energy effect of the field position all combine, with a net resultant equal to the phase angle due to the velocity of the whole gravitational system with respect to lcr.

The velocity phase shift effect starts from the field's equivalent negative energy, and rotates in the direction toward the minimum energy state of lcr. For circular orbits there is a partitioning of energy between particle potential energy with respect to the field source and kinetic energy of motion in orbit; with each equaling one half of the field potential at the given radial distance. The field potential is given by Equation (1-99). When expressed in terms of gram equivalents of energy, the amount available for kinetic energy per gram in orbit is

$$\Delta \text{ E/gram} = (\text{G M/r-[P.E.]})/c^2. \tag{1-100}$$

For radial free fall, or a parabolic orbit without P.E., then

$$\Delta \text{ E/gram} = [\text{G M}/(\text{r } c^2)]. \tag{1-101}$$

(See Equations (2-90) to (2-110) inclusive.)

The velocity phase angle is a phase advance, while a gravitational phase angle is a phase lag with its effect being in the inverse direction to a velocity effect on energy content of the matter units in the field seen from the state of lcr. As a result, the velocity of matter in a gravitational field tends to cancel the field phase angle effect, with the product of the two effects approaching unity in the absence of external energy contributions.

Examination of the reference equations indicates that there can be three different limits applicable. The first occurs when potential energy exactly equals the field potential. This yields:

$$\cosh \theta_v = 1/(1 - 0) = 1, \text{ or}$$

$$\theta_v = 0 \text{ radians.} \tag{1-102}$$

This means that there is no velocity with respect to the system center of mass. This naturally applies to matter supported at rest in the field, such as matter on the surface of a field source mass that is not rotating,

The second limit occurs when there is no potential energy with respect to the field source. This leads to the case for free fall in a gravitational field, where

$$\cosh \theta_v = 1/[1\text{-2G M}/(\text{d } c^2)]. \tag{1-103}$$

This represents the Schwarzchild singularity limit value when the field potential in velocity terms is $-2\text{G M}/(\text{d } c^2) = -1$.

The third limit occurs at $-\text{G M}/(\text{d } c^2) = -1$ for the situation such as circular orbits where energy partition between Kinetic and Potential energies is equal. (See Section 2.5. for the relationships between the gravitational angle θ_g and the velocity phase angle θ_p etc.) If we were to measure the velocity with respect to lcr for a unit of matter upon the earth's surface, the net result would be the net velocity magnitude of the solar system through space corrected for all of its gravitational orbit components in the local galaxy and for any orbital participation of the local galaxy. This velocity with respect to lcr would have a magnitude and a direction. If we made the measurement by utilizing the properties of Iron 56 or free Neutrons, the result would be a measure of the magnitude, without any three-space direction component. (See Section 4.2.). The result of this kind of measurement yields a value for velocity relative to local-cosmic-rest as approximately 378 km sec^{-1} for our solar reference frame.

An implication of these findings is that a gravitational system, sensed from the state of local-cosmic-rest, has a mass response equivalent to the total system mass at rest, plus any velocity effect of motion of the center of mass, regardless of the individual velocities of components in stable orbits. Also, the mass of individual orbiting components, when sensed from lcr, is equal to the components rest mass plus any velocity contribution effect from the velocity of the system center of mass with respect to lcr.

As a reminder again at this point, the new approach does not alter any of our perceptions or results of measurements. However, it does alter what we can read into the results. The effects of motion that have been discussed in connection with the new approach, while yielding the same apparent numbers as Special Relativity and application of the Lorentz transform, imply something different about space than the conventional interpretation of a nothingness that is permeable to radiation. By the new approach, space is something structured and substantial although different from matter units. In Equation (1-31) space was attributed with the characteristic of volume, and being the result of the interaction of the universal field and all matter units (or their potential units) both perceivable and negative, at the cosmic age phase angle. It was hypothesized as the product of the exterior of one type matter unit with the inverse of the interior of the other type matter unit summed over all possible paired combinations. As a result, it would appear that space is potentially the product of 8 + 8 + (16 or 17), for a total of (32 or 33) possible dimensions. Even if the reduced freedom aspect of 5 + 5 + (16 or 17), as (26 or 27) is considered, this is far more than the perceived complexity of matter units. The variation in possible number of dimensions for either of the two possible cases is dependent upon whether the choice of basis is "in a unit of time" or including time as an additional dimension element. The total volume of space is a limiting factor in the universe emergence, limiting the volume of matter to the volume of space available in the early stages. The volume of space at a given age limits the size of the universe at that age. Space, treated as nothingness, cannot limit universe size. If we accept the full meaning of "nothingness", the region of nothingness cannot contain anything manifest or real, hence it cannot even contain or transmit radiation.

Our universe appears to be a closed system; one that is bounded in the *w*t direction. The radiation flowing in space, even the universal field below the level of perceived radiation, appears to remain contained within the bounds of the universe structure. If the universe is bounded by nothingness, it then appears that nothingness cannot accept any form of field flow and thus reflects it back into the confines of the perceived universe. In addition, nothingness cannot exert any force upon matter units, yet there is expansion force exerted upon matter units by expanding space as shown in Equation (1-77). When this force is integrated over all the matter of the universe and the expansion separation distance of matter units, it represents a build up of what I call "Space-Stress" energy. The result of this force-distance integration is shown as Equation (5-71), which, early in the expansion process, exceeded the energy equivalent of all the matter in the perceived universe. By approximately age 10^5 seconds after full emergence, the total "Space-Stress" energy exceeds the energy equivalent of all matter (See Figure 6-2).

Considering all the above, we must look at space differently than the conventional assumption of nothingness. A small amount of potential matter is responsible for a large volume of space existence. For example, consider one gram of matter at the approximate current universe age of ϕ = 1.431 165 876 radians. Adjusting Equation (1-30) to represent the space associated with a single mass-unit of matter yields

$$V_{amu} = N_p\, m_n\, V_o^2\, (p^{3\sin^2 f})\, (\sin^3\phi)\, (1- \alpha\phi/\pi). \qquad (1\text{-}104)$$

This volume when multiplied by N_z, to convert volume due to one gram, is approximately

$$V_{gm} = 1.131 \times 10^{28}\ \text{cm}^3. \qquad (1\text{-}105)$$

This represents approximately ten times the solid matter volume of the earth, as the quantity of space for which one gram of matter is responsible. Matter is continuously responsible for the volume of space. In some way, space is connected to the matter units responsible for it. Considering this, space cannot be some sort of compact bulk structure, but must consist of threads or filaments that, in some space of greater than four dimensions, can intersperse and equalize the stress of concentrating about the matter units from which they are formed. As a result, any sample of space is filled with representational structures from a vast region of matter units. Because of this average mixture at all times, local motions of individual particles of matter make no detectable changes in the bulk properties of space.

In a very real sense then, when the earth moves, the space it is responsible for moves with it, so that it should be almost impossible, with use of ordinary matter, to locally detect relative motion between earth and its adjacent space. The universal field component aspect of space volume and existence, arising from matter interiors in the negative matter portion, comes through the inversion boundary between perceived space and negative matter interiors. A given single unit of perceived matter interacts with all the negative matter units. This portion from the negative matter represents a total negative universe average and thus is constant for perceived space both at local cosmic rest and for space in motion relative to local-cosmic-rest. We have implied that motion relative to lcr generates a phase advance, that can be treated as a phase angle that is in addition to any possible three-space direction angles, for the moving reference frame material. We extend this phase rotation aspect to all the space derived from the moving matter, and imply also its motion relative to lcr is equal to that of the source matter units. As a constant, it is specified that radiation transmission in the structure of space is at the fixed velocity c in any direction in space, when measured relative to local-cosmic-rest.

It has been demonstrated that a velocity parameter in the form of a hyperbolic angle (θ_v) can be substituted for a relative system velocity (v/c) (Taylor & Wheeler 1963). Use of this parameter simplifies calculations and makes it plain that the sum of several velocity increments in the direction of motion cannot exceed the limit tanh $\theta_v = 1.000 \ldots$. Use of this parameter leads to some simple relationships between the velocity parameter of a sum of two or more collinear velocities and the sine and cosine of the velocity phase angle (θ_v) of the velocity sum:

given two velocities;

$$\theta_{v1} = \tanh^{-1}(v_1/c) \text{ and } \theta_{v2} = \tanh^{-1}(v_2/c), \qquad (1\text{-}106)$$

the velocity parameter of the sum of collinear velocities v_1 & v_2 is:

$$\theta_{vs} = \theta_{v1} + \theta_{v2}, \text{ and} \qquad (1\text{-}107)$$

$$v_s/c = \tanh \theta_{vs} = \sin \theta_{ps}. \qquad (1\text{-}108)$$

The maximum radiation velocity relative to local-cosmic-rest in any direction is (c). When a reference frame has a velocity relative to lcr, the space derived from the matter is at rest relative to the moving frame, and shares its velocity and the associated velocity phase shift angle in the direction of motion. Thus, when we examine the situation of matter units moving at a velocity very close to c, we have two velocity components to deal with. First is the velocity of the moving reference frame relative to lcr, and secondly the velocity of radiation in the moving space associated with the moving matter. Using the relationships of Equation (1-107), with the maximum value of the sum equal to v/c = 1.0 and letting one relative velocity be 0.999 999 ... c to some arbitrary number of places, the other value can equal it, provided that the tangent for the sum is 1.0 exact or greater than 0.999 999 ... c to some number of places greater than either component. In effect, the velocity of radiation in the moving space can approach extremely close to c, but never quite attains the full value c for a frame that is moving faster than zero with respect to lcr, unless θ for v = c can be treated as near infinite in hyperbolic radians. In a practical sense however, the velocity of radiation in the moving frame and the velocity of the moving frame can each approach as close to c as we will probably ever be able to measure.

In partial summary: the numbers for ordinary matter and motion in the new approach are the same as obtained by application of the rules of Special Relativity, but the implied meanings are significantly different.

1. Relative velocities must be measured relative to local-cosmic-rest, or to a system whose local-cosmic-rest rest velocity magnitude is known.
2. The shortening of the moving frame time and length, measured in the rest frame in the direction of motion, is the effect of projection at an angle (the relative phase angle).
3. The fixed radiation velocity in space is a fixed velocity relative to local-cosmic-rest, and is the result of space being a structured entity that moves with its source matter and rotates the direction of motion axis in the moving system relative to its direction in the local-cosmic-rest frame.
4. The effect of velocity relative to lcr upon apparent mass is due to the effect upon a unit of inverse length; which, being involved in the inverse volume, has a direct connection to the energy increment required to generate the phase rotation of the energy represented by the mass structure relative to lcr.
5. The relativistic Doppler equation for the ratio of observed frequency to source frequency is simply the combined product of the ordinary Doppler shift in a fluid with fixed radiation velocity, the effect of angle of direction of motion relative to the angle of radiation propagation, and the effect of the velocity phase angle projection upon the inverse time (frequency) as seen from the rest frame.
6. Space is a structured entity that we must study and then take account of its properties to advance our understanding of the physical nature of our perceived universe.
7. Because of the higher dimensional structure implied in the new approach, there are things possible within the new structure that cannot be accounted for in the conventional approach: such things for example as the behavior of Iron 56 and free Neutrons.

In Section 3. on the electron, the effect of interactions of the universal field components inside a structural unit, as seen from the outside, is proportional to the factor e^{-1} in the radius of a mass-unit. The factor e^{-1} is expressed in a form that resolves into a series of sixteen fractions of the fundamental physical unit of wavelength; these are alternately positive and negative. Each term represents a different wavelength contribution. From this we can conclude that the actual potential field before interaction (i.e., the square root of e^{-1}) is a series of sixteen components with alternate real and imaginary coefficients. In the interaction, or squaring, the Kronecker delta applies, yielding a series of sixteen squared elements with no mixed cross products. Physically, this is the result of the interaction of two differing frequency elements yielding zero net energy (except where added constraints of modulation or demodulation and band pass characteristic differences can cause separation into several different flows). The implication of the structure of the potential field is that we have both real and imaginary coefficients in the flowing potential field, in both the positive and negative time directions of our perceived space.

The proposed new approach improves our understanding of the effects of motion, by providing reasons for inertia, for the change in apparent mass with velocity, provides reasons for particular conditions in gravitational orbits, and shows that the mass affected by a gravitational field is identical with the mass that reacts to acceleration in velocity. The new approach is not a final answer, because it has just moved our area of insufficient understanding down to the more fundamental level of the nature of the universal field. The new approach shows why the laws of physics, for most ordinary matter, should be the same in all reference frames regardless of the reference frame's velocity (with, of course, the mentioned exclusion of Iron 56 and free Neutrons).

In the past, the observed extension of the half lives of unstable particles by means of increase relative velocity has been taken as supporting the belief in the slowing of the rate of time flow by increased relative velocity, which is assumed in the conventional approach to Special Relativity. Both Special Relativity and the new approach yield the numerical relationship $t_m = t_0\ (1\text{-}v^2/c^2)^{1/2}$ for the time in the moving system (t_m) as seen from the rest system (t_0). The interpretations differ in how this effect is applied to units of time. Special Relativity employs the interpretation that time flows at a slower rate in the moving frame, so that the number of units experienced in the moving frame, for a given extent in the rest frame, is fewer in the ration $(1\text{-}v^2/c^2)^{1/2}$. The new approach implies that seen from the rest frame, a unit of time in the moving frame appears to be only a fraction of the size of a unit of time in the rest frame: $t_m = t_0(1\text{-}v^2/c^2)^{1/2}$ but, for ordinary matter, both units in their own reference frames correspond to a unit of cosmic time.

If the half lives of unstable particles appear to be extended by the increased velocities in the moving frame, then this is not a normal matter response and must be associated with some special structural circumstance. To yield an increased lifetime observed in the rest frame, there must also be an increased lifetime observed in the moving frame in its time units. This implies an increase in terms of cosmic time elements. The cosmic time units are equivalent to local frame time units at the state of local-cosmic-rest. If more of these units are required to bring about the change involved in the instability, then the change must be due to some state in resonance with the state of local-cosmic-rest. Then, the contribution, of a unit of time in the moving frame, to the change process must occur in proportion to the projection of the moving frame time units upon the rest frame. This would be in the ratio that a moving frame time unit appears as seen from the rest frame. Given constancy of the rest frame unit requirements, the observed time in the rest frame will require $1/(1-v^2/c^2)^{1/2}$ as many units of moving frame contribution.

The unstable particles then must have some portion of their structure that is governed by energy relationships at the state of lcr. This is probably an aspect in the wt direction that has a fixed value in the direction wt_0 of the local cosmic rest phase, so that, as wt in the moving frame changes direction, the projection on wt_0 per unit time decreases. Then this requires more time units in the moving frame in inverse relation to the phase angle effect seen from the rest frame. This extension in half lives of unstable species, then, should be relative to the state of local-cosmic-rest and be dependent upon velocities relative to local-cosmic-rest and not just to ordinary system to system relative velocities. This would represent another case of deviation from the Special Relativity assumption that the laws of physics are the same in all uniform velocity frames regardless of their relative velocities. In fact, the observed property, of half life extension for unstable particles by means of velocity relative to local-cosmic-rest, should provide an additional means to measure the true velocity of a system relative to lcr by means of measurements within the moving frame system. (Due to the statistical nature of half-life measurements, this method would be much less precise than that of using the mass measurement on Iron 56 or free neutrons, as discussed in Section 4.2. .)

When comparing the standard approach and the proposed new approach, there are two fundamental differences that affect what happens during the universe expansion process. These are the response to gravitation in the early stages and the problem of energy absorption in the expansion process itself.

In the standard model it is assumed that gravitation controls the expansion process and the limiting ultimate structure of the universe. This is reduced to a function of the relationship between the actual matter density and the critical matter density, at a given expansion velocity denoted by the Hubble value, as required for the dividing line between positive and negative curvature for the universe. This approach has to be wrong because it does not take into account all that we know about gravitation. If matter distribution is uniform and infinite in extent, or if space is closed and bounded at the size of the uniform matter region, there is no net gravitational field anywhere; but if space extends beyond the region of uniform matter density, there can be self gravitation of the matter content of the universe. This latter case seems to be part of the basic assumptions in the standard model that is used in relating the matter filled region to the space that is assumed to pre-exist matter. The new approach indicates that matter emerges as space becomes available in the early emergence phase, then later on, as space continues to expand it causes the matter to be uniformly distributed with it. The volume of the universe at any given instant is the volume of space, and nothing exists outside of space. The universal field is carried at a fixed velocity within the structure of space and confined to space. By the new approach, space is a structured entity at least as dimensionally complex as matter units. If it cannot be carried outside of space, into a region of nothingness, then the universal field with its modulation must be totally reflected at the boundary. Thus space is bounded and filled with uniformly dispersed matter. This rules out existence of any net gravitational field effect.

The second aspect also relates to how gravitation is handled. In the standard model, as the universe expands it is assumed that gravitation is absorbing part of the energy of motion of the expanding matter region. Then this creates a source of gravitational energy that can be released in forming condensations of matter units such as dust, rocks, planets, and stars. For calculating purposes, it is assumed that energy is absorbed in the expansion process much like the way the energy changes in adiabatic expansion of compressed gas. This too is a place where the proposed new approach differs from the standard. Since maximum potential space volume is created by the interaction of volume elements from normal and negative matter units, and the amount of space that appears in a wave-function state at any given time, is controlled by the sine cubed of the phase angle difference between the two types of matter in the pre-emergence system, the need for energy is different. The expansion process is externally driven by conditions in the pre-emergence region. This generates space stress energy which then supplies any energy released by gravitational condensations that form later in the expansion process. Energy is not removed from the matter portion by this process. It appears that energy is being removed from the matter portion of the system by the expansion, but this is only an appearance brought about by the temperature drop from the continuous energy loss mechanism in the pre-emergence region. This later effect is the result of the operation of the mechanism that is responsible for the continuous decrease in universe matter mass-energy with increasing age.

By the new approach, we do not observe any differences in the ordinary laws of motion (for ordinary stable matter) from what we have been using, however, our understanding of the reasons for these laws has been improved. Now we can move on in Section 2., to exploration of the general gravitation constant G. It was the early work in this area that yielded the first solid clues that the new approach might have some real value. Before moving on, however, there needs to be some mention of the problems associated with the differences in dimensionality of some of our common concepts such as length, time, mass, energy, etc., as they are contained in the new approach.

1.5. Dimensionality

The increased dimensionality involved in the new approach, over that in our conventional four dimensioned spacetime, implies a need to be very careful about the implied dimensionality of various components. This effect extends down to our simplest elements such as length, time, and mass. The exponents for the components of dimensionality of these simplest elements in the new approach appear to be twice the commonly assumed macro-space values for these elements, as though we were operating in an L^2 space. The basic reason for this is that the fundamental length unit and the fundamental time unit are each fixed by the universal field, and neither perceived time nor perceived length exists without the other. A unit vector contains both as the composite Qt. In this, Q is an elementary unit vector and t is the unit time-operator aspect.

At the macro-space unit length level, we perceive only the length component (cm), but we do so in atomic-unit time, which is equivalent to atomic-unit length. We ignore the time component, but must consider the effect of its dimensionality. As a result, the macro-space unit lengths have the dimension (cm)(1)(cm), or cm^2, with respect to the fundamental elements, and with all magnitude effects assigned to the coefficient of the first cm in the dimensionality. In terms of radiation, or universal field transit at the universal field unit level, both an atomic-length unit and an atomic-time unit are equivalent in distance or time.

The continuous motion of the perceived universe in the fourth physical direction wt is not perceived, because we only see the three-space portion and have no reference point in the fourth direction. We perceive continuity of existence, which requires that we take account of the change in *w*t by recognizing the t component of the change in location. We recognize this as an atomic time-unit of dimension (t). It also has a dimension (cm) that we have ignored. At the atomic unit level this is equivalent to a unit time that we have ignored. As a result, the dimension of our perceived time at the atomic unit level is (t)(cm) or (t)(t).

Equation (2-41), repeated here, shows the relationship between the mass-unit volume and the total mass-energy of the universe at a given universe age

$$(4\,\pi\, r_1^3/3)^2 = 1/(\beta\, M_g\, c^2). \qquad (1\text{-}109)$$

The dimension of the current radius r_1 in a unit of time is length or cm. This requires that the dimension of energy or mass be cm^{-6} in a unit of time. This specification of "in a unit of time" is very important because it involves removal of the time factor from many components. For example, a unit of four-space volume is the product of four lengths, each of which contains a time component. If we remove the time unit by specifying dimensionality in a unit of time, and this same unit affects all four components, it removes t^4 from the description of volume.

We have postulated earlier that the fundamental mass-unit is unchanged throughout a universe life cycle. The mass of the universe changes with universe age in proportion with the age phase angle, as in Equations (1-12) to (1-14). With constancy of the mass-unit, then it must be the number of mass-units that changes. At emergence, the emergent mass-unit radius must be proportional to an emergent cm. Then, as the number of mass-units changes, the values of r_1 in terms of the emergent radius r_o must follow in inverse ratio with the sixth root of the mass-unit number change. This yields an expression at the abstract unit level:

$$r_1 = r_0/(1- \alpha\phi/\pi)^{1/6}, \tag{1-110}$$

or its equivalent,

$$cm = cm_0/(1- \alpha\phi/\pi)^{1/6}. \tag{1-111}$$

The ratio of cm and seconds remains constant throughout a universe cycle.

When we use the above relationship to compute the relative size of an ordinary macro-space centimeter to its emergent value, we need to recognize that this is a unit of length materialized in time (i.e., it is not time free). When this is taken into account, the expression for the size of a macro-space cm becomes

$$\text{macro cm} = cm_0/(1- \alpha\phi/\pi)^{1/3}. \tag{1-112}$$

The same holds true for ordinary time as

$$\text{macro sec} = sec_0/(1- \alpha\phi/\pi)^{1/3}. \tag{1-113}$$

These are unit-size ratios; when estimating the number of cm or sec in some fixed unit of length or time, the resultant number of units varies in inverse ratio to the size of the units.

These kinds of considerations have come up in several different circumstances in the new approach, and have needed individual consideration. Eventually it will be necessary to develop some tables of dimensionality of various factors such as mass, length, time, force, energy, charge, acceleration, etc. expressed in the conventional macro-space units, with the expression for the same factors in the new fundamental units in a unit of time. This will increase our understanding of how time behaves in the new approach. Developing a standard way of making the differences clear may require developing some new names to help minimize confusion in the new approach.

2. GRAVITATION

The study of gravitation is the foundation upon which this whole new approach to the perceived structure of the universe has been based. The early aspects were originally taken up as a part time hobby. Gravitation seemed a good subject to explore, being weaker than the other fundamental forces and seeming to resist all attempts to relate it to electromagnetic phenomena. Also, I had a continuing dissatisfaction with the adequacy of the existing concepts of the radiation velocity c being the limitation to the rate of information transfer in stabilizing such a vast structure as our perceived universe. This and other things suggested that our universe might involve more than four dimensions. Some of my early speculative notes relating to a possible eight dimension involvement go back eighteen or twenty years. A simplified derivation was developed that yielded a value for the general gravitation coefficient G. It appeared to be almost right, at least in its numerical result. Further exploration lead to a gradual correction of the gravitation expression and to the development of other related factors, and eventually to the form of the mathematical group mentioned in Section 1.2.. The final form arrived at, for a gravitational field, is a region of space where the flowing universal field leaving matter units in the outward direction has a continuous phase displacement relative to the instant phase of the state of local-cosmic-rest. This phase displacement has an effect that is the inverse of a velocity phase angle displacement and varies in magnitude in proportion to the inverse square of the radial distance from the center of mass of the source, with the intensity gradient toward the source. The following subsection starts with a simplified derivation of the gravitation coefficient G that essentially duplicates the first early path.

2.1. Gravitation Model

The first approach was through a simple analogy with two cold particles injected into a high temperature region, such as the interior of a spherical black body radiation furnace. Before they warmed up, each particle would cast a shadow all around themselves. As a result of this very faint shadow effect, the two particles would receive less radiation on their facing sides than in other directions. This would result in less radiation pressure on the facing surfaces than on other surfaces, and the two particles would tend to be forced together during the time that they were heating up. This action between particles and the surrounding radiation field, then, was a transient analog of the initial approach to the gravitational field.

In applying this approach to the gravitation effect between two particles, certain conditions were assumed, or specified.

1. Neutral matter is treated as an assemblage of fundamental neutral particles of uniform size, and of mass equal to a mass-unit physical (a Carbon 12 mass-unit).
2. As a first approximation, each particle has a well defined and fixed radius that approximates a neutron inside a nucleus.
3. A uniform universal field exists throughout space. It is closely related to electromagnetic fields and has both clockwise and counter-clockwise rotation components, and it appears to originate in the remote distances in all directions.
4. The finite field intensity can be expressed as a number (I_0) in ergs per cm^3 and a duration of a minimum atomic time unit. Inside matter particles this field generates the mass, while in empty space the energy per unit time may average near zero by reason of interaction of opposite flowing components.
5. Matter and space are tentatively considered to be four dimensional complex, with the complex nature hidden from our perceptions by some mechanism, so that spacetime and matter appear to be only four dimensional.
6. In addition to generating the mass, the universal field, in passing through matter, generates a secondary effect that we perceive as the gravitational field effect.

We start the analysis with two isolated mass-unit particles of radius r_1 and r_2 respectively. These particles are separated by a distance (d) that is large relative to their radii. Further, it is specified that these particles do not move relative to each other during the instant of the analysis, and they are in a region free from any net external field unbalances, and remote from any other particles. The cgs system of units is adopted for this and further analyses.

It is assumed that, in ordinary three-dimension perceptions in macro time, the mass-units appear spherical. It is recognized that the true shapes may be different, but with pattern rotations they could average spherical over time. The radii r_1 and r_2, of the two separate particles, are the radii of the equivalent spherical patterns swept out by the mass-units. By reason of symmetry, the analysis can be based upon either particle as a starting point. The convention adopted was to compute the effect upon particle 1 due to the presence of particle 2.

In the early exploratory calculations made to test the possible utility of the furnace analogy model as an approach, it was the intent that the duration time of a mass-unit in terms of field flow time be considered, but it was left out. There was however a serendipitous slip by a factor of r_1 when equating intensity (I_0) to mass divided by three-space volume. This slip ended up being equivalent to multiplying mass by duration time expressed as unit length in radial flow terms. The result of the calculations that included this apparent error was an interesting result, which is the basis for the gravitational equation that was finally derived. In the derivation path that follows, this factor effect is shown as a deliberate inclusion in the form of r_1 as a multiplier of mass in equation (2-2). Without the benefit of this particular form for the inclusion of the duration effect, this whole study might not exist. The range of the effects of expressing the duration in length form is enormous, and it opened the door for consideration of higher dimensional contributions to what we perceive.

Consider particle 1; with particle 2 at a distance (d) center to center, so the spherical surface around particle 1 at this distance is $(4 \pi d^2)$. Then, consider radiation coming in uniformly from remote space: there is a small area of the field of view around particle 1 that is obstructed by particle 2. This area is πr_2^2 at distance d. The fraction, of the large spherical area about particle 1, that is obscured is $\pi r_2^2/(4 \pi d^2)$, or $r_2^2/(4 d^2)$.

With respect to radiation coming in from remote space, particle 1 sees two effects: an unobstructed portion, which is $I_0 [1 - r_2^2/(4 d^2)]$, and an obstructed portion that is $I_0 (1 - A_2) r_2^2/(4 d^2)$, where A_2 is a fractional interaction component for field passing through particle 2. Combining these two effects yields a composite of $I_0 [1 - A_2 r_2^2/(4 d^2)]$. Each element of volume in particle 1 is similarly affected, so the net result is the integrated value over the volume of particle 1. This becomes:

$$I_0 \{1 - [A_2 r_2^2/(4 d^2)]\} (4 \pi r_1^3/3). \tag{2-1}$$

This can be separated into two components, one of which is simply the mass of particle 1, with duration in time expressed in internal length as:

$$r_1 m_1 = I_0 (4 \pi r_1^3/3), \tag{2-2}$$

and the other is the intercept by particle 1 of the gravitational shadow of particle 2. The simple gravitational effect then becomes:

$$-I_0 \{(4 \pi r_1^3/3) [A_2 r_2^2/(4 d^2)]\}. \tag{2-3}$$

Equation (2-2), when rearranged, yields an estimator for field intensity I_0 in terms of mass and volume, which applies to either particle.

$$I_0 = 3 m_2/(4 \pi r_2^2) = 3 m_1/(4 \pi r_1^2). \tag{2-4}$$

Equation (2-3) indicates that the gravitational effect is a directed negative energy effect, while the mass effect is a pure scalar.

To compute the force upon particle 1 due to the negative energy effect of particle 2, we examine Equation (2-3). It is a total effect integrated over the volume of particle 1. To convert it to an energy density effect, we divide by the volume of particle 1, and this reduces to:

$$-I_0\, [A_2\, r_2^2/(4\, d^2)]. \qquad (2\text{-}5)$$

This radiation density can be converted to a radiation pressure effect upon adjacent surfaces, by application of the standard radiation pressure relationship for converting radiation energy density in ergs per cm^3 to pressure in dynes per cm^2. This is to divide energy density by 3. Then, the area affected by this directed energy flow would be the area of particle 1 normal to the direction line to particle 2. This area would be $\pi\, r_1^2$. Combining these effects, now yields the force:

$$F = -\, (I_0/3)\, [A_2\, r_2^2/(4\, d^2)]\, \pi\, r_1^2. \qquad (2\text{-}6)$$

We substitute the value for I_0 from Equation (2-4). This yields

$$F = -\, m_2\, A_2\, r_1^2/(16\, r^2\, d^2). \qquad (2\text{-}7)$$

We now need a value for the interaction coefficient A_2. As a first guess, it was equated to the volume of particle 2, as being a factor proportional-to-mass. Then, we replace the mass of particle 2 by its energy equivalent $m_\mu\, c^2$. This yields:

$$F = -\, [m_\mu\, c^2\, r_1^2/(16\, r_2\, d^2)]\, (4\, \pi\, r_2^3/3), \text{ or} \qquad (2\text{-}8)$$

$$F = -\, m_\mu\, c^2\, r_1^2\, r_2^2\, \pi\, /(12\, d^2). \qquad (2\text{-}9)$$

Particles 1 and 2 are identical, so the expression becomes

$$F = -\, m_\mu\, c^2\, \pi\, r_1^4/(12\, d^2). \qquad (2\text{-}10)$$

Getting this far takes into account only the gravitational field effect of particle 2. The other, particle 1, also generates a similar shadow field. In the region between the two particles, the directed fields are flowing in opposite directions, while beyond the particles they add their effects. (It was an early assumption that the shadow field effects were additive, and was only later recognized that the fields interact as a product of the two, to create an energy potential region.) Including the addition effect then doubles the force on either particle, and modifies the force equation to:

$$F = -\, m_\mu\, c^2\, \pi\, r_1^4/(6\, d^2). \qquad (2\text{-}11)$$

This is the form of the equation that I first stumbled into, and which appeared to be potentially interesting. Examining dimensions of the components, using conventional values of cm^{-3} for mass, cm for time, and cm^{-4} for force, yields:

$$cm^{-4} = cm^{-3}\, (cm/cm)^2\, cm^4/cm^2, \text{ or}$$

$$cm^{-4} = cm^{-1}, \qquad (2\text{-}12)$$

implying a dimensionality error of cm^{-3} somewhere. There are other conceptual errors according to our conventional view in the assumptions also, but accepting that this accidental relationship might be meaningful, and working to straighten it out, was the eventual source of the universal field theory.

The first approximation that I made was related to mass generation by the universal field. I had already specified that I was working in unit time; but then, since the universal field was flowing in all three directions as well as moving in time, I decided that for each dimension of cm^{-1} in the ordinary concept of mass, I needed to take into account a cm^{-1} for the time contribution. This then provided a factor cm^{-3}. Then, using this, the expression becomes:

$$F = - m_\mu c^2 \pi r_1^4/(6 d^2 cm^3). \tag{2-13}$$

Treating mass as dimension cm^{-6} was not the first time a six dimension aspect was used in exploring physical relationships. Eddington had recognized that his 16-element E-number-system components could be treated as equivalent to the set of rotations in a six space. The additional cm^{-3} factor above is a dimensional adjustment associated with the mass-unit. The magnitude of a mass-unit (or a multiple of it such as a gram) is fixed during the life cycle of the universe. As a result, the cm^{-3} adjustment above carries no component of size change with universe age. This particular cm^{-3} component must be treated as invariant, when later computing the possible effects of universe age upon the numerical value of the general gravitation coefficient G.

Equation (2-13) represents the force between two mass-units. To convert to our usual level of grams mass, we need to multiply each by the number of mass-units per gram (Avogadro's number N_A). This yields

$$F = - N_A^2 m_\mu c^2 \pi r_1^4/(6 d^2 cm^3), \text{ or} \tag{2-14}$$

$$F = - N_A c^2 \pi r_1^4/(6 d^2 cm^3), \text{ for two one-gram masses.} \tag{2-15}$$

This is not in our conventional form of a gravitation coefficient, where

$$F = - G m_1 m_2/d^2. \tag{2-16}$$

In the case $m_1 = m_2$ = one gram, we have

$$F = - G/d^2. \tag{2-17}$$

Equating Equations (2-15) and (2-17) yields

$$G = N_A c^2 \pi r_1^4/(6 cm^3). \tag{2-18}$$

The problem now is a very practical one, in that we do not have very precise values for the radius (r_1) of a single mass-unit. There is a standard equation for estimating the radius of a nucleus, that has been derived from experimental data and an assumption of constant density in the packing of nuclear components. This is

$$r = r_1 (A)^{1/3}, \tag{2-19}$$

where A is the atomic number. Two different textbooks gave different values for r_1 as 1.2 x 10^{-13} cm and 1.18 x 10^{-13} cm. As an approximation I used the average, or r_1 = 1.19 x 10^{-13} to test the numerical value predicted by Equation (2-18). This yielded a value as

$$G = 5.6829 \times 10^{-8} \text{ dyne cm}^2 \text{ g}^{-2}. \quad (2\text{-}20)$$

This was calculated using the 1973 standards as N_A = 6.022 045 x 10^{23}, and c = 2.997 924 58 x 10^{10}. For comparison, the 1973 standard for G was

$$G = 6.6720 \times 10^{-8} \text{ dyne cm}^2 \text{ g}^{-2}. \quad (2\text{-}21)$$

The two values differ by a factor of

$$\text{obs/calc} = 1.174 . \quad (2\text{-}22)$$

The implication of this large error was either that the value of r_1 was in error, or there was some missing factor, or both. The first approach was to consider that the actual force might be the result of two components, one real and one imaginary, each of the computed magnitude. This obviously was too much, since it added a factor of $2^{1/2}$.

Long before the first approach to deriving a gravitation expression was attempted, the exploration of possible mathematical groups to replace our ordinary four-vector set had developed the mathematical form for a four-vector that was a candidate to be considered. This was one where the ordinary vectors were squares of subspace vectors, and involved another factor with each elementary vector component. It was not as clearly defined as indicated in the Section 1.1. and 1.2. discussion of the probable vector group, but the subgroup concept was there as a square root of an ordinary perceived vector. Taking this into account, it was assumed that the true forces could be generated, in the subspace, as real coefficient and imaginary coefficient parts that combined at the subspace level. It was possible, then, that the combination effect, instead of being $2^{1/2}$ would be $2^{1/4}$. The value of $2^{1/4}$, as 1.1892 was sufficiently close that I decided to include it. Also, recognizing that the uncertain textbook values for r_1 indicated poor precision, I expected that the balance of the error might be in the value of r_1. The form of the gravitation equation now became

$$G = 2^{1/4} \pi N_A r_1^4 c^2/(6 \text{ cm}^3). \quad (2\text{-}23)$$

Several years after the initial development of Equation (2-23), I returned to a re-examination of the derivation in light of the many subsequent developments; such as, discovery of the "probability actualization factor", the factor β, the inverse coupling of a mass-unit volume and total universe mass, and the inverse structure relationship that makes each structural unit be a source of outgoing universal field. This brought about several changes in the derivation as follows:

1. With the mass being the interaction result inside of the structural unit's

exterior boundaries, each unit became a source of outgoing radiation. This has the effect of altering the effect of the separation distance between the two particles from $(r_1^2/4\ d^2)$ to (r_1^2/d^2). This amounts to a four fold increase in magnitude of G.

2. Each mass-unit being a radiation source eliminated the double shadow effect in the earlier derivation that had resulted in a coefficient of two in the expression. The combination of this with the effect above decreased the net increase in estimated energy by a ratio of two.
3. In the original derivation I had assumed that there were equal real and imaginary volumes, each with equal energy density, so that the net effect was a vector sum in a square root space. This yielded a factor as $(2^{1/2})^{1/2}$, or $2^{1/4}$. In the new approach I found it difficult to reconcile this as a pure geometric effect. Eventually I looked at it differently, as a probability effect related to the fact that we were computing the energy and intensity on the basis of total energy flow from all directions, yet the gravitation coefficient represented the effect perceived in one direction at a given instant. On this basis, the effect computed was a total space effect in all directions, with a probability of one. For information content comparison purposes this can be represented by a factor 2/2, where the numerator and denominator each are the factor for the total probability actualization factor for the whole. The energy flow is in four directions, so that any one direction represents one fourth of the total probability. In information terms, this represents a ratio of $2^{1/4}$. This is a less than total effect, and it makes the probability factor become $(2^{1/4}/2)$.
4. Comparison of the net effect of the changes in factors between the two derivations then shows that the Equation (2-23) remains unchanged. The older factors in the derivation were:

$$(1/4)(2)(2^{1/4}) = (2^{1/4}/2). \qquad (2\text{-}24)$$

The newer derivation values for these same factors were:

$$(1)(1)(2^{1/4}/2) = (2^{1/4}/2). \qquad (2\text{-}25)$$

The net result of reviewing the derivation was that Equation (2-23), in its original form, remains as a valid expression for the relationship between the general gravitation coefficient G and the radius of mass-units.

At the time of first arriving at the above form of Equation (2-23), the numerical evaluation, made by using the 1973 standards and the postulated value of 1.19×10^{-13} cm for r_1, was

$$G = 6.7582 \times 10^{-8}\ \text{dyne cm}^2\ \text{g}^{-2}\ . \qquad (2\text{-}26)$$

It was recognized that this value was very sensitive to the accuracy and precision of a value for the mass-unit radius r_1, so a search for some theoretical way to compute r_1 was undertaken. As a start, the observed value G was put into Equation (2-23) and the required probable value of r_1 estimated. This estimate was

$$r_1 = 1.18618 \times 10^{-13} \text{ cm.} \quad (2\text{-}27)$$

2.2. Mass-Unit Radius

As a start in the direction of a theoretical calculation of r_1, it was recognized that it should be related to the quantum length (L_h) that corresponds to the energy of a mass-unit. Since we have four field function intersections per cycle, because of two rotation directions and two flow directions, it was assumed that a factor $\pi/2$ ought to enter somewhere in the relationship. Then, there should be some factor that is related to electromagnetic aspects and to frequencies or wavelengths. A wide variety of possible factors were tried, and finally e^{-1} was selected as most likely to fit numerically.

At this point there were three factors L_h, $\pi/2$, e^{-1}. I felt there ought to be something relating to dimensionality. If the matter or space were four dimensions complex, there would be eight dimensions, but if the ratio between the real and the imaginary coefficients were specified to be identical for each of the four basic elements at local-cosmic-rest, then the eight dimensions system would only have five free parameters at local-cosmic-rest, for a fraction 5/8. How to use this was a problem for a long time, until a probability approach was considered and the factor adopted was $2^{5/8}$. Now, combining all four factors yields,

$$r_1 = L_h \pi e^{-1} 2^{5/8}/2 . \quad (2\text{-}28)$$

This was a crucial element in further progress. It was only later that I discovered other places where a factor similar to the $2^{5/8}$ was needed. Then, I needed to think through its implications and its potential importance as the "probability actualization factor".

Taking into account the nature of L_h, there are other forms of Equation (2-28) as:

$$r_1 = h \pi e^{-1} 2^{5/8}/(2 m_\mu c), \text{ or} \quad (2\text{-}29)$$

$$r_1 = h N_A \pi e^{-1} 2^{5/8}/(2 c). \quad (2\text{-}30)$$

Using the 1973 standard values for h, N_A, and c yielded

$$r_1 = 1.186\ 193 \times 10^{-13} \text{ cm.} \quad (2\text{-}31)$$

Then, using this in the gravitation Equation (2-23) yielded

$$G = 6.672\ 11 \times 10^{-8} \text{ dyne cm}^2 \text{ g}^{-2}. \tag{2-32}$$

This value was now in excellent agreement with the measured value of G, being far less than one standard error from the measured value, and I set it aside to work on other aspects.

2.3. Total Universe Mass

In General Relativity, the total universe mass is considered to be involved in the value of the Newtonian gravitation constant G. It was also Mach's opinion that this was so, and Eddington's derivation of G in his Fundamental Theory also involved the total universe mass. Accepting that this might be so, we examine the gravitation equation, and some factors considered along the way in the derivation. First, we look at the units of structure, or rather at mass-units, to see if there is some basic way of understanding more about the nature of gravitation.

We have employed a concept of a flowing universal field that is everywhere uniform. If our system is not to be infinite, this flow must be a closed system with the field circulating through it. A possibility is that it is a finite system of mass-units, with the gravitational field being the result of an inverse feedback effect, from each particle, that stabilizes the whole structure.

It had been hypothesized that, in "empty space", the interaction between opposite flowing universal field components averaged zero energy over some small interval of time and distance, except for the small component that is the gravitational field. If we estimate the total universal field energy, then it must be the sum, in our perceived universe, of the energy-equivalent of all matter units, plus position and velocity energy and energy of all ordinary radiation. If every mass-unit contributes equally to the feedback, and the feedback totals the entire circulating energy, then, there must be a relationship between the feedback fraction and the total number of units contributing to the feedback.

Before proceeding farther, I want to make some remarks about the whole process of discovery of the equation for the gravitation coefficient, and the subsequent development of a whole theory of cosmology and structure of the universe (both on a macro scale and on a micro scale). There have been a number of fortuitous circumstances, a considerable number of intuitive choices of paths to investigate, coupled with a vague intuitive feel for the structures and the geometry involved. The results are not due to any high level of skill in any area, but to a broad general knowledge coupled with the intuition and fortuitous circumstances. I mention the foregoing at this point, because what follows illustrates some of these facets. The first is the choice of the cgs system of units. If I had worked with MKS or SI units, some of the relationships might not have been noted, and the whole theory would not exist. The next factor is also related to units. If our unit of energy had been defined differently, or if our unit of length (the centimeter) had not been quite close to the cosmic standard unit L_s, the relationships could have been concealed by scale factors that might have caused potential relationships to be missed. (See Section 4. for explanation of L_s.)

At this point, it is necessary to note that the initial simple concept of mass had been altered to reflect the fact that mass is the interaction result of two field flows; one flow coming from the outside and one coming from somewhere else. The mass concept was now approaching the concept of mass described in Sections 1.2. and 1.4. . Since the concept of flowing field was employed, there had to be a means to maintain circulation of both field flows. To eliminate the need for singularities in every particle, with infinite or near infinite flow densities, some other arrangement was necessary. The discovery of the inverse relationship between a mass-unit size and total universe mass-energy lead to the concept of a mass-unit structure interior being an inverse space. This, in turn, required the existence of counter-balancing negative matter and negative space. Then, if we use I_0 as the intensity of one of the fields, the squared volume enters into the determination of mass.

In examining how particle 2 affected the universal field, to radiate a gravitation field, there were two factors: its mass and a factor proportional to its direct effect (A_2) which was equated with its volume. Mass was assumed also at that level to be field intensity multiplied by volume. Thus, taking these two volume components into account yielded volume squared as the proportionality factor between total field intensity and gravitational field intensity. The feedback factor then, prior to discovering the involvement of the factor β, was $(4\ \pi\ r_1^3/3)^2$. The feedback factor was then combined with the energy of a single mass unit:

$$m_\mu\ c^2\ (4\ \pi\ r_1^3/3)^2. \tag{2-33}$$

(See Equation 2-41 for final form.)

The constant c is dimensionless at the fundamental level. The factor in parenthesis is of dimension cm^6. In common usage, mass is considered to be of dimension cm^{-3}, however after examining the implications, I elected to consider mass as being of dimension cm^{-6} (in a unit of time) at this mass-unit level. As a result, the above is a dimensionless ratio number. Then, if this feedback fraction is dimensionless, its inverse can be equated to the total number of mass units in the field (N_u), using r_1 derived from the 1973 CODATA h:

$$N_u = [m_\mu\ c^2\ (4\ \pi\ r_1^3/3)^2]^{-1} = 1.370\ 8596 \times 10^{79}. \tag{2-34}$$

In looking at this large number, I recognized it as being the same order of magnitude as Eddington's cosmical number N, so I considered it worth investigating that finding further. (See Section 1.2. .)

The calculation of this number N_u was based upon the value of r_1 derived from the then current (CODATA 1973) value for Planck's constant, thus, it involves the current mass of the universe in mass-units. We convert the number of mass-units to grams by dividing by $N_A = 6.022045 \times 10^{23}$ (1973 CODATA N_A value), to yield the total universe mass:

$$M_g = 2.276\,403 \times 10^{55} \text{ grams, or} \tag{2-35}$$

$$E_g = 2.045\,929 \times 10^{76} \text{ ergs.} \tag{2-36}$$

The above three Equations (2-34, 2-35, and 2-36) all imply duration in terms of the existence time; that is, equivalent to the atomic time unit, or to the linear equivalent of universal field time to transit a mass-unit radius. Ordinarily, mass is defined as a time-independent property of matter, so we drop reference to the time unit and just call M_g total current gravitational mass of the universe. This has been discussed in Section 1.2. as M_g.

An estimate of the solar composition by McCrea (1978), is 70% hydrogen, 28% helium, and 2% other. If we assume the average composition of the universe, at the present age, to be similar, then the total mass of the universe can be computed. Using the number of structural units permitted in wave function space (N_w), and an average mass per structural unit computed from the observed composition, (assuming the average of the "other" matter is the same as Carbon 12, or 1.0 mass-units per structural units), then,

$$\text{Mass per structural unit} = 1.005\,6601\ m_\mu. \tag{2-37}$$

This yields a total universe mass estimate as

$$M_g = 2.276\,56 \times 10^{55} \text{ g.} \tag{2-38}$$

This compares very well with the value for Equation (2-35).

Re-examining the equation used to compute the mass of the universe from the theoretical gravitation coefficient, Equation (2-34), we see that it can be rearranged, using N_u as the total number of mass-units, to

$$N_u\, m_\mu\, c^2 = (4\, \pi\, r_1{}^3/3)^{-2}, \text{ or} \tag{2-39}$$

$$(4\, \pi\, r_1{}^3/3)^2 = 1/(M_g\, c^2). \tag{2-40}$$

<u>It was later recognized, when the factor β was discovered, that the proper form is</u>

$$(4\, \pi\, r_1{}^3/3)^2 = 1/(\,\beta\, M_g\, c^2) = V_1{}^2. \tag{2-41}$$

This is a very important relationship. It confirmed my assumption of cm^{-6} for the dimension of mass, and it established a basis for considering inverse symmetries in the total universe structure.

Replacing r_1 by its expression in terms of Planck's constant, (Eq. 2-29 or 2-30), a further rearrangement of Eq. (2-41) yields

$$M_g = 9\, c^4\, e^6/(2\, \beta\, h^6\, N_A{}^6\, \pi^8\, 2^{3/4}), \text{ or} \tag{2-42}$$

$h = [9\ c^4\ e^6/(2\ \beta\ M_g\ N_A{}^6\ \pi^8\ 2^{3/4})]^{1/6}$. (2-43)

This implies that we can determine the value of Planck's constant at any age, if we know the mass of the universe at that age. The mass (M_g) of the universe at any given age is a function of the initial mass at emergence and the universe age phase angle ϕ, as indicated by Equations (1-12) or (1-13). Thus, there is a fixed relationship between the value of Planck's constant and Universe age.

2.4. The Factor β

Over a year after developing the form of the expression for gravitation represented by Equation (2-23), the 1976 determination of G by Luther et al was encountered. This lower value appeared to have been determined with such improved measurement techniques, that I felt it necessary to see if some change in the theoretical approach would yield a value close to this new tentative value of G = $(6.6699 \pm .0014) \times 10^{-11}$ N m^2 kg^{-2}. This is 6.6699×10^{-8} dyne cm^2 g^{-2}. The experimental technique involved, in the tentative value for G, was to accelerate the whole torsion balance system in rotation, so as to just balance the gravitational torque generated upon the small pendulum element. Motion of the pendulum was sensed to control the system acceleration. In effect, some of the dimensions of the pendulum's mass did not matter precisely. It became a null detector system, which altered the total dimensionality in the experimental measurements.

The derivation that follows represents an abstract theoretical value which I call G*. It starts with the same kind of a two-particle system as considered before, with the mass of particle 1 expressed in energy terms as $m_\mu c^2$. This mass is the result of interaction of ingoing and outgoing universal field components. The two sets of field components are equal, so the outgoing components are proportional to the square root of the mass-energy. This is $(m_\mu c^2)^{1/2}$. In using the term "mass", we are describing the mass-unit's volumetric orthogonal-space intercept of universal field interaction energy in one atomic time unit. This volume is described in terms of r_1, which is different than the linear unit L_h, so we need to take the ratio of these two into account when we take the square root of mass-energy, to get the field quantity in square root time. This yields a composite field effect factor as :

Particle 2 field effect = $(m_\mu c^2 r_1/L_h)^{1/2}$. (2-44)

Particle 1 has a similar universal field intercept effect to particle 2, and taking the separation distance (d) into account, the interaction effect, inside particle 1, is proportional to

$(m_\mu c^2 r_1/L_h) r_1^2/d^2$. (2-45)

The above is in an atomic time unit, and needs to recognize the length of an atomic time unit in cms, so we divide by L_h, to convert it to instantaneous energy content per cm^3.

Energy density = $(m_\mu c^2 r_1/L_h^2) (r_1^2/d^2)$. (2-46)

Then, converting to radiation pressure per sq. cm, we have:

$P = (m_\mu c^2 r_1/L_h^2) (r_1^2/d^2) (1/3)$. (2-47)

The question now is, what cross sectional area is affected? If we were dealing with ordinary sphere, this would be πr_1^2. Assuming toroids with maximum radius of the region swept out in rotations as r_1, we compute the average of the three toroid cross section areas: πr_1^2, $2 \pi r_1^2/4$, and $2 \pi r_1^2/4$. The time average value for rotation in all three directions would be $2/3 \pi r_1^2$, seen from any one direction. The interior dimensions must also reflect the fact that we are dealing with an aspect of duration, which is perceived as L_h. Combining this duration effect with the average area, yields a composite effective cross section area subject to the pressure as,

Area = $2 \pi r_1^2 L_h/3$. (2-48)

The computed force then becomes:

$F^* = - [m_\mu c^2 r_1^3/(L_h d^2)] (2 \pi r_1^2/9)$. (2-49)

When simplified, this reduces to:

$F^* = - m_\mu c^2 r_1^4 \pi^2 e^{-1} 2^{5/8}/(9 d^2)$. (2-50)

Converting this force between two isolated mass-units to that between two one-gram masses, and then equating with the standard Newtonian gravitation expression, we find

$G^* = 2^{5/8} \pi^2 N_A r_1^4 c^2 e^{-1}/9$. (2-51)

This, also, should have the cm^{-3} factor adjustment similar to the original derivation, and becomes

$G^* = 2^{5/8} \pi^2 N_A r_1^4 c^2 e^{-1}/(9 cm^3)$. (2-52)

Numerically evaluating the above, using the 1973 standards, yields

$G^* = 6.666\ 737 \times 10^{-8}$. (2-53)

This value is almost as much lower than the Luther et al (1976) value, than that value is below the value computed by Eq. (2-23). Incidentally, the above value is very close to the value computed by Eddington for the theoretical value of G as

$G = 6.6665 \times 10^{-8} \pm$ one part in 5000. (2-54)

On the basis of the similarity with Eddington's theoretical value for G, I decided that Equation (2-51) must represent an unmeasurable theoretical value also; in particular, that it's differences were related to the conversion of inaccessible interior aspects of volume to exterior measurable aspects. Then, depending upon the nature of the tools involved in measurements of G, we could have answers varying between the limits of Equations (2-23) and (2-52).

The ratio of Equations (2-23) and (2-52) is

$$\beta = (3/4)\,(e/\pi)\,2^{5/8} = 1.000\ 805\ 353\ 672\ 043\ \ldots \qquad (2\text{-}55)$$

Then, since mass is of dimension cm^{-6} in a dimensional sense, two techniques differing in critical dimensionality by cm^3, could yield results differing by $\beta^{1/2}$. The factor β is applied as a mass or energy multiplier in the process of converting or equating internal mass-energy to lengths. In the particular case of the tentative value of G determined by Luther et al (1976), it appears that the technique might be different by cm^3 from the technique of the 1973 standard. By adjusting the 1976 value upward by $\beta^{1/2}$, it yielded

$$G_{adj} = 6.67259 \times 10^{-8} \text{ dyne cm}^2\text{ g}^{-2}. \qquad (2\text{-}56)$$

Several years later, a new determination of G was made by Luther & Towler (1982) with the same major masses, and much of the remaining physical system being the same as in the earlier (1976) determination. The technique of measurement was returned back to that of measuring the period of a torsion-balance pendulum, which is a full direct mass to mass effect being measured. The result of the (1982) set of determinations was reported as

$$G = 6.67259 \times 10^{-8} \text{ dyne cm}^2\text{ g}^{-2}. \qquad (2\text{-}57)$$

The agreement of Eq. (2-57) with the value predicted in Eq. (2-56) represents experimental validation of both the existence and the magnitude of the factor β.

These results were discussed with G. G. Luther, and he suggested I examine the technique in a somewhat similar earlier determination of G reported by Pontikis (1972). The apparent dimensional difference here was less, but when the reported value was adjusted for the difference, the new result comes much closer to the Luther & Towler (1982) value than it had been.

Eddington's analysis and derivation of the general gravitation coefficient G was based upon the assumption of cm^{-3} for the dimensions of mass. Two masses are involved in G. As a result Eddington's analysis missed a cm^{-3} for each mass, or a total of cm^{-6}. At this level the required adjustment is a whole value of β. The Luther et al 1976 value appears to have lost an aspect of cm^{-3} in the pendulum's response by eliminating the pendulum oscillation. This is at the level of $\beta^{1/2}$. In the Pontikis setup, with a resonant pendulum coupled to the pendulum that was affected by the driven major mass oscillations, it appears that only one dimension is affected, requiring an adjustment at only the $\beta^{1/6}$ level.

These various results are summarized in the following table, including the adjustments required by the CODATA 1986 revisions.

Table 1
Summary of Values for General Gravitation Coefficient G

Source	Date	Value (dyne cm^2g^{-2}) x 10^{-8}	Std Error (ppm)
Eddington Theoretical	1949	6.6665	200
Eddington Theoretical (adjusted by β)	1949	6.6719	200
CODATA 1973	1973	6.6720	615
Luther et al	1976	6.6699	210
Luther et al (adjusted by $\beta^{1/2}$)	1976	6.67259	210
Luther & Towler	1982	6.67259	75
Pontikis	1972	6.6714	90
Pontikis (adjusted by $\beta^{1/6}$)	1972	6.6723	90
CODATA 1986	1986	6.67259	128
Computed G (CODATA- 1973 h & $_{NA}$)		6.672109	33
Computed G (CODATA 1986 h & N_A)		6.672212	3.8
Computed G (based on Theoretical h & N_Z)		6.672215	1.2

The form of the equation used for the computed G values in the above was:

$$G = 2^{3/4} h^4 N_A{}^5\pi^5/(24 c^2 e^4 cm^3), \text{ or} \qquad (2\text{-}58)$$

alternatively using the computed theoretical value for the number of lcr mass-units per gram (N_Z) where appropriate, with the corresponding computed value for h. A simplified form of the above, combining all well known constants into a single factor, is

$$G = (h N_A)^4 N_A (4.370\ 099\ 0953 \times 10^{-22})/cm^3). \qquad (2\text{-}59)$$

The gravitational force is such a fundamental effect, that it can be expressed in a variety of forms, and can even be derived by different methods, once its nature is recognized. For example, if we consider the connectivities involved, the value of G can be derived by the following path.

We assume the perceived universe is finite, with N_u equivalent units of mass. We assume that each mass-unit is coupled to every other mass unit in the perceived space by a direct coupling, and to every unit in the negative space by an inverse coupling. The magnitude of the total negative matter coupling to one particle is equal to the coupling to one particle in the perceived universe. Then, there are Nu - 1 direct couplings to any one particle.

At the most elementary level, we can treat the problem as dealing with a single mass-unit and its coupling interactions. We have

$$[(N_u - 1)/N_u]\,[(M_g c^2)/N_u] = m_\mu c^2, \quad (2\text{-}60)$$

for the coupling energy, as the total for a single unit m_μ. This defines the energy of a mass-unit m_μ. The negative coupling then is the portion:

$$(-1/N_u)\, M_g c^2/N_u = - m_\mu c^2/N_U. \quad (2\text{-}61)$$

To have a gravitational effect, the radiation of the negative coupling must interact inside some other particle. It interacts with the total outgoing gravitation component in the other particle. The energy is the product of ingoing and outgoing components, so what radiates outward is proportional to a square root. Likewise this interacts with a field proportional to a square root in the other particle. The separation distance (d) reduces the effect to being proportional to r_1^2/d^2. Combining these factors, we have a total interaction I_t as

$$I_t = -(m_\mu c^2/N_u)\, r_1^2/d^2. \quad (2\text{-}62)$$

These effects occur within the volume of the unit, so to convert to an intensity, we divide each of the two unit's contributions by their unit's volumes,

$$I_v = - (m_\mu c^2/N_u)\, [3/(4 \pi r_1^3)]^2\, r_1^2/d^2. \quad (2\text{-}63)$$

This expression is in terms of the energy content of a mass-unit. To re-express it in terms of "per mass-unit", we divide out by the energy of a mass-unit,

$$I_\mu = (1/N_u)[3/(4 \pi r_1^3)]^2\, r_1^2/d^2. \quad (2\text{-}64)$$

One of the new relationships discovered, Equation (2-41), indicates that the square of the volume of a mass-unit is equal to the inverse of the mass-energy of the total universe. Then,

$$I_\mu = - \beta\, m_\mu c^2\, (r_1^2/d^2). \quad (2\text{-}65)$$

The interaction energy is distributed throughout the particle volume. We divide by a mass-unit volume, and then ordinarily multiply by 1/3 to convert to pressure in dynes per square centimeter, but in this case we have a mass volume as a six-space, so the conversion factor to pressure is $(1/3)\mathrm{cm}^{-3}$. The area upon which the pressure acts is πr_1^2. Combining these effects, we have

$$F = - \beta\, m_\mu c^2\, \pi r_1^4/(3\, d^2\, \mathrm{cm}^3). \quad (2\text{-}66)$$

The force has been calculated on the basis of total energy from the connectivities in all directions. The force that we encounter or measure at any one instant is in one direction, when expressed in the form of the usual gravitation effect between two separate masses. The total force represents a total probability, which is the result of flow in four directions. The probability effect for a single direction would be one fourth, for a probability actualization factor of $2^{1/4}$ instead of the factor 2 for a total probability. The result is a modifier of magnitude $(2^{1/4}/2)$. Incorporating this yields

$$F = - [\beta\ m_\mu\ c^2\ \pi\ r_1^4\ 2^{1/4}/(6\ d^2\ cm^3)]. \qquad (2\text{-}67)$$

Converting to masses in grams, and equating to the Newtonian gravitation expression, yields

$$G = \beta\ N_A\ \ \pi\ r_1^4\ c^2\ 2^{1/4}/(6\ cm^3). \qquad (2\text{-}68)$$

The value of β is 1.000 805 354 when dimensional differences of cm^6 exist, but when total direct mass to mass effects are involved, as they are in the stationary torsion-balance pendulum system, with no dimensionality differences, its value is exactly $\beta^0 = 1$. This reduces the equation to the same value as derived earlier as Equation (2-23). We must be very careful where and how β is applied.

The basic form of the gravitation expression (Eq. 2-23) can be transformed by replacing r_1 by its value in terms of Planck's constant h. This yields

$$G = 2^{3/4}\ h^4\ N_z^5\ \pi^5/(24\ c^2\ e^4\ cm^3). \qquad (2\text{-}69)$$

This equation, like almost everything else in the new approach, has been derived for the conditions of our normal perceptions. Our perception of gravitation represents a continuing and unvarying force: something with continuity of existence in time. Our practice with such things as mass, with continuity of existence, is ordinarily to ignore the time continuity aspect in developing the equations. What we are doing in the ordinary approach is to analyze the situation in terms of "per minimum time unit". Such a continuing entity is unchanged from instant to instant so long as the instant of comparison or perception is at least as long as a minimum time unit, and the effect is considered time-free in the perceived form. In its totality, however, when we consider stability or fixed value in respect to long cosmic time intervals, it requires that we consider which of the factor dimensions contain effects of universe mass variations with age. Looking back at Eq. (2-43) and examining its dimensionality, we find :

$$h \approx (cm^{-6}\ cm^{36})^{-1/6}, \text{ or } \approx (cm\ cm^{-6}) = cm^{-5}. \qquad (2\text{-}70)$$

It is only the cm derived from M_g that involves a function of the cosmic age.

Then in Eq. (2-69), the cosmic age variability is contained in the factor h^4 as abstract cm^4 (since it was suggested that the adjustment factor cm^{-3} entered into equation (2-23) was something internal in a mass-unit, and which was specified to be fixed in a cosmic life cycle). The effective age variability then appears to be

$$G = G_0\ /(1 - \alpha\phi/\pi)^{2/3}, \qquad (2\text{-}71)$$

because only the factor h^4 contains age variability:

$$h = h_0/(1 -\ \alpha\phi/\pi)^{1/6}. \qquad (2\text{-}72)$$

This can be seen in Equation (2-43), showing the dependence upon the current universe mass M_g. A comparison of the numerical value for G_0, computed from fundamental constants at the emergence state, with the current age value of G, confirms Equation (2-71), which also verifies that the adjustment factor cm^{-3} must have represented a component of unit-mass when it was introduced during the derivation of Equation (2-13), after the need was demonstrated in Equation (2-12).

The emergence value of the gravitation coefficient (G_0) can be computed by replacing h in Equation (2-69) with the fundamental defining relation as Eq. (2-43). In doing so I have left in the theoretical value N_Z in symbolic form to yield some additional insight. When this is simplified with all known constants except N_z combined into a simple numerical factor, we obtain:

$$G_0 = (N_z^{5/3})\,(1.548\ 926\ 5085 \times 10^{-47}\ cm^{-3})\ dyne\ cm^2\ g^{-2}. \qquad (2\text{-}73)$$

One implication of this expression is <u>that the value of N_Z is determined by the size of our fundamental standard units of cm, g, and sec, or their equivalent cm, g, and c, at emergence.</u>

If we want to find out how G changes per unit time, we differentiate Eq. (2-71) with respect to ϕ and then divide by Eq. (2-71). This yields

$$dG/G = \{(2\ \alpha)/(3\ \pi\ )\}(1 - \alpha\phi/\pi)^{-1}\ d\ \phi\ . \qquad (2\text{-}74)$$

The rate $d\phi/dt$ is given by Equation (1-59) as $3.668\ 933\ 706 \times 10^{-18}$ rad sec^{-1}. Multiplying this by the number of seconds ($3.155\ 693 \times 10^7$) in a standard SI year yields the change ($\Delta\phi$) for a year.

$$\Delta\phi = 1.157\ 8028 \times 10^{-10}\ \text{rad per SI year.} \qquad (2\text{-}75)$$

Using the current best estimate for the present age ($\phi/\pi = 0.455\ 554$), in Equation (2-74), we can compute the yearly rate of change in G. This is

$$dG/G = +\ 2.467\ 017\ 727 \times 10^{-13}\ \text{parts per year,} \qquad (2\text{-}76)$$

which is consistent with estimates for a rate that would be just out of reach of our current measurement technology.

Before leaving this section on gravitation, there is a potential question that must be addressed concerning the radius involved in one form of the equation for G. Equation (2-23) repeated here is

$$G = 2^{1/4}\ \pi\ N_A\ r_1^{\ 4}\ c^2/(6\ cm^3). \qquad (2\text{-}77)$$

The numerical value of r_1 utilized in computing G is the value of a mass-unit radius, yet matter particles involve neutrons, protons, and electrons. Should some composite radius average for the actual particle structure composing a given matter species be substituted for the mass-unit radius? I believe not; I think that the mass-unit radius, which is directly related to the units of the universal field, is the proper value. I expect that some more direct derivations of the expression for G will be developed by others and will prove it so. Equation (2-79) below, which is the equivalent to Equation (2-58), does not directly involve the physical structural-unit radius, but involves a combination of more fundamental characteristics as :

$$G = 2^{3/4}\, h^4\, N_z^{\,5}\, \pi^5/(24\, c^2\, e^4\, cm^3). \qquad (2\text{-}78)$$

Existing experimental results from tests of the effect of different materials upon the response to changes in intensity of the gravitational field: the Eötvös experiments and the Roll, Krotkov, and Dicke experiment, imply that masses with different ratios of neutrons, protons, and electrons, all respond in an identical linear manner to changes in field intensity (Misner, Thorne, & Wheeler 1973 Box 1.2). These results are not sufficient to answer the question raised above, but some of the findings in the process of developing equations to compute the charge of the electron in Section 3. suggest that there are internal compensating factors such that it is the total mass resulting from universal field interactions that governs the responses of individual particles. With universal field interaction-product volumes governing the response, rather than the shape of the volumes involved, the natural volume unit is related to the volume of a universal field interaction unit, and r_1 is directly related to a unit of field interaction volume.

2.5. Gravitation and Phase Angle

In linear motion of matter units, the direction of motion relative to local-cosmic-rest establishes the direction in which the coordinates of the field and matter interaction separate into real and imaginary coefficients relative to the universal field flow in the same direction. The universal field flow at local-cosmic-rest may actually be complex compared to some more fundamental coordinate system, but to our ordinary perceptions it is perceived as the magnitude only and this is accepted by our perceptions as being real. Then, relative motion introduces a phase angle displacement which is resolved into a real and an imaginary component. The real is the projection of the complex coefficient upon the perceived lcr flow as $\cos\theta_p$. For ordinary matter in linear motion this is a single dimension effect as discussed in Section 1.4., with uniform motion in any three-space direction representing a phase advance of the incoming universal field in the direction of motion, with respect to the phase of the portion of field coming from the particle interior.

A given direction of three-space motion and its exact opposite each result in the same amount of phase shift, so that the sign of the direction of motion relative to any fixed reference frame has no effect upon the magnitude of the resultant phase shift angle θ_p , and hence the projection upon the perceived real axis is the same. It is the result of a quadratic effect, where $v^2/c^2 = \sin^2\theta_p$, and the maximum value of $\theta_p = \pi/2$, with a minimum of $\theta_p = 0$ for a velocity based phase shift.

From our ordinary experience, and from the analysis of gravitation in the earlier part of this section, we have some clues as to its mode of operation. By the new approach, a gravitational field appears to result from a phase lag in one component of the outward flowing universal field coming from matter units. The phase lag is in the direction of motion of the field flow in the positive time sense. The positive time sense is associated with outward flow into perceived space from mass-units. The intensity of a gravitational field from a collection of matter, at a given radial distance from the center of mass of the collection, appears to increase linearly with the mass of the collection. The conventional expressions for the field intensity at a given radial distance appear to have no upper limit, so long as the reference point radial distance is outside of the source mass radius. A direct implication from this is that the presence of a high gravitational field has no effect upon the field strength contribution of additional matter being brought into contact with a large source mass. If the added matter is at rest relative to the large field source mass, then it is at the same state relative to local-cosmic-rest as the large source mass. If matter is added to a gravitational system in the form of an orbiting mass in a stable circular orbit, the contribution of the added mass is its lcr rest-mass adjusted for its initial velocity relative to the system, and for any initial potential energy relative to the field source prior to its becoming a part of the system. When the added matter is on the surface of a central field source mass it has potential energy relative to the center of mass. Since it is at the same state relative to lcr as the central source mass, then the effect of the potential energy is to neutralize the gravitational field effect of the source upon the internal state of the added matter. Thus, both potential energy of field position and kinetic energy of motion can act against the phase shifting aspect of a gravitational field with respect to the internal state of the matter relative to lcr. Potential energy of matter in a gravitational field must be taken into account together with kinetic energy of motion, when using matter response to measure the intensity of a gravitational field at a given radial distance.

The field interaction effect of matter motion relative to lcr and the effects of a gravitational field differ considerably. Motion of matter relative to the state of local-cosmic-rest shifts the encountered phase of the incoming perceived-space universal field components in the direction of motion. This adds a phase shift to that component, which then can pass into the matter-unit interior, where it shifts the phase of the interior interaction with the field components coming from the negative universe region. The effect is in the direction of matter motion and affects a single dimension of the volume interaction. Seen from the exterior of matter units, a length in the direction of motion is perceived as its projection upon the lcr direction, however, perceived mass is a function of inverse volume, so, the mass effect perceived is the inverse of a velocity effect upon perceived length or time.

The effect of a gravitational field seen from lcr is a phase lag of the component of universal field in the direction of the center of mass of the field source matter. The field that matter interacts with in the presence of a gravitational effect has one of the physical length dimensions with a shifted phase, so that it is no longer the same as the normal lcr universal field. As a result, when matter is in motion in a gravitational field region, the field that the matter interacts with is the phase shifted field. When perceived from the normal state of lcr, the starting point for perception of velocity effects is the phase lag affected universal field. The phase advance effect of motion then starts from the delayed phase, and the perceived effect is the result of addition of the two phase angles. The phase shift angles are additive, but the individual effects are multiplicative, so that it is the product of the two effects that is perceived. This requires that the effects of gravitational field be in the inverse direction in magnitudes to the effects of matter motion. As a result, if we use the effects of fields upon matter velocity as a measure of gravitational field intensity, the gravitational intensity will be expressed as a negative phase angle or an inverse velocity function. There is an additional qualification to the differences in the two effects. The effect of velocity of matter is a single dimension effect in the direction of motion, while the effect of gravitation is involved with the perceived space universal field as a whole, so that the magnitude of its interaction with matter in motion is the same regardless of the direction of motion, even though the gravitational force effect is manifested in the direction of the field intensity gradient.

The above phase relationships are what appears to be necessary to make the two types of interactions agree with our perceptions. An implication of these perceptions is that we are seeing complex flows expressed in exponential form, where a positive phase displacement results in a multiplicative action, and a negative phase displacement results in a divisor action. Thus, while the phase displacements as angles combine arithmetically considering sign, the effect upon our perceptions of interaction with matter is the product of the individual effects for the combination of the effects of velocity and a gravitational field.

The presence of a gravitational field alters the total interaction between matter units and the universal field. Gravitation has been described as a phase lag effect of the outgoing field from matter particles, which interacts with incoming field in space to yield imperfect cancellation, and hence a small residual universal field interaction effect. Because the outgoing field is late, the incoming component predominates (when seen from the state of lcr) and results in a negative energy potential. The field modification due to the presence of field source mass extends in all three-space directions, with intensity or magnitude decreasing with the inverse square of radial distance to the source. When it is sensed in any one particular direction, the magnitude of the field effect is a single dimension effect in that direction, with an effect upon mass kinetic energy that is the inverse of the effect of velocity upon mass for a given magnitude of phase angle displacement.

The effect of velocity upon length and time is

$l = l_0 \cos \theta_p$, and (2-79)

$t = t_0 \cos \theta_p$, (2-80)

with l and t being the projection of the magnitude of length and time units in the moving system units upon the observer rest frame units. Since mass and energy are a function of inverse lengths, the effect of linear velocity upon these characteristics is

$m = m_0/\cos \theta_p$, and (2-81)

$E = E_0/\cos \theta_p$. (2-82)

Thus, mass in a moving system appears to the observers perceptions as though one of its dimensions was affected in the inverse direction to the effect of motion upon length units. In contrast, <u>the effect of a gravitation field seems to be the inverse of the effect of linear motion</u> in that a combination of potential energy and motion in a circular orbit in a gravitational field can yield results that imply the moving mass is at the state of lcr.

A gravitational field seems to affect the perception of mass and energy the same as linear motion affects the perceptions of length and time seen from lcr. The effect of linear motion is a single dimension effect in the direction of three-space motion but the effect of a gravitational field is also single dimensional in any given direction, but independent of the direction of motion. This yields an apparent single dimension effect as

$m = m_0 \cos \theta_g$, and (2-83)

$E = E_0 \cos \theta_g$, (2-84)

where θ_g is the magnitude of the phase lag angle due to the gravitational field.

Its effect upon length and time in the field is

$l = l_0/\cos \theta_g$ and (2-85)

$t = t_0/\cos \theta_g$ (2-86)

In the process of adopting a relative velocity parameter in the form of a hyperbolic angle for use in adding velocities, so as to preserve the length of interval in our perceived spacetime four-space geometry, some additional relationships were established. These relate phase angles to the velocity parameter, as the effect of rotations or angles in the implied but hidden complex background structure of space and time. Using θ_v as the hyperbolic velocity parameter, where $v/c = \tanh \theta_v$, then $|v/c|$ is also sine θ_p, with θ_p as the velocity-process phase angle displacement. We also then have

$$\cos \theta_p = (1 - v^2/c^2)^{1/2}, \tag{2-87}$$

$$\cosh \theta_v = 1/(1 - v^2/c^2)^{1/2}. \tag{2-88}$$

Then,

$$1/\cos \theta_p = \cosh \theta_V = \cos \theta_g\, i. \tag{2-89}$$

The basic mathematical group is anti commutative in multiplication, and this must be considered when interchanging θ_g and i.

We measure or infer effects by what we perceive as the response of matter structures. The gravitational field interacts with matter to produce observable effects. It is by these effects that we characterize the field intensity. The system of matter units in a gravitational field is conservative. Matter units, starting at rest at infinity, have an energy relative to the field source as zero. As matter responds to the field, it maintains a total energy of zero, consisting of field potential, matter potential energy (P.E.), and matter kinetic energy (K.E.). The effect of the field intensity is to induce an energy level in the matter that corresponds to the field potential level per unit mass, but of opposite sign. The energy level change in the matter units can consist of both potential energy and kinetic energy of motion. It can be all kinetic energy, as in the case of the limiting orbit form of a parabola, or in radial free fall, or it can be half kinetic and half potential as in the case of circular orbits, or it can be all potential energy as in the case of an object suspended motionless in the field, such as an object at rest on the surface of the central gravitational field source-mass.

A gravitational field effect is the result of an altered universal field flow, that is different than the state of local-cosmic-rest, interacting with the interiors of matter units. This forms a new level for reference that is basic and different than that perceived at the state of lcr, and due to a lower total energy level under the field conditions than in regions free from the gravitational field. The constancy of the sum of the field effect potential and the energy content of matter structures, per unit of lcr rest mass at zero, implies a balance. The result of this balance requires that the particles of matter in the field must be at the same state relative to lcr as the whole gravitational system. We need to explore how this state comes about in the presence of obvious motion in orbiting mass that ordinarily generates a velocity phase shift. The situation for rest-mass free items such as photons is slightly different than for mass.

The intensity of a field force on matter units at a given radial distance is given by the standard force expression as

$$F = -G\, M\, m\, /R^2, \tag{2-90}$$

and its potential by the change in potential energy level as a matter unit moves from infinity inward to the radial distance (R) from the implied source. The change in energy level corresponds to the work done per mass unit on the matter units in the field as they move in the direction of R :

$$\Delta E = \int_{\infty}^{R}(GMm / R^2)dR \;=\; {}_{\infty}^{R}[GMm / R. \tag{2-91}$$

Treating m as a unit mass and M as the system field source mass, the field potential is the negative of the increase in matter unit energy ΔE. Then, the field potential (P) is

$$P = -\, G\, M/R \text{ erg gram}^{-1}. \tag{2-92}$$

The potential of the field is the same for matter and radiation, but the effects are different.

Free fall velocity in a gravitational field is one of its most obvious effects, and is a readily measurable form of energy, so we choose to relate field potential level to an implied velocity for comparison with the velocity energy of matter. For matter in motion relative to lcr, the change in energy level is given by

$$\Delta E = m_0\, c^2\, [(1/\cos\theta_p) - 1], \tag{2-93}$$

where θ_p is the phase angle representing the velocity with respect to lcr. Utilizing the infinite series approximation to the small-angle value for [(1/cos θ) -1] yields

$$\Delta E = m_0\, v^2/2. \tag{2-94}$$

For maximum velocity (in the small phase angle range) in situations where all the matter energy appears as kinetic energy, the relationship per unit of mass is

$$\Delta E = (1/2)v^2 = G\, M/R. \tag{2-95}$$

In orbits, we are dealing with a situation where the phase shift effect of the gravitational field neutralizes the phase shift effect due to velocity, so we remain in the small net phase angle region where K.E. = $m\, v^2/2$ for all velocities due solely to the gravitational field. The ΔE then is kinetic energy of the orbiting mass, which is derived from field potential at the orbit radial distance. It is

$$\text{K.E.} = m\, v^2/2 = (-P - \text{P.E.}), \text{ or}$$

for unit mass,

$$v^2 = -2(P + \text{P.E.}). \tag{2-96}$$

With P = -G M/R, this becomes

$$v^2 = 2[(G\, M/R) - \text{P.E.}]. \tag{2-97}$$

Then, for the general case of matter in orbit in a gravitational field, we have, for the matter contribution,

$$\theta_p = \sin^{-1}\{2[G\, M/R - \text{P.E.}]/c^2\}^{1/2}, \tag{2-98}$$

where the type of orbit determines the fraction of P that appears as potential energy of field position.

For a circular orbit, P.E. = -P/2 = G M/(2R).

For a parabola or free fall, P.E. = 0.

For elliptical orbits, the fraction as P.E. varies in different stages of the orbit, while the angular momentum remains constant.

For maximum velocity orbits the field contribution is a negative potential energy that balances the total energy (K.E.) of the moving matter. In this case, the equivalent gravitational matter phase shift angle θ_g is fixed by P as

$$v/c = i\,[2\,G\,M/(R\,c^2)]^{1/2} = i \sin x\,. \qquad (2\text{-}99)$$

By standard relationships,

$$i \sin x = \sin x\, i, \qquad (2\text{-}100)$$

and by reason of system anticommutativity,

$$\sin x\, i = \sin -i\, x\,. \qquad (2\text{-}101)$$

Then, the angular magnitudes are related as

$$\theta_g = -\theta_p. \qquad (2\text{-}102)$$

The meaning of the minus sign is that θ_g is an angle in the opposite sense of rotation from θ_p. Also, by Eq. (2-90) standard relationship, with equal angular magnitudes, the differences in the properties of the two types of angles relates their cosines as

$$\cos \theta_g = 1/\cos \theta_p. \qquad (2\text{-}103)$$

This the case for equality of the energy of motion with the negative of the field potential per unit mass. The phase angle effect of a gravitational field is a rotation in the opposite sense to a velocity phase angle and is its inverse in magnitude. The above two equations explain why the effect of gravitation is the inverse of the effect of velocity upon the phase of matter structures, when expressed in real number terms. The true fundamental explanation lies in the nature of the dual interacting complex universal field flows, expressed in exponential form, where positive angle increments are multipliers and negative angle increments are divisor factors.

For matter in an orbit in a gravitational field, at any given radial distance R, the sum of field potential and the matter energy per mass unit is zero. For a gravitational situation where there is no input of external energy or loss to external effects or dissipative losses such as radiation of energy, this is

$$P + K.E. + P.E. = 0. \qquad (2\text{-}104)$$

In the case of circular orbits, the K.E. of orbital motion is half of the total matter energy. The other half is potential energy of the matter. Matter potential energy has no velocity aspect associated with it. The matter potential energy has the effect of neutralizing an equivalent portion of the field potential as far as the matter is concerned. This leaves a net field potential as 1/2 P acting as an equivalent velocity phase shift source. Thus the residual field potential effect for circular orbits is

$$\theta_g = \sin^{-1}[i\ G\ M/(R\ c^2)]^{1/2}, \qquad (2\text{-}105)$$

and the orbital velocity effect is,

$$\theta_p = \sin^{-1}[G\ M/(R\ c^2)]^{1/2}. \qquad (2\text{-}106)$$

With the magnitude of the two phase angles being equal but of opposite rotation directions, and their respective projection effects being inverses, the composite effect is unity. This means that the matter in orbit is at the same state relative to local-cosmic-rest as the gravitational field source.

$$\Delta E = m_0\ c^2\ (1/\cos\theta_p)(1/\cos\theta_g) - m_0\ c^2, \text{ or} \qquad (2\text{-}107)$$

$$\Delta E = m_0\ c^2\ [(1/\cos\theta_p)(\cos\theta_p) - 1] = 0. \qquad (2\text{-}108)$$

The same analysis holds true for the maximum orbit velocity at the parabolic path limit to orbits. Here,

$$\theta_g = \sin^{-1}[i\ 2\ G\ M/(R\ c^2)]^{1/2}, \qquad (2\text{-}109)$$

$$\theta_p = \sin^{-1}[2\ G\ M/(R\ c^2)]^{1/2}. \qquad (2\text{-}110)$$

The universal field affecting matter units in a gravitational field, is altered by the presence of the gravitational field, so that it is the resultant, <u>after correcting for any gravitational potential energy of the matter</u>, that determines matter velocity in the field. Then, the effect of motion relative to the field source starts with a reference state defined by the composite field intensity and then rotates matter in phase from that state toward lcr. If the field state relative to lcr represents $-i\theta$ and the velocity state θ , then the resultant is that their effects cancel and the matter units in the moving frame are essentially in a state equal to the state of the field source. If the field source is not in motion, then the orbiting particles are also at the state of lcr.

As an example of the standard situation of matter in orbit in a uniform circular path in a field of a source of mass M at the state of lcr, we use the planet Mercury. We set $M = 1.989 \times 10^{33}$g (solar mass), and assume an orbit 5.79×10^7 km (Mercury mean distance). Using the theoretical value for G, the gravitational potential P at orbit distance is

$$P = -G\ M/R = -2.292 \times 10^{13} \text{ erg g}^{-1}, \qquad (2\text{-}111)$$

Then, using the small angle approximation to $[(1/\cos\theta_p) - 1]$ as $(1/2)\ v^2$,

$$v/c = (2\ G\ M/R\ c^2)^{1/2} = 2.2584 \times 10^{-4}, \qquad (2\text{-}112)$$

expresses maximum velocity for a parabolic path. The orbit velocity relative to c, for a circular orbit about M is

$$v/c = (G\ M/R\ c^2)^{1/2} = 1.5970 \times 10^{-4}. \qquad (2\text{-}113)$$

This computed physical velocity = 47.875 km sec^{-1}, (2-114)

and the observed Average Velocity = 47.9 km sec^{-1}. (2-115)

Orbital velocity-energy per gram (kinetic energy) is

$$\Delta E = m\, v^2/2 = 1.1460 \times 10^{13} \text{ erg gram}^{-1}. \quad (2\text{-}116)$$

Subtracting this from the position potential energy leaves the residual potential energy of the matter in orbit as

$$\Delta E = 2.292 \times 10^{13} - 1.1460 \times 10^{13} = 1.1460 \times 10^{13} \text{ erg g}^{-1}. \quad (2\text{-}117)$$

Then the gravitational phase angle due to the remaining potential is

$$-i \sin^{-1} (1.5969 \times 10^{-4}) = i\ 1.5969 \times 10^{-4} \text{ rad}, \quad (2\text{-}118)$$

and the velocity phase angle is $\sin^{-1} (1.5969 \times 10^{-4}) = 1.5969 \times 10^{-4}$ rad. The effect of the remaining potential energy of the field on the effective mass-energy of the particles is

$$m\, c^2 = m_0\, c^2 (\cos 1.5969 \times 10^{-4}). \quad (2\text{-}119)$$

The effect of the orbital velocity upon sensed mass-energy is

$$m\, c^2 = m_0\, c^2 [\ 1/\cos (1.5969 \times 10^{-4})]. \quad (2\text{-}120)$$

The composite net effect is the product of these two modifier components, and this is exactly 1.0. This implies that the matter in the Mercury orbit is effectively at the state of local-cosmic-rest of the solar frame. This is the general case for circular gravitational orbits, that their effective mass reflects the state of motion of the system as a whole, and that the orbital kinetic energy is one half of the negative of the field potential at the orbit radius distance.

The limiting path for orbiting is the parabola. Here the linear velocity in the parabolic path is $2^{1/2}$ times the velocity in the intersecting circular orbit at any given radial distance. In this case the velocity kinetic energy is the negative of the total field position potential energy, and there is no matter potential energy to reduce the effective field phase angle. The net effect is that the matter in the parabolic path in a gravitational field is also effectively at the state of local-cosmic-rest. For hyperbolic paths, the moving matter has more energy and system angular momentum than can be accommodated in any orbit, so there is a residual positive effect of the velocity energy upon velocity phase angle, which then is always greater than zero. Then, there is a positive velocity phase angle so that matter in this state has a net velocity level with respect to lcr in all parts of the hyperbolic path.

The numerical example above was computed using the small angle approximation approach to orbital velocity energy as

$$\Delta E = m_0\, v^2/2\ . \quad (2\text{-}121)$$

The more general form for the velocity phase angle is derived from

$$\Delta E = m_0\, c^2 [(1/\cos \theta_p) - 1], \quad (2\text{-}122)$$

for linear matter velocity effect. Then, for a unit gram mass, and ΔE in ergs per gram, this yields

$\cos \theta_p = c^2/(c^2 + \Delta E),$ (2-123)

for positive energy of motion (K.E.) values. For the field effect, we replace $\cos \theta_p$ in Eq. (2-123) by the cosine of the gravitational equivalent velocity phase angle, which is $-i\ \theta_g$ This then yields

$\cosh \theta_v = c^2/(c^2 + \Delta E),$ (2-124)

with ΔE confined to negative values, and being the matter energy per gram, after deduction of the portion of the matter potential energy from the field potential value. Both equations yield the same result at $\Delta E = 0$.

In a more general situation, we should specify that ΔE in the matter velocity situation is the actual matter K. E., and in the gravitational field phase angle situation the effective energy is the field potential P less the value of the matter potential energy. This latter value is the portion that contributes to the balancing of the velocity phase rotation against a field rotation contribution <u>as far as the particular matter particles are concerned.</u> The actual maximum potential phase shift in the space region that would affect radiation in space is due to treating ΔE in the gravitational phase shift equation as the field potential P at the given radial distance R. For an orbit such as an ellipse in a gravitational field, where there is a regular cyclic interchange of some velocity energy and field position potential energy, there is still a continuous balance of phase shift effects as far as the orbiting matter is concerned. The matter in orbit is effectively at the same state relative to lcr as the gravitational field source. Matter having more energy and angular momentum than can be accommodated in any potential, orbit in the given gravitational field, is not in phase balance with the gravitational field effect and has a residual velocity phase angle effect that is not compensated by the local potential field effect. This matter is not at the same state with respect to lcr as the field source matter.

It would appear from Eq. (2-93) that matter energy of motion could be independent, but the introduction of a gravitational field introduces a coupling that acts over a range. This is in the form of Equations (2-109) and (2-110). This places an upper limit upon matter in free fall, starting at a state of zero energy relative to the field source, in terms of the field potential P. In the case of a circular orbit, where half of the total matter energy is in potential energy form, Eq. (2-105) and (2-106) indicate that the value of $\sin \theta_g = i$ at $G\ M/(R\ c^2) = 1$. This is a more intense field than is permissible for a pure free fall situation. At this more intense level, $G\ M/(R\ c^2) = 1$ implies that the field potential per unit of mass is equal to the negative of the energy equivalent of the mass. If we put this into the hyperbolic angle form for the velocity angle equivalent of the gravitational phase angle, we have, as a limit,

$\cosh \theta_v = 1/(1 - 1).$ (2-125)

This represents a singularity which no gravitational field can exceed and still have the matter remain in our perceived universe. This also is the field intensity limitation for radiation in space. The above is also the limit for orbiting mass, where the gravitational force matches the centrifugal acceleration effect.

The above equations lead to two different limit situations for matter velocity and gravitational field intensity. The first is the limit for free fall velocity in a gravitational field as caused by the field alone. This is free fall from a state of zero energy relative to the field source at infinity. In this case the limit is attained at $\sin \theta_p = 1 = |v/c|$. This occurs at the radius defined by

$$2\ G\ M/(R\ c^2) = 1. \tag{2-126}$$

This is the conventional Schwarzschild Radius of the event horizon. Free falling matter at that distance attains a velocity energy close to c^2 ergs per gram. There is a barrier to the gravitational field causing matter velocity energy to attain the c^2 ergs per gram level because the slope of the two relationships near $(v/c)^2 = 1$ diverges. The gravitational expression approaches a singularity at $E/c^2 = 1$, while for matter velocity E/c^2 is a continuous function on both sides of the value $E/c^2 = 1$. On the other hand, matter with a large amount of potential energy can exist in orbit at the above radius, having a velocity in orbit near

$$v/c = 2^{-1/2}. \tag{2-127}$$

This matter can not escape even though all of its potential energy with respect to the field source was converted to kinetic energy, if its orbit radius is less than the Schwarzschild limit. Circular orbits could exist up to the field intensity defined by

$$G\ M/(R\ c^2) = 1, \tag{2-128}$$

with half the total energy in the form of field position potential energy. In this case we have the field intensity level approach the singularity level of θ_v as a hyperbolic angle approaching infinity. [See Eq. (2-125).]

The situation in high intensity gravitational fields is different under the new approach than under the conventional Schwarzschild limit. On the new basis stable matter orbits could exist inside the Schwarzschild limit, but outside of the new upper limit for field intensity. At this new limit, the effect of the gravitational field is to rotate one dimension of mass units to the limit where their projection on the normal universal field flow direction becomes zero (for non moving matter). Velocity does not affect the mass of photons, so, as far as the field is concerned, radiation is already at zero mass and is rotated out of the region of perception. There are other aspects to the behavior of radiation in a gravitational field, which are discussed in the next two subsections.

A major difference between the conventional approach and the new approach, that concerns their behaviors in intense fields, is the conventional assumption that matter collapses toward infinite density at high fields in the neighborhood of the Schwarzschild limit, while in the present new approach an upper limit to a mass-unit matter density is approximately 2.380 592 x 10^{14} gram cm^{-3}. This has a significant effect, as discussed in Subsection 2.7. .

2.6. Light Deflection in a Gravitational Field

The deflection of radiation in a gravitational field is a standard textbook calculation. In the text "Gravitation", by Misner, Thorne, and Wheeler, several different approaches are utilized and they yield the same general answer for the case of radiation from a star grazing the sun. Typical of these values is that calculated in Box 7.1 as subsection 7.3E which, employing a flat-space symmetric tensor approach, yields

$$\Delta\Phi = (2\ M/l)\int_{-\infty}^{\infty} d\Phi \,/\left(1-x^2\right)^{3/2} = 4\ M/l, \qquad (2\text{-}129)$$

in the geometrized units employed in the text. When translated into cgs units, this becomes

$$\Delta\Phi = 2[2\ M_1\ G/(R_0\ c^2)] = 8.486\ 94 \times 10^{-6} \text{ rad, or } 1.75056 \text{ arc sec.} \qquad (2\text{-}130)$$

Where: M_1 = Solar Mass = 1.989 x 10^{33} grams,

R_0 = Solar Radius = 6.9598 x 10^{10} cm,

G = 6.672 59 x 10^{-8} dyne cm^2 g^{-2},

Φ = angle of radiation deflection.

In the new universal field approach, using ordinary Euclidean geometry and the simple assumption that photons are moving at velocity c and cannot change in velocity, but only in direction, and excluding any effects of the differences in structure between matter particles and photons, the following expression is derived:

$$\Phi = 2\ M_1\ G/(R_0\ c^2). \qquad (2\text{-}131)$$

This differs by a factor of 2 from the value derived in M.T.W. above. The necessary factor 2 in the M.T.W. derivations appears to be an arbitrary "impact" factor from classical scattering theory assigned to make theory and observations agree. I find no rational explanation for it in my limited scanning of the text.

Not being willing to accept the "impact" factor as the reason for the added factor of 2, I explored the differences between units of mass and photons as a possible explanation. The following is what I arrived at as a reason for the added modifier factor, before I shifted to examining gravitational field factors in terms of the phase-shift angle approach.

In the new universal field theory there is good reason for a factor close to 2 as a modifier to Equation (2-131) above. The contributions of the new theory to this additional factor relate to fundamental structural differences between a photon and a mass-unit.

A photon exists only in perceived space. It has no rest mass, hence it does not have an inversion boundary. Its boundary is a standing wave boundary or a soliton boundary. As a result, the phase shift of $\pi/2$ in crossing the boundary into the interior of a mass-unit does not exist for radiation reaching the interior of a photon. This adds a factor of $\pi/2$ to the interaction with the field.

The gravitation coefficient G involves the squared radius of the affected mass-units and the squared radius of the field source units as the product $r_1^2\, r_2^2$ which appears as r_1^4 in Equation (2-23). The photon exists only in perceived space, hence does not involve the mass-unit radius r_1 directly, but rather its linear three-space space equivalent L_h representing the radius of the space region involved in a minimum time unit. This is larger than r_1. Rearranging Equation (2-28) yields:

$$L_h = r_1(e/\pi)(2/2^{5/8}), \text{ or} \qquad (2\text{-}132)$$

$$L_h/r_1 = (e/\pi)(2/2^{5/8}). \qquad (2\text{-}133)$$

The square of the above ratio factor then affects the photon's gravitational responses.

Then, there is a third factor involved as $\beta^{1/2}$. The general gravitation constant G is derived for the case of direct mass to mass interaction effect. The photon does not have rest mass, hence it does not react with the full dimensional response of mass-units. This is similar to the experimental situation in the 1976 determination of G by Luther et al, which eliminated some of the test-mass dimensionality by making it into a null detector instead of a normal mass response unit. As a result, it is necessary to divide the standard value for G by the factor $\beta^{1/2}$. The combination of these three factors related to photon structure results in an adjustment factor for its gravitational response as:

$$\text{Adj.} = (e^2/\pi)(1/2^{1/4})/\beta^{1/2}, \text{ or} \qquad (2\text{-}134)$$

$$\text{Adj.} = 1.977\ 000\ 516\ . \qquad (2\text{-}135)$$

This is quite close to the arbitrary value of 2 used in the reference text and in other similar calculations. For theoretical work, the value 2 in conventional expressions for the deflection should be replaced by one of the two above forms for the adjustment factor. Doing this yields a new expression for the radiation deflection by the sun's gravitational field as:

$$\Delta\Phi = 2\, e^2\, M_1\, G/(2^{1/4}\, \pi\, R_0\, c^2\, \beta^{1/2}), \qquad (2\text{-}136)$$

$$= 8.389\ 340\ 8 \times 10^{-6} \text{ radians, or} \qquad (2\text{-}137)$$

$$= 1.730\ 43 \text{ arc sec}, \tag{2-138}$$

using the same values for M1, Ro, and G as used in Eq. (2-128). This is a slightly lower value for the deflection than the conventional value of 1.75 arc seconds for grazing radiation.

After changing point of view to that of considering the problem again in light of the phase shift approach to gravitation, a much simpler reason for a factor of 2 becomes obvious, and it is dependent upon the differences in structure between photons and mass-units. The effect of the structural differences is that mass-units can have potential energy of position with respect to the field source, while photons, lacking the inversion boundary, can not have potential energy of field position.

In deriving the deflection of the energy packet represented by a photon, in Eq. (2-131) and likewise in the standard approach before including the disputed "impact" factor, the value for the force was computed using the standard gravitational force expression. This number is correct for computing a circular orbit in the field, but it does not recognize the full effect of the field potential in generating a total energy level in the concerned matter that is equal to the field potential and opposite in sign. Also, for a circular orbit, half of the matter energy is in the form of kinetic energy and half in potential energy form. The expressions that apply in this situation are Eq. (2-93), (2-96) and (2-106), which yield a velocity phase angle as

$$\theta_p = \sin^{-1} [G\ M/(R\ c^2)]^{1/2}. \tag{2-139}$$

Since photons can not have potential energy of position relative to the field source, the proper expression would be the equation for free fall in the absence of potential energy in the matter. The expression for this in velocity equivalent terms from Eq. (2-98) is

$$\theta_p = \sin^{-1} [2\ G\ M/(R\ c^2)]^{1/2}. \tag{2-140}$$

For motion, energy is proportional to velocity squared, which means to $\sin^2$. Examining the above two equations at that level shows that the effect at a given radius (R) is twice as great for the case without matter potential energy of position as for the case of circular orbit level forces. <u>This is the true reason for the factor of 2 required to bring Equation (2-131) up to the conventional level,</u> without using a questionable factor such as the "impact" parameter.

Looking back at the difference in the equations for circular orbits and free fall conditions, we re-examine the energy concepts involved. The kinetic energy of orbital motion is the vector product of a velocity and an angular rotation rate arm, yielding a vector product that is perpendicular to the orbit plane. On the other hand, matter field position potential energy is essentially something collinear with field potential direction, but of opposite sign. Thus it is easy to see that, as far as the particular matter units are involved, matter potential energy acts in direct opposition to field potential, thereby directly reducing the effective field potential on the matter involved. It is the remaining potential after this partial cancellation that generates the phase shift effect that is to be neutralized by the velocity phase shift effect for the particular units of matter.

The small field deflection angle equation [Eq. (2-130)] for total deflection in a path that begins outside of the field region and ends outside the main field area after transit close to a field source, is based upon approximations that may not be valid in very high gravitational fields. For these conditions we need to know more about the behavior of radiation in the free space of intense gravitational fields, and must also consider the concurrent effects upon transit time measured at the state of local-cosmic-rest and the effect of the time delays in intense gravitational fields. These aspects are discussed in the next subsection.

2.7. Radiation in a Gravitational Field

A gravitational field is a region of space with a special property generated by a local concentration of matter units. The specific property is a phase lag in a universal field component flow. The effect is in all three-space directions, but in a concentration of matter units some cancellations take place between flows so that the net result is an effect that appears to radiate from the center of mass (when observed from outside the mass concentration). In macro-space, this results in an intensity gradient following an inverse square law decline with radial distance from the center of mass. This center of mass may be in motion, or may be at rest relative to the state of local-cosmic-rest. First we will consider the situation with the center of mass at rest relative to lcr.

The matter units in a given orbit about the center of mass are at the same state relative to lcr as the center of mass, as shown in Subsection 2.5.. As a result, the atoms are at states equivalent to lcr. This implies that the energy available for any specific atomic transition is the same as the value at rest relative to lcr in a system free from the gravitational field. At the source then, the frequency and wavelength for a given atomic transition radiation is the same as the rest standard values. However, as soon as the radiation enters bulk space associated with the particular source atom, it must adjust to the conditions standard for the space. It no longer has the mass-unit structure and inversion boundaries that neutralize he special universal field conditions that are due to the gravitational field

The effect of a gravitational field in phase angle terms is a phase shift effect due to an angle θ_g. For the full field effect, this angle is determined by the relationship

$$\cosh \theta_{pg} = c^2/(c^2 + \Delta E), \qquad (2\text{-}141)$$

where, θ_{pg} is the hyperbolic of a gravitational phase angle. For small angles, and with ΔE negative, the velocity-equivalent unit mass energy is $v^2/2$. then, with $v^2 = -2(P + P.E.)$ from Eq. (2-96), and with P negative:

$$\cosh \theta_{pg} = 1/[1 - (G M/R - P.E.)/c^2] \tag{2-142}$$

in the general case, and

$$\cosh \theta_{pg} = 1/\cos i\, \theta_g, \tag{2-143}$$

where $-i\, \theta_g$ is the gravitational phase angle in terms equivalent to a velocity phase angle.

Under normal lcr conditions, in the absence of a gravitational field, the effect of velocity upon the perceived length or time is the projection of the moving frame length or time upon the lcr frame in the given direction of motion. These normal velocity effects would be

$$l = l_0 \cos \theta_p, \text{ and} \tag{2-144}$$

$$t = t_0 \cos \theta_p. \tag{2-145}$$

The gravitational phase angle has different properties than the simple velocity phase angle. The velocity-equivalent gravitational phase angle $-i\, \theta_g$ implies rotation in the sense opposite to that of a velocity phase angle and inverse magnitudes for the cosine. As a result the effect upon length and time is that of an inverse of a velocity effect, or, in magnitudes

$$l = l_0/\cos \theta_g, \text{ and} \tag{2-146}$$

$$t = t_0/\cos \theta_g. \tag{2-147}$$

Replacing $\cos \theta_g$ by its equivalent magnitude effect on length, from Eq. (2-142), and setting P.E. = 0, we have

$$l = l_0 \{1/[1 - GM/(R c^2)]\}. \tag{2-148}$$

When radiation originates within an atom, it is based upon the standard lcr energy change for the particular transition involved because the source matter in orbit, or at rest in the gravitational field is at the state of lcr, or whatever state the gravitational source is with respect to lcr. When the radiation passes from the source atom into bulk space, it becomes subject to the universal field conditions in space without the protective compensatory reactions of matter units.

The gravitational field in space represents an alteration of the usual local-cosmic-rest universal field flow. In this altered flow, time and length units in the direction of the universal field flow are exactly the same as in the normal field flow. The direction of flow, however, is at an angle with respect to the lcr flow so that whatever occurs in a unit of length and time in the lcr universal field flow is spread over more units in the gravitationally modified flow by the projection aspect. When this projected and transferred radiation reaches the regions of space free from the gravitational effects, the units of the flow are parallel to the normal lcr units. The result then is that the frequency detected outside the gravitational field region will be exactly the same as the value after transfer from lcr to the tilted flow direction. The result for wavelengths detected outside of the field region then is

$$\lambda_g = \lambda_{lcr} \{1/[1 - GM/(R c^2)]\}, \text{ or} \qquad (2\text{-}149)$$

$$\Delta\lambda/\lambda = 1/[1 - GM/(R c^2)] - 1, \qquad (2\text{-}150)$$

where the radial distance R is the distance from the field source at which the transfer from matter to field space occurs. The small field-energy approximation to this would be

$$\Delta\lambda/\lambda = GM/(R c^2), \qquad (2\text{-}151)$$

which is the same as the conventional value.

The above change in wavelength is what would be observed by a remote observer outside of any gravitational field region. If observed from somewhere inside the same gravitational field, there would be an inverse transform effect as the radiation passed from space to the detector unit atoms so that only the difference in wavelength due to the difference in radial distance (R) between source and detector locations would be perceived. This can be expressed for small differences in radial distances as,

$$\Delta\lambda/\lambda = GM/c^2 \, (1/R_{source} - 1/R_{detector}), \qquad (2\text{-}152)$$

with detection being at a larger distance from the gravitational source than the origin of the radiation. The effect works in a reverse direction for radiation generated outside of the field region and detected inside of the field region by transfer to orbiting detector elements. Radiation is carried by the universal field flow, which changes orientation with respect to the normal lcr flow as it proceeds deeper into the field. Its flow direction then is such that when radiation is transferred to orbiting detector elements in the field, the inverse transfer occurs, so that an increase in frequency is detected. This is exactly the inverse of the matter to field change that occurs at the given radial distance. The conventional assumption is that this represents an increase in radiation energy by pickup from the field. This is conventionally believed to be an energy increase because higher frequency corresponds to higher energy quanta responsible for the given radiation. Actually there is no gain in total energy of the radiation in the process. The gain in frequency is offset by an exactly equivalent shortening of radiation pulse train duration, or a decrease in average intensity, which maintains total energy constant despite a higher equivalent quantum level.

Radiation passing through a gravitational field region in space retains its exact frequency and wavelength with respect to the universal field flow that carries it. This flow changes orientation with respect to the normal lcr flow, and then the orientation returns to the normal direction as the universal field flow leaves the gravitational field region. The orientation changes as it passes through the field region and returns to normal on leaving. There is no change in its energy content or frequency anywhere in the process. It is only in the process of detection within the field region that there appears to be any change in frequency or energy. The radiation path can, however, be deflected in such a field passage, with the extent of deflection being dependent upon field intensity over the path and the direction of the deflection being toward the field source. A primary effect of this kind of passage through a gravitational field region is that the tilt (or phase shift) with respect to normal results in a longer path involving more time units for the traverse. This means more time units elapse for this flow than would be the case for a path in lcr space similar to the perceived projection upon normal lcr directions. Time flow thus appears to be slowed down, relative to apparent distance traversed by radiation, in the presence of a gravitational field.

In the above, discussion was confined to changes related to the emission or detection of radiation at some single point of transition from radiation confined to matter, to radiation confined to space, or the reverse. When whole paths are considered, the comparisons must involve the integrated effect over the path. For example, in the case of radiation coming from outside of the gravitational field region and passing through the field, it will experience a time delay that is dependent upon the ratio of the integrated phase shift effect over the path through the field, less the computed normal time for the perceived path at the state of local-cosmic-rest (or at the observer's state). The delay will depend upon path length and its orientation at every point along the way with respect to the gravitational potential and to its magnitude. For radiation from a source in the field, the time lag will be that in the path from source to observer. For detection in the field, the delay will be due to the part of the path from source to detector that is within the field.

As an example, the transit delay in radar signals from an earth source to an earth orbiting transponder will consist of three components. These are the delay in the path from source to transponder, internal transponder delays, and delay in the path from transponder to the earth based detector. Part of the problem in establishing the exact value of these delays is involved with how we determine the perceived separation between transponder and source or detector units. We can not use direct radar ranging measurements to establish the perceived space separation unless we know the gravitational field strength everywhere along the path and correct for the effect of field strength. This holds true even if the path from source to detector is at the same field strength all the way, there will be some correction unless the region is totally free of gravitational field, which it cannot be if one unit is on the earth. The existence of a gravitational field at the earth's surface may even affect our fundamental units of length and time, but even so, the ratio between them has been fixed so that both length and time units are proportionately affected and remain in the same ratio at all field levels (i.e.

constant numerical radiation velocity c). The possible gravitational effect will depend upon whether the space close to the earth's surface is free space or is space carried along by earth's matter. If it is the latter, the space will be at local-cosmic-rest and we will have standards that are valid and equal to those that would be obtained at lcr in a gravitation free region (except for a small effect due to the solar system velocity relative to lcr). These kinds of considerations place precision limits upon any length and time measurements unless we take extraordinary precautions to either eliminate the causes or take their effects into account. At the earth's surface, at the equator, the length and time error by Eq. (2-151) would be 7 parts in 10^{10} if the close space is unaffected by the earth's status with respect to lcr, but the error would be very much smaller if the source and detector are each supported by the earth and the near surface space between the two is carried with the earth's matter motion, and reflects its lcr status.

As the intensity of the gravitational field potential increases, we must abandon the small field-energy approximation and use the gravitational equivalent of Eq. (2-98), but even this breaks down when $-2\ G\ M/(R\ c^2) = -1$, at the gravitational free-fall velocity singularity level. Thus, we also need to examine conditions that are close to singularity level gravitational fields.

Continuing with a simplistic approach to high fields, we need to examine conditions where very high fields can arise. These would be in regions of high matter density such as in connection with White dwarf stars, Neutron stars and the assumed endpoint of "Black holes". These represent three successive limits in the conventional series of conditions encountered with increasing density, short of a singularity of infinite mass density.

The White dwarf star stage represents the quantum state of support of the gravitational collapse pressure by degenerate electron pressure, plus some small contribution from thermal energy pressure of the matter core. The Neutron star stage represents gravitational pressure being supported by pressure of degenerate neutrons, with very little contribution from thermal energy or degenerate electron pressure by reason of combination of electrons with protons to produce neutrons with the absorption of energy.

In the conventional approach, there is no further barrier beyond the degenerate neutron pressure to the total collapse of matter with increasing gravitational pressure at a star's core. Given the lack of a final limit, a few "Black holes" could swallow up much of the remaining matter in dense regions of the universe and destroy any semblance of planned structure to the Universe. The possibility for gravitational collapse to a "Black hole", contained in the equations of General Relativity, was recognized by a number of people. Eddington was one of these, but he was reluctant to accept this as a potential endpoint.

By the proposed new approach, I don't recognize the indefinite continued collapse under gravitational pressures to form a "Black hole"; but something can be formed at the limit of Neutron star size that has some of the external properties similar to a "Black hole". I arrive at this by a chain of reasoning following the strong Anthropic principles.

Back in Section I it was indicated that an information based probability factor representing "selection of which probabilities should be made actual" is included at the most fundamental level of the elements governing structural relationships in our perceived universe. This is the "Probability Actualization Factor". The implication of the inclusion of this factor is conscious intent in the structure.

In processing materials or information, where a high degree of conformance of output to input characteristics is desired, we have found that perfection of design of individual components in the processing sequence is a less efficient path than the inclusion of inverse feedback. Increasing the amplitude of the feedback improves the tolerance of the system to the presence of distortion or introduction of extraneous noise in the system, with an amplitude of the total system response ratio approaching unity for the most exacting situations.

In the case of our perceived universe, every matter unit (of the N_u total units) processes the universal field. The gravitational effect of a single unit is an effect that is $1/N_u$ of the universal field intensity in net effect. In the perceived universe all matter units exist simultaneously in the same instant of cosmic time. This amounts to N_u units operating in parallel, with an output from each of $1/N_u$, for a total of $N_u(1/N_u) = 1$. This insures maximum fidelity between system input and output, and in turn insures that the universe processing stays very close to the design parameters.

The vast separations between parts of our perceived universe raises questions about the timing and phases of the feedback. The existence of the four inversion boundaries makes all areas in close contact through the inverse path so that feedback occurs within a single time cycle and, in proper phase relationship for the structures, for the highest frequencies encountered in the universal field. In the applications of inverse feedback in electronics, it is common to use bandpass filters to limit the feedback to the desired components. In our perceived universe something similar is incorporated in the form of the modulation and demodulation characteristics of universal field flows in crossing the inversion boundaries, where amplitude modulation on the field components is confined to the region of origin of the modulation and not permitted passage where it could affect the fidelity of reproduction of the universal field.

The universal field circulation is one of the prime driving forces in our perceived universe. It is responsible for energy, mass, time, length, charge, and the structure of matter and space. Another prime mover is the cosmic age phase angle, who's change is responsible for the emergence of space and matter, and the expansion of the universe, and in addition is responsible for the "Space-Stress Energy" that supplies the energy released in gravitational condensations. The inverse feedback insures the purity of the circulating universal field and prevents distortions that would be detrimental to the planned objectives of our perceived universe. One indication of the coupling between the whole and individual parts is Equation (2-41), which is

$$[(4/3)\, \pi\, r_1^{\,3}]^2 = 1/(\beta\, M_g\, c^2), \qquad (2\text{-}153)$$

where r_1 is the radius of a mass-unit at a given age, and M_g is the total mass of the universe at the given age (initial complement less any loss by the continuous loss mechanism up to the given age).

The inclusion of a high level of inverse feedback implies intent that the universe continues to function in a mode planned to achieve some objectives. This brings up the problem of "Black Holes" that are assumed to exist by reason of a fit to the equations of General Relativity. With their assumed properties, these would be destructive to large scale structures if they behaved according to conventional concepts. These imply a lack of any mechanism to halt gravitational collapse after the maximum support pressure of degenerate neutrons is exceeded. This lack is a failure in completeness of the existing General Relativity theory.

By the new approach, matter emerges into wave-function space as there is space available for additional structural units, up to the maximum probable number of wave-function units of structure permitted. As the units emerge, they completely fill the available space at the time, and are at a temperature of 0 ^{o}K because there is no space for thermal motion. The mass of individual units is a measure of the internal energy content of each unit, this energy is in the form of interactions between opposite flowing components of the universal field. These flows appear to be complex conjugates in pairs, which is what is necessary for some of the simplistic approaches used in the present analysis to yield valid answers. The internal interactions that yield the effects that we perceive as mass are equivalent to contained radiation within the unit's boundaries, (which are portions of the inversion boundaries). Sensed from our ordinary perceived space, this represents the equivalent of the radiation contained within the perceived volume, which represents a radiation pressure within the perceived surface. Any unit in perceived space that contains rest-mass must partake of the inversion boundary, and conversely, particles that do not contain rest-mass do not partake of the inversion boundaries separating an interior from perceived space. Photons for example consist entirely of interaction patterns of modulation on the universal field flow, and thus should constantly move at the phase velocity in the universal field flow.

The emerged structural units have sufficient internal pressure to resist distortion and collapse by the force tending to cause additional units to emerge into wave-function space, which suggest that when this critical pressure is exceeded units of structure go out of perceived space existence and return to the potential region that precedes emerged existence. Thus, units that are forced out of existence in perceived space by high local pressures should return to a region from which they can return to perceived space in locations of less than the critical pressure. This should be a reversible equilibrium process after full emergence of the permitted number of potential wave-function units of structure have emerged, so long as there is more wave-function space in existence than the minimum volume required to contain the maximum permitted number of units.

When the initial complement of structural units (Neutrons) has emerged from potentiality into actuality in perceived space, and it has assumed the velocity associated with the universe expansion at the state of local-cosmic-rest, then the units have the effective mass that we perceive as neutrons. What we measure as mass is the response of the contained energy of the structural unit to force or change in velocity with respect to local-cosmic-rest. The perceived volume of a structural-unit can be computed for a given age by use of a slight modification of Eq. (2-41) as

$$V_n = m_n[1/(\beta\ M_g\ c^2)]^{1/2}. \tag{2-154}$$

The maximum density of a structural-unit at emergence is given by

$$\rho_{max} = (m_n/N_z)/V_n, \tag{2-155}$$

$$\rho_{max} = (m_n/N_z)/[m_n/(\beta\ M_g\ c^2)^{1/2}], \tag{2-156}$$

$$\rho_{max} = (\beta\ M_g\ c^2)^{1/2}\ /N_z, \tag{2-157}$$

$$\rho_{max} = 2.380\ 592\ 457 \times 10^{14}\ \text{g cm}^{-3}. \tag{2-158}$$

The equivalent internal radiation pressure then is given by

$$P_{max} = \rho_{max}\ (c^2/3), \tag{2-159}$$

$$P_{max} = 7.131\ 899\ 331 \times 10^{34}\ \text{dyne cm}^{-2}. \tag{2-160}$$

By the conventional approach, White dwarf stars support the high gravitational pressure by means of degenerate electron pressure. This mode allows the mass of these stars to range up to approximately 1.4 solar masses. The mean density of these stars is in the region of 10^6 g cm^{-3}, with density increasing with increased mass.

As a next step in supporting increasing pressures, quantum limitations imply that degenerate neutrons can support condensed matter stars up to approximately 3 solar masses, with core densities approaching that of atomic nuclear densities in the region of 10^{14} g cm^{-3}. As the mass accumulated by white dwarfs exceeds the 1.4 solar mass limit, the degenerate electron pressure is no longer capable of supporting the increased gravitational pressure and the star collapses suddenly toward greater density. In this process electrons combine with protons so that most of the matter becomes neutrons, and the increased pressure is supported by degenerate neutrons. An illustration in Kaufmann (1985) suggests a central core density of 4 x 10^{14} g cm^{-3}, and a density of 2 x 10^{14} g cm^{-3} at 5 km below the star surface of a 1.3 solar mass Neutron star.

According to the conventional approach, at an upper limit above 3 solar masses, degenerate neutron pressure can no longer support the increasing pressures with increased mass, and the star must collapse toward the singularity at infinite matter density, leaving only a "Black hole" residue that retains the external gravitational effect of the total mass. This is an inadequacy in the General Relativity approach to the endpoint of increasing gravitational field intensity.

By the new approach, both White dwarf stars and Neutron stars are possible, but not "Black holes". The pressures and densities for White dwarf and Neutron stars are prescribed by Quantum relationships in wave-function space, which should apply in both the conventional approach and in the new approach up to the point where the internal pressure in matter units takes over, and eliminates the further collapse that appears to be possible in the conventional approach by reason of the absence of a maximum density limitation. In applying the quantum approach, matter units are treated as points in a six dimensional phase space, with the volume of the phase space cell determining matter density in the conventional approach. So long as the cell volume computed by the quantum approach exceeds the volume computed by the new approach, there is no conflict, but when there is a conflict the new approach minimum volume governs. This represents an upper limit to density of 2.38 x 10^{14} g cm^{-3}, and a corresponding pressure of 7.13 x 10^{34} dyne cm^{-2}. The above density is sufficiently close to the values computed for Neutron stars by the conventional approach, to assume they exist under both approaches, with differing limits to maximum sizes. "Black holes" do not exist in the new approach, but large neutron stars will have sufficient core pressure at the center to force matter units out of perceived space existence into the pre-emergence potential region. Since there has been no change in the maximum number of permitted wave-function structural units, these displaced units can re-emerge into perceived space at some lower stress location anywhere in the total space, even millions of light years away from their former locations. This relocation process should require no more time than a single cycle of four atomic time units, and possibly only a single time unit.

We examine some of the numbers associated with the process in the new approach. First we assume that the reversal of a matter unit emergence requires a 10 percent over pressure. This would amount to 7.845 x 10^{34} dyne cm^{-2}. Also, assume surface density is that of close packed spheres in contact (at 0.74048 of total space filling) and total space filling equivalent to dodecahedrons in total surface contact at the center. Also, assume the average density of a column of matter from surface to center is then 2.0717 x 10^{14} g cm^{-3}.

A standard equation for computing the pressure at the center of a homogeneous sphere of nearly incompressible material is

$P_c = \rho$ G M/(2 R). (2-161)

If we replace the mass by its expression in terms of density and radius, and then insert the average density and the maximum pressure, we can solve for the maximum radius.

$P_c = (2\ \pi\ /3)\ \rho^2$ G R^2, (2-162)

R^2 = 1.308 x 10^{13} cm^2, (2-163)

R_{max} = 36.166 km, (2-164)

M_{max} = 4.1051 x 10^{34} g, or

M_{max} = 20.639 solar masses. (2-165)

This is considerably different than the conventional assumption of a maximum of approximately 3 solar masses as an upper limit.

Changing assumptions a little, by removing the ten percent over-pressure requirement, and allowing full maximum density from surface to core center of the Neutron star, yields:

R_{max} = 30.009 km, (2-166)

M_{max} = 13.549 solar masses. (2-167)

The above two examples suggest that the conventional limit to the maximum size of Neutron stars at approximately 3 solar masses is unrealistic.

To examine the implications of the new conditions somewhat farther, we compute the Schwarzschild gravitational radius by the conventional approach. This yields respectively

R_s = 60.951 km, and (2-168)

R_s = 40.012 km. (2-169)

By the conventional interpretation neither matter particles or radiation inside the Schwarzschild radius could escape. This is not correct for radiation, since radiation photons have no rest mass, they cannot possess potential energy of position. All matter particles inside R_s would be trapped in both cases, but radiation would be trapped only if it was inside the higher field potential limits defined by

R_r = G M/c^2. (2-170)

These limits respectively would be:

R_r = 30.476 km, (2-171)

R_r = 20.006 km. (2-172)

The surfaces of the two Examples are both outside these limits. so radiation would not be totally trapped, but only reduced in frequency by the gravitational red shift for the respective stars.

Maximum size Neutron stars could continue to gather in additional matter, but the star's mass would not increase, because the added mass would cause an equivalent quantity to go out of local existence and then return to perceived space at some remote location of lower stress. In this process the gravitational potential contribution of the added matter would be taken with the relocating mass and probably some thermal energy as well.

The conventional concept "Black hole" does not exist in our perceived universe. This would seem to be a design provision in our perceived universe structure. Uncontrolled "Black holes" could wreck havoc in congested regions, while large Neutron stars could provide a useful function in thinning out excessive concentrations, while at the same time conserving the total quantity of matter in the universe and tending to maintain uniformity in the large scale distribution of matter in the universe.

3. ELECTRONS

Almost from the instant the first form of the gravitation expression was completed, it was obvious that some special aspects of structure would be required for electrons, because the magnitude of the gravitation effect appeared to be dependent upon the fourth power of the radius. Mass of ordinary physical solids is ordinarily considered to be proportional to the third power of the radius, and this would not yield the proper gravitational force between electrons. The discovery of how to solve that problem lead to the ability to compute charge, mass-unit ratio to electron mass, and the inverse fine structure constant a^{-1}.

3.1. Electrons and Gravitation

The first of the proposed new equations for the coefficient of gravitation, Equation (2-23), involves the fourth power of the radius of the mass-unit particles. In examining the derivation process for that equation, it appears that this is actually $r_1^2\ r_2^2$, reflecting the square of the radius of both particles involved at the elementary two-particle level. In our ordinary four dimension perception of spacetime, the mass of particles with equal time extensions is proportional to three-space volume (or r^3), so that the new equation does not imply gravitational linearity with mass unless all particles are effectively of the same size. Electrons are much smaller than neutrons or protons, so that there would be a variation in the coefficient of gravitation for different materials, if electrons were simple spherical particles, like mass-units have been assumed to be. Experimental evidence (Misner, Thorne, & Wheeler 1973) indicates that gravitational response of most ordinary matter is linearly proportional to mass to better than one part in 10^{12}, regardless of structural variations due to the relative numbers of electron-proton pairs and neutrons in the nuclear structure of the various elements.

If we put the mass of two electrons into the standard Newtonian expression for gravitation, and compute the gravitational force between two electrons, we obtain the standard force estimate. Then, if we consider electrons to be of the same time duration as mass-units, we can compute the equivalent three-space volume radius on the basis of the ratio of the mass of an electron to a mass-unit (1/K). Then, using these values in the new gravitation equation, we obtain an estimate for the gravitational force. The standard Newtonian expression yields a force estimate for the electrons that is $1/K^2$ times the force for two mass-unit particles. If we treat the mass ratio (K) of a mass unit to an electron as a three-space volume effect, this would yield an estimate for the electron gravitational radius (r_g) as $r_g = r_1/K^{1/3}$. Then, putting this directly in the new equation would yield a force estimate as $1/K^{4/3}$ of that for two mass-units. The standard Newtonian gravitation expression based upon the same masses would yield force = $1/K^2$ of that for two mass-units. These two values are incompatible. If we insist that the new equation should yield the same result as the Newtonian equation, and recognize simultaneously that the r_1^4 in the new expression is the product of two areas, then we can look at the problem a little differently. When we do so, and specify that the force computed by the two independent equations must be the same, this requires the relationship $r_1^4 = K^2 r_g^4$ or $r_g = r_1/K^{1/2}$. We accept this as the necessary relationship between the effective gravitational radius of an electron and the radius of a mass-unit. This implies that from the ordinary spacetime perception, the total mass-energy of the electron appears to act as though it is confined to an ordinary volume of radius r_g.

The difference between the gravitational radius ratio that we would derive from ordinary three-space volume relationships, $r_g = r_1/K^{1/3}$, and the gravitational equality requirement for $r_g = r_1/K^{1/2}$, is such that a single three-space spherical structure cannot meet both requirements. Then, by implication, the new gravitation expression has to be wrong, unless there is some special structure involved in electrons that effectively permits both conditions to be met. This problem of electron structure had to be faced almost immediately after verifying that the new gravitation expression worked for neutral mass-unit particles. A structure was proposed for the electron that would yield both the correct mass ratio and gravitational force. It was a concentric structure in perceived space, with energy collected in the outer region, concentrated in the inner region, and interacting as though it were of radius equal to that of the inner region alone.

At this point, the natural question arose as to whether this was only an ad hoc factor to allow the new gravitation expression to be applied to electrons, or was it something related to the true structural nature of electrons? It turned out that the proposed structure lead to derivation of a method to calculate the exact charge on the electron from pure geometry and the properties of the universal field. As a result, I concluded that the assumed concentric structure must actually be involved in electron structures, or that the structure interacts with the field components in a manner that is equivalent to what would be computed for concentric structures.

In the derivation of the charge on the electron, and the related value for the constant a^{-1}, in the next few subsections, a simplistic approach based upon ordinary perceived spacetime has been employed. This approach is very close to the path by which it was first discovered that "charge" was a computable quantity. The dual volume structure found necessary is treated as though it is an ordinary-space volume in the derivation. In later subsections concerned with structure, it is necessary to recognize complex subspace and inverse space to properly relate the electron and proton structures. Then, in this section, it becomes clear that the gravitational radius r_g applies to the perceived space and the electrical radius r_e implies something in interior inverse space.

3.2. Structure and Charge

In the universal field, there are four rotating components about any direction line. There are clockwise and counter-clockwise rotation components in the outward flowing field and a similar pair in the inward flowing field. I postulate that electrons are structures that are individually involved mainly with one of the rotation components of the field. They interact with the outflowing field and one of the two rotational directions. In interacting with the universal field component, the electron demodulates field and removes rotation from it, producing a field component without rotation but containing all the energy. This requires that two types of electrons must exist; one that removes clockwise rotation and one that removes counter-clockwise rotation. The field that results from either type electron (at rest) is the same and is free from the rotations at the characteristic frequencies of the universal field. Its total energy is the same as though the rotation was still present.

Similar type structures, that operate upon the inward flowing (negative time aspect) components, are positrons; and there must also be two types of spin positrons. The structure requirements must be looked at in a four dimension spacetime fashion. First, we must require that the electron structure must have the same extension in time as mass-unit particles. To yield a linear relationship with mass, the radii of electrons involved in the gravitation expression must be such that r_g^4 equals r_1^4/K^2, if electrons are 1/K of the mass of mass-units, where r_g is the equivalent gravitational radius of the electron:

$$r_1^4 = K^2 r_g^4. \qquad (3\text{-}1)$$

Physical-mass wise, we have another requirement for the actual mass of the electron. The electron interacts with one component of the field out of the normal four. Its volume then, to have a given mass, must be four times what it would be if it involved the total universal field. Its time extent must be the same as the time extent of a mass-unit. This yields the following relationship:

$$4 \pi r_1^4/3 = 4 K (4 \pi r_e^3 r_1/3), \text{ or}$$

$$r_1^3 = 4 K r_e^3. \qquad (3\text{-}2)$$

We now have two relationships with the mass-unit radius r_1. A single electron radius will not satisfy both conditions, so we must have both a gravitational radius r_g and an electrical radius r_e. If the electron is at one location, and symmetric in our three-space, then the structural components must be concentric. I postulate a concentric structure such that the outer perceived space electrical volume intercepts a quantity of field that is effectively conducted to the core volume, where it can then interact gravitationally after it has undergone the volumetric concentration. This is 4 K concentration of 1/4 of the field, hence its effect upon equivalent intensity is:

$$I_0 (4 K)/4 = I_0 K. \qquad (3\text{-}3)$$

The apparent outer volume is V_e , and the inner volume is $V_e/(4 K)$. If we consider that the electrical intercept field-effect is confined to the region between the two boundaries, then this volume is V_e [1 - 1/(4 K)]. I utilized this factor initially as the electrical potential field intercept and computed the charge on the electron. When I took up the process of trying to compute a better value for the charge on the electron, I recognized that, in removing rotation from the field components, there was a change in path length involved. This would bring in a function of π at some level. In the process of computing the value of K directly from properties of geometry and partitioned segments of the infinite series representation of e^{-1}, I found that a complement factor appeared to the eighth root. Since we are dealing with a four-space, at the ordinary matter level, and potential fields occur in the square root subspace, I decided that the factor π must appear as the eighth root here. When this was included the volume factor became:

$$V_e [1 - 1/(4 K \pi^{1/8})] \text{ for charge aspects.} \qquad (3\text{-}4)$$

Now, before starting into the details of the derivation of charge, some assumptions and conditions are summarized:

1. The total mass-energy of the electron is $m_\mu c^2/K$.
2. The fraction of volume as charge potential field is $[1 - 1/(4 K \pi^{1/8})]$.
3. The structure acts as though the energies were concentrated in the inner volume insofar as interactions are concerned. The apparent gravitational radius of the electrical-field-source is the inner radius r_g.
4. The field from both types of spin electrons is the same. As a convention, it is considered that electron's structures interact with the outward flowing universal field components in positive time.
5. Protons have a field that is the complement of that of electrons. They are considered to be a symmetric neutron minus the electron.
6. What radiates from the electron is a universal field component that has been altered by removal of its rotational aspect, without reducing the energy. On the average, in unit of time, it is distributed uniformly over time in all three-space directions.
7. The change in the universal field component can be treated as a modulation effect on the universal field component. The modulation can pass through the boundaries of the opposite type charge particle, but not through boundaries of symmetric neutral structures such as neutrons. When encountering neutral particles, the field is demodulated and the anti-rotational modulation is then Passed on to other universal field emerging from that particle, without any loss.

For the analysis, we examine the relationship between two electrons in otherwise empty space. We specify that the electrons do not move during the analysis period, and that the two particles are separated by a distance (d), that is large compared to the particle radii. The particles each have the dual volume concentric structures with two apparent radii: outer radius r_e and inner radius r_g.

Particle 1 is a source of radiating field. Instead of dealing with the universal field as its composite intensity I_0 in four component, as done in the derivation of the gravitation coefficient, we will deal with the equivalent of a single component field. To put this into uniform time terms, we will imply unit time, so that we can use the mass of the source point as the quantity determinant of energy in a unit of time. In a mass-unit, only one fourth of the energy is derived from the one component involved with our electron. This yields a factor $m_\mu c^2/4$ from a mass-unit. We would have the following quantity available in a mass-unit, per unit time, using r_1 as the duration aspect:

$$m_\mu c^2 r_1/4. \tag{3-5}$$

The energy represented by mass is a product of inward flow in the perceived universe with outward flow that originates in the negative universe. The outward flowing component, then, is the square root of the above mass factor. Thus, our field source reflects this aspect, plus the fact that our source electron has a mass that is 1/K of a mass-unit. This field source then is

$$[m_\mu c^2 r_1/(4 K)]^{1/2}. \qquad (3\text{-}6)$$

Not all of this possible field source is involved, because, in unit time, it is only the volume between the sphere of outer radius r_e (approximately r_1) and the inner radius r_g that is the electrical portion. This would be V_e [1 - 1/(4K)] from pure geometry uncorrected for path changes, however this factor needs to be modified to correct for a path changing effect of the field straightening. This is the factor given in Equation (3-4). This yields the field source due to particle 1 as

$$[m_\mu c^2 r_1/(4 K)]^{1/2} [1 - 1/(4 K \pi^{1/8})]. \qquad (3\text{-}7)$$

As a field source, this potential field flows through space in all three-space directions. Near its source it is flowing through a surface of radius r_1 in a unit of time. At distance d the flow is reduced in the ratio r_1^2/d^2. As a flow effect at distance d, we now have

$$[m_\mu c^2 r_1/(4 K)]^{1/2} [1 - 1/(4 K \pi^{1/8})] [r_1^2/(d^2)]. \qquad (3\text{-}8)$$

To convert this flow effect to an instantaneous density-like effect, we divide by the duration of unit atomic time expressed in cms (L_h):

$$[m_\mu c^2 r_1/(4 K)]^{1/2} [1 - 1/(4 K \pi^{1/8})] [r_1^2/(d^2 L_h)]. \qquad (3\text{-}9)$$

When this field encounters the electronic outer volume of electron 2, it is conducted to the surface of the inner volume. Particle 2 has a similar energy intercept to particle 1, which yields the same source given by expression (3-7). The product interaction of Equations (3-7) and (3-9) yields

$$[m_\mu c^2 r_1/(4 K)] [1 - 1/(4 K \pi^{1/8})]^2 [r_1^2/(d^2 L_h)]. \qquad (3\text{-}10)$$

When this is divided by the inner structure volume, it yields a field density which is

$$[m_\mu c^2 r_1/(4 K)] [1 - 1/(4 K \pi^{1/8})]^2 [r_1^2/(d^2 L_h)][3/(4 \pi r_g^3)]. \qquad (3\text{-}11)$$

This product is in ergs cm^{-3}, which can be converted to radiation pressure on surfaces in dynes cm^{-2} by dividing by 3. Doing that, and regrouping terms, yields

$$(m_\mu c^2 r_1^3) [1 - 1/(4 K \pi^{1/8})]^2/(16 K \pi d^2 L_h r_g^3) \text{ dyne cm}^{-2}. \qquad (3\text{-}12)$$

The surface area of particle 2, normal to the line of connection, would be πr_g^2. This yields an effective area factor as

$$\text{Area} = \pi r_g^2. \qquad (3\text{-}13)$$

Then, using this and the pressure from expression (3-12), we can compute the force:

$$F = (m_\mu c^2 r_1^3) [1 - 1/(4 K \pi^{1/8})]^2/(16 d^2 K L_h r_g). \qquad (3\text{-}14)$$

Then, replacing r_g by its required equivalent $r_1/K^{1/2}$, and replacing the remaining r_1^2 in the numerator by its equivalent in terms of Equation (2-29), then the above simplifies to

$$F = h\ c\ 2^{1/4}\ \pi^2\ e^{-2}\ [1 - 1/(4\ K\ \pi^{1/8})]^2/(32\ d^2\ K^{1/2}). \qquad (3\text{-}15)$$

When the charge on the electron is defined in electrostatic units, the force between two electrons separated by 1 centimeter is numerically equal to the square of the charge on the electron. Thus, setting (d) in the above equation as exactly one centimeter, the force should be equal to the square of the computed charge on the electron. Numerical evaluation of (F), using Cohen (1974) values, as h = 6.626176×10^{-27} erg sec and observed $K = 1/m_e = 1822.88735$ is:

$$F = 2.308\ 972\ 76 \times 10^{-19}. \qquad (3\text{-}16)$$

We equate this to e^2, and then take the square root, which yields a theoretical value

$$e = 4.805\ 177 \times 10^{-10}\ \text{esu}. \qquad (3\text{-}17)$$

The observed value for the charge on the electron (Cohen 1974) converted to electrostatic units was

$$e = 4.803\ 2424 \times 10^{-10}\ \text{esu}. \qquad (3\text{-}18)$$

Upon arriving at this stage, it was recognized that the path followed in the derivation of the force was parallel to that used in obtaining the unmeasurable theoretical value G* for the general gravitation coefficient. The result for Equation (3-17) is likewise an unobservable value, and it requires correction of e^2 by the factor β. Gravitation is an inverse field effect, while electrostatic effects are direct field effects, so that the factor β is applied to the "charge" relationships in an inverse fashion to the manner applied in the gravitation derivation. This requires dividing the unmeasurable value of e^2 by β. The result for the observable value becomes

$$F = 2.307\ 1147 \times 10^{-19}, \text{ and} \qquad (3\text{-}19)$$

$$e = 4.803\ 2434 \times 10^{-10}\ \text{esu}. \qquad (3\text{-}20)$$

which now is in good agreement with the 1973 value of

$$e = 4.803\ 2424 \times 10^{-10}\ \text{esu}. \qquad (3\text{-}21)$$

On the basis of this agreement, the value of β in terms of its component elements [Eq. (2-55)] was combined into Equation (3-15) to yield an expression for calculating "charge squared" of an electron as an observable value. This takes the form

$$e^2 = h\ c\ \pi^3\ e^{-3}\ 2^{5/8}[1 - 1/(4\ K\ \pi^{1/8})]^2/(48\ K^{1/2}). \qquad (3\text{-}22)$$

Incorporating the factor β in the expression for "charge squared", brings an implication that the structure of the electron may involve toroids that rotate about all three-space axes to yield the perceived average effects.

The above Equation (3-22) only solves part of the problem of computing electron charge. It relates charge to mass, but requires input of the mass ratio of a mass-unit to an electron mass to yield a value for charge. It has related the two unknowns of electron mass and electron charge when the input values are expressed in terms of a system of units in which the new theoretical mass-unit is identified as unit value.

The new fundamental mass-unit is smaller than a standard Carbon 12 based unit. The mass of the carbon 12 based unit divided by the mass of the new fundamental unit is approximately

$$\Delta\, m_{\mu} = 1.000\ 000\ 2480 \pm (2 \times 10^{-11}). \qquad (3\text{-}23)$$

To convert an existing atomic mass value (excluding electron mass) from the number of Carbon 12 based units to the number of new fundamental units of mass, multiply by the factor $\Delta\, m_{\mu}$.This yields the adjusted number of mass-units, which I call ca units (for adjusted carbon units) or lcr units (for local cosmic rest units), depending upon the context of the particular relationships involved. The above "best value" for $\Delta\, m_{\mu}$ is derived in the following Subsection 3.5. and is confirmed in general magnitude by other calculations that are based on different observed relationships.

Numerical evaluation of Equation (3-22), using the theoretical value of the ratio K (derived in subsection 3.5.) and the fundamental constants based upon the CODATA 1986 standards, yields a value that is still contaminated by some function of the mass-unit differences, because Planck's constant also involves the size of the mass-unit and is coupled to the value of Avogadro's number.

In the CODATA 1986 report, in the section comparing the 1986 adjustments with the 1973 adjustments, it is indicated that the product ($h\ N_A$) is a constant at any given universe age. In the present analysis, the product ($h\ N_z^{5/6}$) is a constant at a given universe age, but this constant varies in proportion to $(1 - \alpha\phi/\pi)^{-1/6}$. (See Section 4.) As a result, with a given size gram, the change to a smaller new mass-unit would increase the numerical value of the product by the ratio $(\Delta\, m_{\mu})^{5/6}$. The constancy of the product then requires that the numerical value of h decrease in this same ratio. This results in a similar decrease in the value of e^2. Comparing the computed values for the charge, obtained by Equation (3-22) for the case where the $\Delta_{m\mu}$ adjusted value of h derived from the CODATA based age (Eq. 2-43) is coupled with the theoretical value of K (Eq. 3-24), with the case of the observed value of h adjusted for $\Delta\, m_{\mu}$ (divided by $\Delta\, m_{\mu}^{5/6}$) and used with the observed value K (1822.88851) (Eq. 3-25), shows these two results to be within 0.11 ppm of each other.

$$e = 4.803\ 205\ 180 \times 10^{-10} \text{ esu.} \quad (\Delta_{m\mu} \text{ adjusted h \& theoretical K}) \qquad (3\text{-}24)$$

e = 4.803 205 718 x 10^{-10} esu. ($\Delta_{m\mu}$ adjusted h & observed K) (3-25)

The CODATA 1986 recommended value for "charge" converted to electrostatic units is

e = 4.803 2068 x 10^{-10} esu. (0.30 ppm) (3-26)

When this value is adjusted to reflect the size effect of using the new mass-unit, by dividing the numerical value by $(\Delta\ m_\mu)^{5/12}$, it becomes

e = 4.803 2063 x 10^{-10} esu. (0.30 ppm) (3-27)

The difference between this value and the theoretical value obtained in Equation (3-24) is 0.23 ppm. This difference probably reflects experimental measurement tolerance effects plus a contribution from the probable difference between a theoretical gram and the physical prototype standard gram.

The calculation of the theoretical electron charge from universal field relationships, and its excellent agreement with the CODATA value indicates that both gravitation and electrostatic forces are derived from the same fundamental field, and that this field has electromagnetic properties. In essence we can say that both gravitation and electrical effects are a form of electromagnetic manifestation.

3.3. The Electron Landé g Factor and the Mass-Unit

The electron Landé g factor is a ratio between the electron spin moment (j) and its spin magnetic moment (μ). In atomic unit terms, this is expressed as

$g = (\mu/j)(2\ m_e/q_e)$. (3-28)

The values of the electron and positron g values have been measured to a precision of 4 parts in 10^{12}, (by Van Dyck, Schwinberg, & Dehmelt in 1987 and quoted by H. Dehmelt 1990), providing our most precise measures of any atomic properties. The measurements upon single elementary particles in a Penning trap were based upon determination of the ratio between the spin frequency and the cyclotron frequency at the corresponding j level in the same magnetic field. The reported electron value was

$g/2 = Hz_s/Hz_c$ = 1.001 159 652 188(4), (3-29)

where Hz_s is the spin frequency and Hz_c is the cyclotron frequency.

At the time that I first encountered a high precision value for the above factor, it was in an article by Pipkin & Ritter(1983), which reported a value at that time as

g/2 = 1.001 159 652 200(40). (3-30)

At that time I was struck by the resemblance of this number to the inverse of the structural resonance factor $(N_w/N_p)^{8/5}$, which is

$1/(N_w/N_p)^{8/5}$ = 1.001 159 723 125 439 ..., (3-31) which differs by approximately 7 parts in 10^8 from the g factor. I felt that there must be some connection between these two numbers, but I didn't see precisely where until early 1990.

The experimental value of g/2 was determined by measuring two frequencies. Both time and length units in this measurement are the same for the two frequencies, so that the result must be precise and take into account the actual electron mass and electron charge in the proper and true fundamental values, if the equation contains all the proper factors. I hypothesize that the true fundamental value of g/2 is exactly the inverse resonance value as of Equation (3-31). If so, there is a missing or incorrect factor in the conventional expression for g/2.

Before going into the above possibility, we need to examine the standard factor of 2 for the ratio of the unit orbit magnetic moment and the unit spin magnetic moment. This value is assumed to be exactly 2 on the basis of experimental findings, but without an accepted geometric reason. With electrons considered as point charges, there was no geometric reason that could be settled upon as the cause of the ratio being exactly 2. In the new approach, electrons have finite boundaries and possibly a non spherical structure.

If electrons have a spin magnetic moment orientation, and measurements indicate that they do, they must have a structure that can yield differences in concentration of field flow in different directions, with at least two favored directions. This is a natural property of a toroid as a simplest form of electron field boundary (inversion boundary). Examining the moment of inertia of a toroid about its three possible axes of rotation yields (7/16) m r^2 for rotation about the hole axis, and (9/32) m r^2 for rotation about either of the two diameters that are perpendicular to the hole axis. Then, since the electron field flows uniformly in all three-space directions, the effective value must be the average of the three values. This yields an average spin moment as

$$\mu_s = (1/3)\, m_e\, r^2. \qquad (3\text{-}32)$$

When acting as a whole, in orbit, the externally perceived moment value would be that equivalent to treating the field mass effect as that of the total radiation, in a unit of time, as it passed through a surface with the radius of the spin pattern of the electron in all directions. This spin pattern would be a sphere of radius r. The moment of inertia would be equivalent to that of a sphere with the mass concentrated in a thin surface shell. This is a moment of

$$\mu = (2/3)\, m\, r^2. \qquad (3\text{-}33)$$

This is exactly twice the spin moment, so that we can accept the conventional assumption that the ratio is exactly 2 and proceed on to examining other aspects of the g/2 factor.

In subsection 3.5., concerned with the mass ratio factor K, it is shown that the electrons have dimensions such that they involve only 14 of the 16 components of the universal field. This is 7/8 of the total dimensional aspects of field interactions. In terms of ordinary neutral mass at the perceived level of interactions (field squared), the effects reduce to four perceived parameters in a unit of time. This is as though we have an effect similar to (1/8) + (1/8) = (1/4). The equivalent situation for the reduced dimension action could be (1/7) + (1/7) = (1/3.5).

The conventional assumption is that the mass of the electron is the same kind of mass as that of a neutral particle, This is obviously not so. The conventional equation for g/2 contains the conventional assumption of equivalence of the two types of mass. If this were true, the differences between standard Carbon 12 based mass-units and the new fundamental mass-units would not show up in the g/2 measured value, because the numerator and denominator in the frequency ratio would be proportionally affected. However, as the equation assumes equivalent mass responses in the two situations, but the actual mass responses differ, a reflection of the differences in mass-unit sizes can show up in the measured results. Since the neutral mass components contain all of the charge mass component but have an excess of 1/7, we would expect this ratio to be involved in the response differences. Relative to the four parameter response of neutral mass, the electron would equate to a three and a half parameter unit. In some other resonance responses, the difference in parameter responses has shown up as a fractional root involvement as the 1/n root where the total involvement is n parameters. In similarity with this experience, I tested a possible response to the mass-unit size difference ratio Δm_μ as $\Delta m_\mu{}^{1/3.5}$ in the expression for g/2.

A somewhat different approach to considering the possible involvement in the expression is to examine the dimensionality of the Bohr magneton when expressed in the dimensions of units in the new system.

$[q_e/(2\ m_e)] \approx (h\ c)^{1/2}/m_e \approx cm^{-5/2}/cm^{-6}$, or

$$[q_e/(2\ m_e)] \approx cm^{3.5}. \tag{3-34}$$

If we accept the resonance approach, then, this will modify the answer obtained by measurement by a correction factor for the ratio of the assumed Carbon 12 mass-unit to the fundamental mass-unit taken to the 1/3.5 root. This factor would be $\Delta m_\mu{}^{1/3.5}$. The form of the composite expression would become:

$$(g/2\ \text{theoretical})/(g/2\ \text{measured}) = (\Delta m_\mu)^{1/3.5},\ \text{or} \tag{3-35}$$

$$1.001\ 159\ 723\ 125\ 439\ /1.001\ 159\ 652\ 188(4) = (\Delta m_\mu)^{1/3.5}, \tag{3-36}$$

$$\Delta m_\mu = 1.000\ 000\ 247\ 993\ 474. \tag{3-37}$$

If this were the only way to obtain an estimate of the ratio of a Carbon 12 mass-unit to the new fundamental mass-unit, it might be open to question, but there is a direct method based upon the mass of a free Neutron and the resonance value of 1/56 of an Iron 56 atomic mass, discussed in Section 4.2., that yields a value as

$\Delta m_\mu = 1.000\ 000\ 247 \pm (0.032\ \text{ppm}).$ (3-38)

Also, there are indirect approaches that yield values ranging from 1.000 000 245 to 1.000 000 260.

The observed value of K as the inverse of the observed electron mass in Carbon 12 mass-units reflects some function of the true electron mass relative to the new fundamental mass-unit. At first glance, it would only appear necessary to multiply the observed K value by Δm_μ to obtain the theoretical value for K in the new units, however, this is not so. The basic observational data from which the electron mass is calculated is the measurement of the ratio e^2/m_e. The measurement reflects the actual value of m_e and the actual value of e^2. The e^2 component contains Planck's constant, which is also a function of the true mass-unit size, but expressed in Carbon 12 based units in the conventional experimental results. The component (h c) in e^2 is of dimension cm^{-5}, while the mass-unit is of dimension cm^{-6}. As a result, the "charge squared" is affected by $\Delta m_\mu^{5/6}$. When this effect is combined with the direct effect upon the expression of the electron mass, the composite effect becomes $\Delta m_\mu^{11/6}$. Then the ordinary electron mass-unit ratio is affected to the above extent. The ratio of K for CODATA electron mass to theoretical K expressed in the new mass-units will be $1/\Delta m_\mu^{11/6}$. (See subsection 4.4. .)

$K(\text{CODATA})/K(\text{theoretical}) = 1/\Delta m_\mu^{11/6},$ (3-39)

$1822.888\ 506\ (0.023\ \text{ppm})/1822.889\ 326\ 18 = 1/\Delta m_\mu^{11/6},$ (3-40)

$\Delta m_\mu = 1.000\ 000\ 245\ (0.013\ \text{ppm}).$ (3-41)

The value of K(theoretical) is calculated in subsection 3.5. and can be computed to as many places as necessary (Equation 3-61).

On the basis of the existence of these other confirming values, I accept the value in Equation (3-37) as the best value, with the implied precision; and then rounded for ordinary use as

$\Delta m_\mu = 1.000\ 000\ 2480 \pm (2 \times 10^{-11}),$ (3-42)

and the value of the electron g/2 factor as

$g/2 = 1.001\ 159\ 723\ 125\ 451...$ exact, (3-43)

<u>in a system of units adjusted to the new value for the mass-unit.</u>

In the process of using the ratio of two frequencies to determine the value of g/2, the effect of the current length of a time unit relative to an emergent time unit is the same in both numerator and denominator, so the effect of universe age is eliminated. As a result, the measured value of g/2 will be independent of the age of the universe.

The actual measured value for the electron g/2 value represents the response of the actual electron mass and charge to the imposed electrical and magnetic fields. Since the conditions are the same for both modes (spin and cyclotron orbit) these conditions wash out in the frequency ratio. In using the ratio of the postulated theoretical g/2 in combination with the actual measured value, as a function of the difference in mass of an actual mass-unit and a Carbon 12 mass-unit, it implies that the value of the conventional Carbon 12 based mass-unit is contained somewhere in the relationships. It is not obvious in any of the relationships, but it must be there, contained implicitly in our basic system of units for m, l, t. This is possible because our system of units is not uniquely defined over the full range of values. Length and time have a fixed ratio over the full range, mass and energy have a fixed ratio over the full range, but a unique mass value is not employed. The physical prototype standard gram is not necessarily the same as the theoretical gram that is consistent with the units of length, time, and energy. The Carbon 12 mass-unit at the atomic level does not precisely fit the system requirements as it is also considered an independent prototype at the atomic level. The relationship of the Carbon 12 unit to the physical prototype gram is still not known with adequate precision (Avogadro's number). The new fundamental mass-unit however is precisely related to the system's theoretical gram that is consistent with the concepts of centimeter and second as restricted by the value of c, and the relation between mass and energy as restricted by the value of c^2.

Also, from the fact that the mass difference is detectable at all, there is a supporting implication that the electron's mass response to the universal field relative motion is different than the response of neutral mass. This is connected with the fact that in computing the mass ratio of a mass-unit to an electron mass, the omitted first two wavelength components (the fraction 1/3) appear at the 1/8 root, while the remaining components appear at the first power. (See Equation 3-56.) In effect, when using the conventional Carbon 12 based mass-unit as fundamental, we assign some ordinary neutral-matter mass excess to the electron mass. This excess mass does not respond the same in spin, where it is affected by the electrical field components, and in cyclotron orbit motion where it is affected by neutral universal field in addition to the electrical components. If it were not for this difference in response to the two situations, the effect of the mass-unit ratio difference (Δm_μ) upon the implied electron mass would cancel out in the frequency ratio and be undetectable.

On the basis of the above findings, we can express the experimental results of the frequency ratio experiments in two forms: one for use with the present system of units, and one for a system of units that recognizes the new mass-unit and the theoretical gram. (See discussion of system of units in Section 4. .)

$$Hz_s/Hz_c = [1/(N_w/N_p)^{8/5}]/(\Delta m_\mu)^{1/3.5} = g/2, \qquad (3\text{-}44)$$

for the present system of units, and

$$Hz_s/Hz_c = [\ 1/(N_w/N_p)^{8/5}] = g/2, \qquad (3\text{-}45)$$

for a new system of units for m, l, t.

The observational data in our present system of units for m, l, t is contaminated by a false assignment of mass-unit values. The resonance ratio $[1/(N_w/N_p)^{8/5}]$ must be associated with the electron spin characteristics as the more fundamental properties than the orbital motion properties, and the $(\Delta m_u)^{1/3.5}$ factor is most likely associated with the orbital response resulting from the mixed mass type assignment.

3.4. Fine Structure Constant a^{-1}

The relationship between the fine structure constant (a^{-1}) and the square of the charge on the electron has long suggested that there is a dependence such that if one is determined, the other is fixed:

$$a^{-1} = h\,c/(2\,\pi\,e^2) = \qquad (3\text{-}46)$$

We insert the equation for the observable value for e^2, Equation (3-22), and obtain

$$a^{-1} = 24\,K^{1/2}\,e^3/\{2^{5/8}\,\pi^4\,[1 - 1/(4\,K\,\pi^{1/8})]^2\}. \qquad (3\text{-}47)$$

The only factor, in the right hand side above, that is not presently considered a known pure number, is K. It is the ratio of a theoretical mass-unit mass to an electron mass. The value of the constant K can be derived from observational data or by geometry and probabilities, but only the value derived from the theoretical mass-unit is properly applicable in Equations (3-22) and (3-47). For maximum precision in computing a theoretical value, the full 16 place computed value for K (Eq. 3-61) should be used, and the value used for e should be the inverse of the value for the e^{-1} series terminated with the 17! term (Eq. 3-55). The first approximation would involve comparing the mass of the electron with that of a mass-unit as observed.

If we utilize the computed theoretical value for K (from Equation 3-61), based upon the electron mass in lcr mass-units, in Equation (3-47) above, it yields a theoretical value for a^{-1} as

a^{-1} = 137.036 054 799 2528 . , using the std value for e, or

a^{-1} = 137.036 054 799 2527 . . using e from ending with 17! term. (3-48)

Examining Equation (3-47) indicates a^{-1} to be dimensionless with respect to h and e^2 as properties of an electron as an entity, but it is not necessarily dimensionless with respect to the units in which the mass of an electron is measured. Since it was indicated in subsection c, that the ratio K implied the units in which the electron mass was expressed (Equation 3-39), I feel that a^{-1} as a fundamental property, of an electron as an entity, should reflect exactly the same ratio of the effect of the fundamental mass-unit to Carbon 12 based mass-unit in comparisons involving the current observational value for a^{-1}. This ratio is $(\Delta m_\mu)^{11/6}$. (See Section 4.4. .) Then, making the comparison with the CODATA 1986 recommended value for a^{-1}:

$$a^{-1}\ (\text{theoretical})/a^{-1}\ (12C) = (\Delta m_\mu)^{11/6}, \tag{3-49}$$

The CODATA 1986 recommended value for a^{-1} is

$$a^{-1} = 137.035\ 9895\ (.045\ \text{ppm}). \tag{3-50}$$

Solving these yields

$$\Delta m_\mu = 1.000\ 000\ 2599\ (0.035\ \text{ppm}). \tag{3-51}$$

The true fundamental value for a^{-1} in the new system of units should be its value computed from the theoretical value for K, from the electron mass expressed in local-cosmic-rest units. This is the value given in Equation (3-48) above.

3.5. Ratio (K) of Mass-Unit to Electron Mass

This ratio number (K) is involved in the structure of the electron in such a way that it is an element in determining both the "charge" of an electron and its mass, relative to a standard local-cosmic-rest mass-unit. I believe that the value of K is fixed by the fractional portion of the wavelength spectrum in the universal field that is transmitted by the electron, which then relates it properly to the local-cosmic-rest mass-unit. The factor e^{-1} was adopted as representing the composite of the wavelength distribution in the universal field. This factor appeared in the equation for the radius of a cosmic rest mass-unit, and thus is involved in many other equations. The factor e^{-1} can be expressed in an infinite series form as

$$e^{-1} = \sum_{n=1}^{n=\infty}\left(-1^{(1+n)}\right)/(1+n)!,\ \text{or} \tag{3-52}$$

$$e^{-1} = 1/2 - 1/6 + 1/24 - \ldots -1/17! + \ldots\quad . \tag{3-53}$$

Although I have ordinarily used the value of e^{-1} as the usual computed limit of the infinite series, I believe the correct usage would be to stop with the term (1 + n) = 17. This is because the universal field appears to be of 16 dimensions, in a unit of time, in its rotation interactions with the basic mathematical group. This value would involve a last term in the series as 1/17!. The usual value for e^{-1} to 16 places is

$e^{-1} = 0.0367\ 879\ 441\ 171\ 4424$. (3-54)

The series in Equation (3-53) c0arried through the 1/17! term yields

Series total = 0.367 879 441 171 4423 . (3-55)

Components in the universal field determine the dimensions of stable structures at the fundamental level. I believe that the size of the electron is not arbitrary, but is fixed by universal field wavelength interactions. In line with this belief, then the size of the electron could be governed by relationships among partition fragments of the series for e-1 and the total series. The first partitioning of Equation (3-53) that yields two positive fragments, each of which is less than e^{-1}, is following the term -1/6. The two portions then will be 1/3 and (e^{-1} - 1/3).

An electron is smaller than a mass-unit, so we will attempt a construction utilizing the two fragments. First, however, we can eliminate some factors. The equation for r_1 (Equation 2-28) is $r_1 = L_h\pi\ e^{-1}\ 2^{5/8}/2$. Since we are going to refer everything to the mass-unit, all the size factors in the radii will be the same as those in the above equation, except for the aspects related to e^{-1}. We discard the other factors from our ratio, and deal only with the parts that will relate to the series for e^{-1} and the partition fragments.

The smaller fragment (e^{-1} - 1/3) should be directly involved in the radius of the electron, but the fragment (1/3) must also be involved at the fundamental level, since the dimension somewhere must be such as to accommodate the longer wavelength components, as simple sub-harmonics if nothing else, in making the electron and the structure left (the proton) be complements. In our perceived space we are dealing with an 8 parameter structure, so we will include the 1/8 root of the larger fragment as $(1/3)^{1/8}$ in the volume radius. If we include the smaller fragment directly, as also being involved in the radius, it will appear as the cube in the three-space volume. Then, what we are actually interested in is our factor K, which has two aspects. The first of these is a pure total-effective-volume ratio in a three-dimension sense. To obtain this, we set up a ratio of e^{-1} to the new volume components

$\text{Ratio}^{1/3} = e^{-1}/[(1/3)^{1/8}\ (e^{-1} - 1/3)]$, or

$\text{Ratio} = e^{-3}/[(1/3)^{1/8}\ (e^{-1} -1/3)]^3$. (3-56)

The above takes in only one aspect of the ratio factor K, and that is the pure mass ratio, but it has not included the interior volume-concentrating-aspect that is part of the hypothesized electron structure. To take this into account, we must look at the concentric volume composed of a mass-unit volume outside of an electron core volume. The electron, in isolation, has a mass 1/K of a mass-unit in isolation. On a conservation basis, when combining the volumes of the two structures, the structure will have a volume equivalent to a mass of K + 1 electron masses. Considering the electron as a central volume, it is 1/(K + 1) of the total.

The volume outside the electron, in one time unit, contains the electrons radiation in one mass-unit volume. Then, as a composite, we have

$$V = V_{\mu} [1 + 1/(K + 1)]. \tag{3-57}$$

If we reduce this to radii effects, we would obtain $r_1 [1 + 1/(K + 1)]^{1/3}$, but we are interested in the volume ratio related to K, where the connectivity is not a simple linear volume ratio. What is needed is a connection where the dual volume aspect relates to only one component out of four in the field. V_{μ} involves the ratio K relative to the interior volume a0nd is a cubic effect. If we treat this as the normal space aspect and consider the root represented by $[1 + 1/(K + 1)]^{1/3}$ as the single electrical field component aspect, and then combine these factors to represent the dual volume effect upon the mass ratio, we obtain the factor $K [1 + 1/(K + 1)]^{1/3}$. Then, we equate this ratio factor to the factor derived from the series partitioning Equation (3-56), and obtain

$$K [1 + 1/(K + 1)]^{1/3} = e^{-3}/[(1/3)^{1/8} (e^{-1} - 1/3)]^3. \tag{3-58}$$

If we let a factor Z equal the right hand side of the above equation, the equation can be expressed in simple form for solution by successive approximations as

$$K = Z/[1 + 1/(K + 1)]^{1/3}. \tag{3-59}$$

This converges to a solution very rapidly. Evaluating Z, using the series for e^{-1} truncated at the term 1/17!, Eq. (3-55), yields

$$Z = 1823.222\ 415\ 882\ 725, \tag{3-60}$$

and the solution as

$$K = 1822.889\ 326\ 176\ 941\ . \tag{3-61}$$

For ordinary calculator usage, this is rounded off to

$$K = 1822.889\ 326\ . \tag{3-62}$$

This geometry derived value is not the full story. It is necessary to recognize that K relates to electrons, and they are involved with charge as a major mass factor. This is a universal field effect, and it appears that the electron's electrical field can not contain the full wavelength distribution that is in the neutral universal field. This is by reason of the small size of the electron core, which has a band-pass characteristic that cuts off the first two terms (1 + n = 2 & 3) in the series representation for e^{-1}. This restricts the electrical field to 14 components, and since it is the longer wavelength components that are excluded, it can have an effect on the field interaction with the electron structure.

3.6. Exploration of Structural Factors

In the process of derivation of the charge on the electron, the structure was treated as though it was some kind of a concentric structure with a large outer radius (r_e) and a smaller inner radius (r_g), both of which were related to the field mass-unit radius (r_1). The r_e part of this seems to be an artifact of the need to treat the structure in the ordinary perceived spacetime. Although r_e may not be perceivable in our ordinary spacetime, it can be an interior space aspect that has an effect equivalent to an external r_e, and can be reflected in aspects of the proton's structure. The small inner radius r_g utilized in the derivation represents the implied equivalent radius of the electron in our ordinary space time sense: that is, in a three dimension space sense only, since the time aspect of an electron is the same as the time aspect of a mass-unit. With the time aspect being the same as that of a mass-unit, the quantity of field from an electron in a unit of time appears to be a sphere of essentially the same radius as r_g plus a mass-unit volume. Most of the field at any one instant is outside of the electron's core inversion boundary.

The field-volume concentrating aspect is primarily an interior space aspect, that represents the electron structure acting upon the whole field in the interior inverse space. There, it only permits into perceived space the wavelengths that are characteristic of the bandpass properties of the small radius r_g in perceived space. This radius was specified to relate to the mass-unit radius as $r_g = r_1/K^{1/2} = r_1/42.695...$, or as $r_g = r_1$ (2.342... x 10-2). The equations for r_1 in terms of the quantum length L_h, that are representative of a mass-unit of field (Equations 2-28 to 2-30) contain several factors. The component that represents wavelength component distributions is e^{-1}. If the component of longest wavelength is represented by the term 1/2 in the series for e^{-1} (Equation 3-53), then to obtain relative wavelengths with respect to r_1, we must divide by ($2\ e^{-1}$). Doing this for the electron radius r_g yields its equivalent length (L) as

$$L = (r_1/K^{1/2})\ e/2 = 3.1833 \times 10^{-2}\ r_1. \qquad (3\text{-}63)$$

This can also be expressed as a fraction,

$$L = r_1/31.4134. \qquad (3\text{-}64)$$

The best first approximation to the bandpass characteristics of the interface would be to treat it like a hollow metallic sphere, where a large change in phase of incident radiation occurs (in analogy with the almost 90° phase change in crossing from interior to exterior space for universal field). A hollow metallic sphere has an interior resonance wavelength for plane electromagnetic radiation (I.T.T.C. 1956) that is approximately 2.28 times its radius. At resonance, the interface would be highly reflective and very little radiation would pass through. This resonance wavelength would be 2.28 times the L value in Equation (3-64), yielding an upper limit to the bandpass characteristic as

$$L\ (\max) = r_1/13.78, \qquad (3\text{-}65)$$

for the upper limit to what could be passed by the interface of radius r_g.

This limit (to what is passed by the electron) is smaller than the fraction 1/6, but larger than the fraction 1/24 in the series for e^{-1}. Thus, the electron does not pass the longer wavelength components in the universal field, but only those represented by the fraction 1/24 and smaller in the series.

The theoretical value for the ratio of a mass-unit to an electron mass is 1822.889 326. In computing K, a partitioning in the series for e^{-1} was made between the series terms -1/6 and +1/24. With the electron structure being related to the smaller component portion of the series, the bandpass characteristics above for the radius r_g are consistent with that partitioning.

A direct consequence of the electron size is that electrical fields do not involve the full spectrum of wavelengths that are contained in the neutral total universal field. The electron excludes the components in the series that are represented by the terms n = 1, or 2, and passes those represented by n = 3 through 16. In a field dimension sense, then the electrical field can be considered to be of two dimensions less than the neutral universal field.

The fact that we have two types of electrons with opposite spin characteristics, and yet do not detect any differences in the field from either type (at large separations), suggests that the field from either type is the same. This would imply that the electron removes the three-space rotational characteristics from the universal field components concerned, when it is converted to an electrical field component in our perceived space at the state of local-cosmic-rest.

The electron contains the energy represented by the terms +1/24 and beyond. The terms are alternately positive and negative. We can account or this if we attribute the positive terms to the real-space field squares and the negative terms to the imaginary-space field squares. This provides a further bit of information about the electrical field (and the universal field), in that probably the n = odd and n = even components at any one instant are 90^o (of phase) apart with respect to each other in the complex four space.

The summary equation for observable "charge squared" (Eq. 3-22) contains a factor for the fraction of an electron's mass that is not charge. This measure on the non-charge portion is

$$1 - [1 - 1/(4 K \pi^{1/8})]^2 = 2.377\ 060\ 073\ 236... \times 10^{-4}. \qquad (3\text{-}66)$$

The total electron mass in new fundamental units is

$$m_e = 1/K = 5.485\ 796\ 562\ 851\ 379... \times 10\text{-}4\ m_\mu. \qquad (3\text{-}67)$$

The charge portion is

$$5.484\ 492\ 556\ 053\ 435... \times 10\text{-}4\ m_\mu. \qquad (3\text{-}68)$$

The non-charge portion is

$$1.304\ 006\ 797\ 945... \times 10\text{-}7\ m_\mu. \qquad (3\text{-}69)$$

At this point it seems appropriate to mention again the relationship among the three kinds of mass-units. The ordinary mass-unit physical is 1/12 of a Carbon 12 atom. All atomic masses (except Iron 56 and the free Neutron) retain the same numerical value when expressed in the Carbon 12 based units in any uniformly moving frame.

The ca unit is of a size equal to a local-cosmic-rest mass-unit, and to a Carbon 12 based unit divided by 1.000 000 2480, when both are at the state of local-cosmic-rest. It behaves the same way toward reference frame motion that the Carbon 12 unit does.

The local-cosmic-rest mass-unit is a fixed unit of mass throughout the life cycle of the universe. It is coupled to cosmic relationships and the total emergent mass of the universe. It does not vary in mass with rest frame velocity, because it refers only to the state of local-cosmic-rest. In a general way, when talking about the mass of atomic units (without specifying velocity) the number of atomic mass-units as ca units or as lcr units is numerically the same.

3.7. Electron Field Radiation

The electrical field of electrons and protons must be derived from the neutral universal field by some partitioning and transform processes. We do not yet have sufficient understanding, of the full nature of the universal field, to put it into mathematical form. At least, we can examine the requirements of electron and proton behavior, and test whether or not the present concept of the universal field is adequate to contain the required properties.

In deriving the charge on the electron, it was specified that only one of the four rotation components that make up neutral mass was involved with an electron. We adopted a convention that electrons affected field that is moving outward in our normal time sense. The field has two rotation directions in the ordinary outward flow, so it can accommodate two types of electrons. Each of these unwinds one type rotation and generates a resultant field that has no rotation with respect to local cosmic rest; that is, no rotation in the ordinary perceived three space. Likewise, there can be two types of positrons that deal with the two rotation components in the negative time sense.

A proton is a neutral structural unit which has lost an electron, and which transforms the complementary component to its lost electron in the same manner as a positron does. The proton, however, also deals with the two longer wavelength components in the universal field that are excluded from the electron and/or positron structure. This maintains total balance in the universal field.

The electron's fields, for the two types of electrons, at distances greater than atomic diameters, appear to be indistinguishable with regard to potential levels and magnetic field effects due to motion. This is easy to reconcile with respect to static charge effects, but for electrons in motion, we need to examine the possible field relationships somewhat closer.

The universal field has rotation components about all four physical direction axes. The field of an electron in ordinary three-space is only rotation free in the state of local cosmic rest. Any motion at all in three space, other than that associated with the universe expansion, is motion relative to lcr. Then, this motion, interacting with the fourth physical-space-direction rotation-components, produces a vector product that is orthogonal to both the fourth physical direction and to the three-space direction of motion. There are two of these directions, and they constitute a plane normal to the direction of motion. This is exactly what we find as a magnetic field effect about a moving electron: it is in a plane normal to the direction of electron motion.

This vector cross product will vary in magnitude with the product of the two velocity components. The fourth physical direction component, however, is constant at a rate $c/(2\ \pi)$, so the total cross product is a direct function of the three-space linear velocity. At velocity zero there will be no cross product and hence no magnetic field. Also, since the cross product is directly proportional to velocity, the effect per unit of electron path traveled per unit time will be identical regardless of electron velocity (for velocities greater than zero). Thus, for magnetic field effects, the electron velocity makes no difference in field intensity integrated over a given time. The effect would be proportional to the total number of electrons passing a given reference plane normal to the electron path in a unit of time. This is exactly what we experience; magnetic field is proportional to electron flow count per unit time, but independent of electron velocities.

Protons or positrons involve the opposite time flow components of the field, and a given current flow in one direction for electrons represents an opposite motion direction for protons or positrons. If the negative time flow components were considered by themselves, the vector cross product would be in the opposite direction, but coupled with opposite physical flow direction, the net magnetic field effects are the same as the opposite flowing direction for the opposite charges. The field effect is proportional to current flow direction and is independent of whether the actual current is composed of negative or positive charge carriers.

Neutral particles do not exhibit such effects, because there are exactly equal clockwise and counter-clockwise field rotation components that balance out over a universal field unit cycle.

Now, we need to examine the stationary "charge" radiation. The electron operates upon one of the two rotation directions in the positive time sense. If the field consists of alternating components it could not have unidirectional effects, except as intensity or pressure difference effects, and would only cancel opposite flows if phase relationships were proper. We need something less dependent upon precise combinations of phase and frequency relationships. It is postulated that the electron performs a transformation equivalent to full-wave rectification on the particular component as it leaves the electron structure. The result, then, is a series of unidirectional pulses, which is equivalent to a zero frequency modulation combined with a double frequency carrier containing higher harmonics. The opposite charge particles perform a similar rectification operation, but in the opposite potential sense. Charge fields can leave the perceived universe by way of opposite charge particles, thus maintaining the balance in universal field flow through our universe. Charge field encountering a neutral matter particle is demodulated at the inversion boundaries, and the zero frequency component is then transferred onto outgoing universal field from the neutral particle. In this way charge fields are conserved in the universe of their origin, except for their interactions with opposite sign charge fields. Two similar type charges being brought into proximity build up radiation pressures upon the facing surfaces and appear to repel each other. Two opposite sign charges reduce radiation pressures on the facing surface, so that pressures on the far sides force them together, which appears as apparent attraction.

There is a lot of potential in this universal field approach to lead us to better understanding of electromagnetic phenomena. Before we go too far however, we need to re-examine our conventions about field line directions relative to current flow, and current flow relative to electron flow, and determine whether the vector system is right handed for electrons and left handed for positive charges, or vice versa, or whether both right and left handed vector systems are involved. Then, taking into account phase synchronization factors should lead to better understanding of the quantizations of electron orbits in atoms, etc.

The charge effect of an electron represents a continuous inflow of energy from inverse space into the perceived universe. The effect of a positive charge represents a continuous outflow of energy from the perceived universe into inverse space. These two must be identical over the long haul to maintain stability of the relative sizes of the four major components of perceived matter, perceived space, negative matter, and negative space, and of their coupling through inversion boundaries.

4. STANDARDS, UNITS, AND CONSTANTS

4.1. General

Ordinarily we would not need to examine the foundations of our system of standard units of mass, length and time, but in the present theory there are implications that the length and time units change with universe age. Also, there are the deviations of the isotope Iron 56 and free Neutrons from the behavior of other matter in reference frames with different velocities relative to local cosmic rest.

Our unit of time, the second, was originally based upon the ephemeris second, and has since then been converted to a unit based upon a count of cycles of a selected Cesium-133 transition. This relates the second to a precise quantity of energy and to the actual value of Planck's constant at the instant of measurement. With the modern improved timekeeping techniques, the atomic second is now our most precisely measured standard unit. The unit of length, the meter, was initially a measured distance on a physical prototype meter bar, but was subsequently converted to a distance spanned by a fixed number of wavelengths of a selected Krypton-86 transition radiation. The value of the radiation velocity constant (c) has become so dependable that it has been accepted as part of the primary standards, defined as exactly 299,792,458.0 meters per second. Then, taking advantage of precise timekeeping techniques, the meter has been re-defined as the radiation travel distance in vacuum in 1/299,792,458.0 second. This utilizes the value of c as the specified ratio between the selected scales of time and length. This is $2.997\ 924\ 580 \times 10^{10}$ cm/sec as the value that I have used throughout the present work. I have also used the pure numerical ratio as c as a scale factor in some equations at the fundamental level, where the minimum unit of length and the minimum unit of time both represent the same minimum unit of the universal field, with a net effect of a dimensionless factor.

The time and length standards can both be materialized, at locations remote from the physical prototypes, with high precision. The unit of mass, however, is difficult to materialize at remote locations, except through copies of the physical prototype that have been directly calibrated against the original. The mass standard actually represents a fixed number of atoms of a particular product mix of elements in the physical prototype. If atom counting techniques were sufficiently precise and Avogadro's number was known with adequate precision, for some standard atomic species, then it might be possible to materialize mass standards at remote locations with useful precision. The possibilities for this are discussed by Pipkin & Ritter (1983). The Implications in the mass-unit standard are something that needs careful study for possible hidden connections with the other two units.

In defining the time unit by an atomic phenomenon, we have coupled it to the energy of a specific atomic transition and to the value of Planck's constant (which has been assumed to be fixed). By using a time unit and the radiation velocity c to define the meter, we have also coupled the length unit to a fixed quantity of energy (with c defined as fixed). We have also defined a relationship between mass and energy, involving time and length, that establishes an additional relationship between our three fundamental standard units. The erg is defined as a dyne-centimeter and the dyne as the force required to accelerate a gram mass at one centimeter per second per second. Combining these we have:

one erg = one gram cm^2 sec^{-2}. (4-1)

Then, if we replace one cm by its defined time equivalent of one second divided by c, (where c is the dimensionless numerical ratio) this becomes

one erg = one gram/c^2. (4-2)

This brings a circularity into our set of standard unit definitions such that, once a time-unit standard is set, as based upon a specific energy transition, then the other two units must be in some fixed ratio to the time unit. There is only one degree of freedom in our set of three primary units. Once that one unit is set as a standard, the associated values of the other two units are determined.

The internal relationships in our set of three fundamental units imply now, that once the size of the time unit (the second) is fixed in relation to a specific atomic transition, then there is a precise theoretical meter and a precise theoretical kilogram. Our physical prototype standards for length and mass may be very close to the theoretical standards, but they are probably not exact materializations of the length and mass standard units that are implied by our time unit standard. The physical realities of measurement technology are such that the correspondence between the theoretical length and the prototype length standard is very good, but such is not the case for mass.

The local instant value of Planck's constant is not a fixed value throughout the universe life cycle, but increases slightly with cosmic age. With c defined as a fixed ratio, then length and time stay in the same fixed ratio, even though the specific individual values relative to the emergent values change with universe age. With c fixed, the ratio between mass and energy remains fixed throughout the universe life cycle. The unit of mass can be treated as equivalent to a collection of atoms of water, and as such it is a fixed number of atomic-mass units. This being so, it should be related to Avogadro's number and the size of an atomic mass-unit.

Presently the atomic mass-unit physical is defined as one twelfth of an atom of the isotope Carbon 12, but the natural elementary mass-unit differs very slightly from the Carbon 12 based unit. We have defined the elementary mass-unit in the present new approach as the mass of a natural minimum volume-unit of universal field interaction. It is specified to remain a fixed quantity of energy throughout the life cycle of the universe. This unit is called the local-cosmic-rest mass-unit or lcr mass-unit. Being a fixed quantity, if we could find the proper set of equations, it should be possible to compute the theoretical number of mass-units in a theoretical gram (N_z) with high precision. This then could be related to Avogadro's number by means of the relationship between a Carbon 12 based mass-unit and a local-cosmic-rest mass-unit, and the relationship between a theoretical gram and a physical prototype gram.

4.2. The mass-unit, the free Neutron, and Iron 56

In our current usage, the mass-unit physical, that is employed in measurement of atomic species and particles, is 1/12 of a Carbon 12 atom. This unit was arrived at through a series of steps with reference to the mass of atomic hydrogen, an atom of oxygen, and now an atom of Carbon 12 isotope. If there is a true fundamental unit of mass, it is not likely to agree exactly with any one of the units we have used. As it happens however, the present Carbon 12 based unit is quite close to the fundamental unit, when its energy content at local-cosmic-rest is compared with the energy content of a local-cosmic-rest mass-unit at local-cosmic-rest. Present data indicates that, at the above situation, the difference is very close to 0.248 parts per million, so that for many approximations the use of the Carbon 12 based unit is quite adequate.

One of the basic postulates of the new approach is that there is a minimum size unit of the universal field that contains a full representation of all the field components and potentialities. The universal field, in interaction with the abstract mathematical group, determines dimensions of units of structure. The simplest unit of structure involves one unit of universal field, in a physical unit that has the full range of structural potentialities. At some stage in the structural evolution of our universe then, the mass-unit and the mass of the unit of matter (structural unit) should be equal. It appears that this point of equality is that of emergence of a wave-function-space unit of neutral matter, the Neutron, into our perceived space at the state of rest relative to the emergence point. This is not local-cosmic-rest, but rather an absolute state of rest relative to the origin point.

A further postulate is that the mass-unit is a fundamental quantity of energy, fixed in amount relative to the cosmic origin and invariant throughout the universe life cycle. This specification of fixity makes it different in character from our ordinary mass-unit that is based upon a Carbon 12 atom. To keep the fundamental mass-unit separate from our ordinary Carbon 12 based unit, this fundamental unit is identified as a local-cosmic-rest (lcr) mass-unit. It is invariant in terms of energy relative to the state of local-cosmic-rest. It is a fixed quantity of mass equivalent, throughout the universe life cycle, but it is strictly applicable only to the state of local-cosmic-rest.

Our ordinary system of standard units has the property of changing all its energy relationships and absorbing them into its structure in such a way as to make differences in system velocity relative to local-cosmic-rest be invisible within a given system. This is the reason that the laws of physics are numerically the same within systems moving at different velocities relative to local-cosmic-rest (except for the behavior of Iron 56 and free Neutrons). This is also in conformance with the requirements of special relativity. Using the local-cosmic-rest mass-unit to compare systems of matter at different velocities would complicate our physics by requiring knowledge of the velocity of each system relative to the state of local-cosmic-rest. To get around this complication, a new mass-unit is proposed. It is an adjusted Carbon 12 mass-unit, that I call a ca mass-unit. This unit is of a size such that, at the state of local-cosmic-rest, its energy is exactly equal to a local-cosmic-rest mass-unit, and it behaves like ordinary matter (and Carbon 12) under changes in system velocity relative to local-cosmic-rest. This ca unit of mass is smaller than a Carbon 12 based unit in the ratio 1/1.000 000 248, so to convert atomic masses in Carbon 12 based units to ca units we multiply the number of Carbon 12 units by 1.000 000 248 to get the number of ca mass-units. A similar conversion also needs to be applied to Avogadro's number, and in appropriate form, to other fundamental constants, depending upon their dimensional structure, to yield compatible factors. It is necessary to recognize the operational differences between a ca mass-unit and a local-cosmic-rest mass-unit when calculating energy relationships. In referring to the nominal values for atomic masses, I use local-cosmic-rest (lcr) mass-units as applying to the standard conditions, recognizing that these are numerically the same as the ca units. For cosmic relationships it is necessary to use the lcr values in calculating standard conditions, which are all referred to the state of local-cosmic-rest.

In the process of exploring relationships that might account for the stability of Iron 56 and account for its position as having the lowest energy level atomic structure, the value of mass for a particular elementary unit, that I call a resonance factor, was computed and found to be quite close to 1/56 of the Iron 56 isotope. This unit is:

$$(N_w/N_p)^{8/5} = 0.998\ 841\ 620\ 274\ 317... \qquad (4\text{-}3)$$

The observed atomic mass of Iron 56 (Wapstra & Audi 1985) in Carbon 12 based units is

$$\text{Iron } 56 = 55.934\ 9393 \pm 16 \text{ in last digits.} \qquad (4\text{-}4)$$

$$1/56 \text{ of above} = 0.998\ 838\ 2018\ (.0285 \text{ ppm}). \qquad (4\text{-}5)$$

Upon examining the resonance stabilized ratio and comparing it with the observational value for 1/56 of an Iron 56 atom , several alternatives present themselves.

1. There is no relation between the two numbers.
2. The resonance value, in local-cosmic-rest mass-units, is the same as the 1/56 of Iron 56 in Carbon 12 based units. The numerical difference reflects the relative size of the two units of mass.
3. The Carbon 12 mass-unit and the local-cosmic-rest mass-units are very close, but part of the difference between the two numbers is accounted for by the velocity of the solar reference frame with respect to local cosmic rest, or some other relationship.

I flatly reject the first possibility because there is a definite relationship between the probable numbers N_w and N_p for maximum numbers of possible structures in the wave-function state and the pre-emergence state. Furthermore, with 8 parameters involved in the structure of pre-emergence units and a similar set of 8 parameters reduced to 5 independent ones by relational limitations in the wave function state, these parameter numbers are related and must influence some probable state of emerged-matter structural units. The problem is to find out what the relationships are, and how to use them.

Iron 56 is the atomic species with the lowest energy per structural unit, yet there are stable atomic structures with both more and less structural units than Iron 56. Something contributes to this particular nuclear stability. The conventional answer relates the stability to a minimum in the combined effects of an increase in relative nuclear surface energy with a decreases in internal position energies, as the number of components in the nucleus increases. At some level this may be a correct analysis, but the resonance of probability states is a more fundamentally likely cause for stabilizing a particular energy level of interaction with the universal field. In fact, if this stabilization of energy level is sufficiently strong, it could partially stabilize the isotope Iron 56 against changing some of its phase-angle energy with changes of its velocity with respect to local cosmic rest.

If the stabilization effect is sufficiently strong enough to hold all four length dimension aspects to their lcr lengths, while at the same time participating in the velocity of the moving reference frame, then, relative to the moving frame there would be a phase lag effect in all four directions. The net effect would be as though there were gravitational phase shifts of $-i\ \theta_g$ in all four physical directions. The effect of this upon mass measured in the moving frame then would be

$$m_v = m_0/\cos^4 \theta_g = m_0 \cos^4 \theta_p. \qquad (4\text{-}6)$$

If this is the result of the resonance factor stabilization effect then, for Iron 56,

$$m_v/m_0 = \cos^4 \theta_p. \qquad (4\text{-}7)$$

The next question is, what velocity is implied by the difference between the resonance stabilization value and the observed Iron 56 mass? Putting the mass numbers into Equation (4-7) above yields:

$$0.998\ 838\ 201\ 786/0.998\ 841\ 620\ 27 = 0.999\ 996\ 5775 = \cos^4 \theta_p, \quad (4\text{-}8)$$

$$\text{Sin}\ \theta_p = 1.308\ 139 \times 10^{-3}, \quad (4\text{-}9)$$

$$v = 2.997\ 924\ 58 \times 10^5\ (\text{Sin}\ \theta_p) = 392.17\ \text{km sec}^{-1}. \quad (4\text{-}10)$$

This computed velocity is in moderately good agreement with the observed velocity of the solar frame with respect to the cosmic microwave background radiation. This observational value is 360 ± 5% km sec-1, as determined from the anisotropy in the microwave background radiation [Wilkinson 1986]. The reported value based on later observations is 370 ± 10 km sec^{-1}, (Peebles, 1993, Equation 6.29).

Computing the value of 392.170 km sec-1 above assumed that the value of a local-cosmic-rest mass-unit was the same as that of a Carbon 12 based mass-unit at the state of local-cosmic-rest. This calculation does not give an exact result, but only says that the two mass units are probably quite close. We actually need some other relationship to eliminate the remaining uncertainty.

In search of an additional relationship, I explored the possibility of computing the mass of the free Neutron from some similar first principles. This involved some basic assumptions as follows:

1. Since a structural unit emerges into wave-function space initially as a Neutron, and the universal field is the size and energy determining entity, we assume that, at the point of emergence (and before picking up expansion velocity), a structural unit is identically one mass unit.
2. The velocity of expansion relative to the emergence point is $c/(2\ \pi)$ and it is in the unperceived direction that we only associate with time. The result is that the state of local-cosmic-rest is moving at a rate of $c/(2\ \pi)$ in the fourth dimension sense relative to the cosmic origin.
3. The ratio of the probable numbers of structural unit states, in the pre-emergence and in the wave function state, is also involved in the free Neutron's properties.
4. Some aspect of the dimensional freedom in matter structures is also involved. To determine a composite effect, we start with the velocity relative to the cosmic origin and form an equivalent phase velocity cosine:

$$\cos \theta_p = \{1 - [1/(2\ \pi)]^2\}^{1/2}. \quad (4\text{-}11)$$

For an external perceived-space effect, we raise this to the fourth power. We recognize that this is a different situation than just motion relative to local-cosmic-rest, because most of the universe is involved, and the effect may be distributed among all six dimensions of mass at the unit level. If distributed, the net effect would be reduced to a sixth root. Combining these two effects results in a 4/6 exponent multiplier:

$$\{1 - [1/(2\,\pi)]^2\}^{4/12} = \{1 - [1/(2\,\pi)]^2\}^{1/3}. \tag{4-12}$$

This will act as a divisor effect, in contrast to the effect of $\cos^4\theta_p$ for motion relative to local-cosmic-rest for Iron 56. Then, with the initial cold emergence mass equal to a mass-unit, we have part of the mass determining relationship as

$$1/\{1 - [1/(2\,\pi)]^2\}^{1/3}. \tag{4-13}$$

This implies that we are adopting the local-cosmic-rest state and time-unit as our reference standard units.

In the structural units of perceived matter, we have 8 components each of external and internal structure, that are both reduced to five degrees of freedom by the specification relating real and imaginary coefficients. This amounts to 10 total effective degrees of freedom. We then spread the effect of the probability ratio among these, resulting in a 1/10 root effect in the numerator as $(N_p/N_w)^{1/10}$. Combining this factor with the partial mass factor above, yields an estimator for the Neutron mass (m_n) in local cosmic rest mass units as:

$$m_n = (N_p/N_w)^{1/10}/\{1 - [1/(2\,\pi)]^2\}^{1/3}, \tag{4-14}$$

$$m_n = 1.008\ 661\ 950\ 291\ 588...\ . \tag{4-15}$$

The observed mass of a Neutron in standard Carbon 12 based mass units is

$$m_n = 1.008\ 664\ 904\ (.014\text{ ppm}). \tag{4-16}$$

The direction of this mass difference is in the inverse sense of the effect for Iron 56. If we assign the non-standard responses of the mass of Iron 56 and the free Neutron to the presence of a function of the resonance ratio in the mass determining structures, then we should expect the responses of these two substances to be inversely related, because the resonance factor appears in one sense in Iron 56 and in an inverse sense in the free Neutron. If we assume that the theoretical Neutron's computed mass is correct, and that the mass difference from the observed value is the velocity phase effect in an inverse sense from the Iron 56, that is $1/\cos^4\theta_p$ instead of $\cos^4\theta_p$, we can compute the system velocity relative to local-cosmic-rest.

$$1.008\ 661\ 950\ 29/1.008\ 664\ 904 = \cos^4\theta_p\ , \tag{4-17}$$

$$\sin\theta_p = 1.210\ 086\ 24 \times 10^{-3}, \tag{4-18}$$

$$v = 2.997\ 924\ 58 \times 10^5 \sin\theta_p = 362.77\text{ km sec}^{-1}. \tag{4-19}$$

This computed velocity is also in fairly good agreement with the observed microwave background based measure of 370 ± 10 km sec^{-1}.

In each of the above two approaches, the mass differences have been totally attributed to the velocity effect, neglecting the possibility that there is a difference between the assumed Carbon 12 mass-unit value and the actual mass-unit value. By themselves, neither the Iron 56 based value nor the Neutron based value are sufficient to permit exact calculation of the relationship of local-cosmic-rest mass-units and Carbon 12 based mass-units. The velocity effects upon the masses are in inverse directions for the two substances, so that we can try solving them simultaneously. With two equations in two unknowns, if they are independent, we can solve both for the true velocity and for the difference between Carbon 12 and cosmic mass units.

Consider a factor Δm_μ such that the number of Carbon 12 based mass units multiplied by Δm_μ is equal to the number of local-cosmic-rest mass-units. This allows setting up the equations. For the Neutron, we have:

$$\text{Observed } {}^{12}\text{c mass/Theoretical} = 1/(\Delta m_\mu \cos^4 \theta_p). \qquad (4\text{-}20)$$

For the Iron 56, we obtain:

$$U_{Fe}/\text{Resonance Value} = \cos^4 \theta_p/\Delta m_\mu, \qquad (4\text{-}21)$$

where U_{Fe} is 1/56 of the observed Iron 56 mass in Carbon 12 units. If we divide Equation (4-21) by Equation (4-20), the right hand side becomes $\cos^8 \theta_p$, and the Δm_μ cancels out. Then using the numbers in the left sides of Equations (4-21) and (4-20), we can compute $\cos^8 \theta_p$, which yields:

$$0.999\,993\,649\,22 = \cos^8 \theta_p \qquad (4\text{-}22)$$

$$\sin \theta_p = 1.260\,038\,97 \times 10^{-3}, \qquad (4\text{-}23)$$

$$v = 2.997\,924\,58 \times 10^5 \sin \theta_p = 377.75 \text{ km sec}^{-1}. \qquad (4\text{-}24)$$

This computed velocity is within the tolerance limits to the observed value of 370 $\pm$ 10 km sec^{-1} (Peebles, 1993, Eq. 6.29).

Fitting the velocity effect back into either of the two Equations (4-20) and (4-21), yields a value for Δm_μ to correct the relationship between the two values for mass units as:

$$\Delta m_\mu = 1.000\,000\,247 \quad (0.032 \text{ ppm}). \qquad (4\text{-}25)$$

This says in effect, that a Carbon 12 mass-unit is slightly larger than a local-cosmic-rest mass-unit, so that the number of Carbon 12 mass-units needs to be multiplied by Δm_μ to yield the number of local-cosmic-rest mass-units. The difference in size of the two mass-units appears to be approximately 0.247 parts per million by the above calculations.

This value compares very well with the determination from the Landé g/2 relationships examined in Section 3.3., which yielded an estimate for the ratio as $\Delta m_\mu = 1.000\,000\,247\,993(14)$ as (Eq. 3-37).

The precision limits on the estimation of Δm_μ from the observed masses of Iron 56 and free Neutrons are dependent upon the precision limits for the observed mass of Iron 56 (0.0285 ppm) and for the observed mass of the Neutron (0.014 ppm). The composite of these is (0.032 ppm). Two additional determinations of Δm_μ calculated from other electron properties in Section 3.3. and 3.4., ranging from 1.000 000 245 to 1.000 000 260, confirm the general region of the proper value, so, as a result, the Electron g/2 based value with its high precision is selected as the probable "best value". This is rounded off for most ordinary uses as the value given in Equation (3-42) :

$$\Delta m_\mu = 1.000\ 000\ 2480 \pm (2 \times 10^{-11}). \qquad (4\text{-}26)$$

I must admit that it was disturbing to come up with two significant cases of violation of the strong equivalence principle of relativity, which in turn says that the laws of physics in different moving reference frames are not totally the same for these two materials, if the reference frames have different velocities with respect to local-cosmic-rest. The discovery of the Iron 56 deviation was not particularly difficult to accept, because of the references to iron in some of the ancient legends and occult writings implying something unusual about iron. Also Iron 56, in a way, seems to be tied to the MIR cubit that is involved in the construction of the great pyramid, and to some of the size ratios in that structure. This will be discussed later. When considered together, the existence of the two deviations seems to be more logical than a single one would; with Iron 56 being the lowest energy structural units, and the free Neutron being the highest energy structural unit, and the two velocity-effect deviation trends being inverses. Both these effects open up new areas for experimental exploration. The free Neutron is difficult to manipulate, so that it may be quite difficult to verify the predicted effect. For Iron 56 the verification may be much simpler. In fact, the data may already exist. I seem to remember reading a note concerning some work on the very high energy heavy-ion accelerators, where a shortage of mass-energy was encountered in adding up the components of nuclear shattering of iron.

Despite the good agreements in the calculated system-velocity effects and the relative mass ratios, there is still the possibility that I missed some factor in computing the theoretical mass of the Neutron and of the 1/56 of an Iron 56 atom. If the missing factor was involved in both, and affected mass in an inverse ratio in the two, it could account for the velocity effect agreement. However, it would require quite a coincidence for this factor to also yield an effect so closely matched to the observed solar frame velocity relative to local-cosmic-rest.

The properties of the isotope Iron 56 need to be carefully explored. It may be the only material that we have that can conveniently be used to affect phase angle in the universal field coming out of matter. This may imply potential for manipulation of gravitation. Also, from what has been said earlier about velocity phase angle effects and gravitational field effects being inversely related, it is obvious that the mass change effect in Iron 56 measures only the part of the total local velocity-effect that is not neutralized by the local gravitational field. Thus, for example, on the earth's surface it measures system velocity with respect to local-cosmic-rest, but not the motion component due to the sun's and/or the earth's gravitational field. It is a cosmic motion detector for motion relative to local-cosmic-rest. It detects motion relative to local-cosmic-rest, ignoring the effect of the local space curvature, and excluding any part of the velocity that is coupled to neutralizing the gravitational field curvature contribution. In contrast, using the velocities relative to neighboring galaxies and systems of galaxies requires correction for the earth's velocity about the sun and the sun's velocity in its greater local galactic orbit, etc.

The Neutron's velocity effect, being the inverse of the Iron 56 effect, then would require it to be in the direction of a normal velocity effect, but having a total effect upon the mass as though relative to the state of lcr, all five degrees of freedom in matter unit volume are affected in the same direction by the difference in phase angle. This would represent $1/\cos^5 \theta_p$ relative to lcr. The net effect then, measured in the moving frame, would be the difference, or 1/cos4 p with respect to ordinary mass in the moving reference frame. If two deviations from the constancy of the laws of physics, in reference frames moving at different velocities relative to local-cosmic-rest, are to exist, it seems fitting that they be at opposite ends of the structural-unit energy distribution pattern.

The correction factor ($\Delta_{m\mu}$ **)** of 1.000 000 2480, based upon the Landé g/2 determination and confirmed by the results of the combination of free Neutron and 1/56 of an Iron 56 atom, is a valuable contribution to our knowledge of fundamental constants. It says that the new mass-unit in <u>theoretical grams</u> that are consistent with the standardized values for the length and time units in our basic standards for m, l, t is equivalent to carbon 12 mass-units divided by 1.000 000 2480 . It does not say, however that the number (N_Z) of new mass-units in a theoretical gram is equal to the number of mass-units in the practical unit based gram. The potential for some difference between the practical gram based upon the prototype standard kilogram and a gram that is consistent with the atomic standards of length and time in the m, l, t, basic system still exists.

The best that we can do for the moment is to assume that the two gram values are very close to being the same, and continue to use the physical carbon 12 atom as a comparison fundamental unit of mass at the atomic level, and then correct the result to the new unit value. Then for theoretical purposes we must correct the observed N_A from the CODATA value to a new value (N_Z) by multiplying by the factor $\Delta_{m\mu}$**.**

$$N_Z = 6.022\ 1367 \text{ x } 10^{23} \text{ x}(1.000\ 000\ 2480) = 6.022\ 138\ 193\ 49 \text{ x } 10^{23}, \qquad (4\text{-}27)$$

with the same observational limits of 0.60 parts per million as the CODATA N_A value.

The full 12 digit number will be used in theoretical calculations, but when testing against observations, the CODATA tolerance band must be considered until such time as we improve the N_A observational value, or find some improved means to relate the value of one carbon 12 mass-unit to a theoretical gram.

4.3. Universe Mass

Now we review the relationship of the mass-unit and the total mass of the universe. The total matter mass of the universe is the number of pre-emergence structural units N_p multiplied by the mass of a neutron at local-cosmic-rest. This is one of the very fundamental assumptions that is necessary in order to make any calculations about the size of our perceived universe. This is the starting-point initial mass of the universe. It is identified as N_{u0}, as the initial number of mass-units:

$$N_{u0} = N_p\, m_n = 1.376\ 042\ 437\ 037\ 466... \text{ x } 10^{79} \text{ lcr mass-units.} \qquad (4\text{-}28)$$

This is an exact number of local-cosmic-rest matter mass-units plus free energy equivalents at the state of local-cosmic-rest. It is likewise the number of emergent-size ca matter mass-units plus free energy equivalents perceived at our solar frame velocity.

To convert the above to the number of grams, we need a value for Avogadro's number converted to ca mass-units per gram. For this I use the adjusted N_A value as $N_z = 6.022\ 138\ 193\ 49 \text{ x } 10^{23}$, assumed exact. The source of this number is given above as Eq. (4-27). When we make this conversion, we obtain the number of theoretical grams in the initial universe mass. These theoretical grams are a specific number of units of atomic structure and, when adjusted back to local-cosmic-rest, the number of solar-frame grams is exactly the same as the number of local-cosmic-rest grams at local-cosmic-rest. Thus, when we talk about there being a particular number of grams mass in the universe, we are indirectly specifying the number of local-cosmic-rest mass-units at the state of local cosmic-rest. Considering the probable error level in N_z, we utilize the universe mass to only 10 places as

$$M_0 = 2.284\ 973\ 199 \text{ x } 10^{55} \text{ theoretical grams,} \qquad (4\text{-}29)$$

The number N_{u0} is exact, but the precision of the mass in theoretical grams depends upon the precision of the value for N_z.

Now, the expression for the radius of a mass-unit in terms of the total universe mass is derived from the expression in (Equation 2-41)

$$[(4/3)\ \pi\ r_1^{\ 3}]^2 = 1/(\beta\ M_g\ c^2), \qquad (4\text{-}30)$$

where the square of the ordinary three-space volume is equated to the inverse of the total mass-energy of the universe. The factor β was derived back in the section on gravitation. It appears to be related to the time and shape aspects in the conversion of energy to ordinary perceived space containment dimensions. Since the matter mass of the universe (M_g) changes with cosmic age, the volume represented by a mass-unit must also change. The unit's energy is specified to remain a constant throughout the universe life cycle, so that the universal field energy contained within the volume $[(4/3)\ \pi\ r_1^{\ 3}]^2$ must be constant even while the total universe energy changes with age. The change in total universe matter mass would force the coefficients of the length units in r_1 to change in accordance with Equation (4-30). The only way for this equation to remain valid throughout the universe life cycle, then, is for the size of the units of length in which r_1 is expressed, to change. Thus, the size of the length unit (the centimeter) must vary throughout the universe life cycle.

> Note: I have used the phrase "matter mass" in some of the immediate foregoing material for what has normally been called mass. This is to differentiate it from any effects encountered later (Sections 5. & 6.) from the accumulated "space stress" energy that has a mass-like distributed effect that may contribute to the gravitational forces in extended structures such as galaxies.

This raises a question about our fundamental standards. The standard unit of mass (and hence gram, kilogram, etc.) is a constant in cosmic cycle terms. The unit of length is a variable, and so automatically is the unit of time. It is only the local-cosmic-rest unit of mass that is a constant; our ordinary gram still changes in energy content with the reference frame velocity with respect to the local-cosmic-rest state.

There is a further connection between the unit of mass and the units of time and length. This is the definition of energy, as shown in the previous subsection as Equations (4-1) and (4-2). Expressed in our usual terms for converting the number of units of mass to number of energy units, this becomes the familiar

$$E = m\ c^2. \qquad (4\text{-}31)$$

This equation holds at local-cosmic-rest and in any reference frame moving at constant velocity relative to local-cosmic-rest, but the total energy contents of the grams and ergs in the different velocity frames may be different than those at local-cosmic-rest. Thus, if we define the value of the fixed local-cosmic-rest erg at some particular age of the universe and at a particular local system velocity relative to local-cosmic-rest, then we have added some constraints to our system of standard units.

What we have done, in essence, is to take the concepts that we call centimeters and seconds and specify that their values are exactly 1 at the particular cosmic age and local system velocity for which the precise values are finalized. Then, the values at a different age or a different reference frame velocity are not exactly 1 relative to those standards, but they are still the entities we call centimeter and second, so that they are the nominal standard units in the new reference frames. Superficially it does not appear that this has much effect on our standards, because, if we examine Equation (4-1) we see that, if we used a length of 100 cm as the length unit and 100 seconds as the new time unit, the value of c as a pure dimensionless number would be unchanged. The value of the erg would be unchanged, and likewise the value of the energy equivalent of a gram. However, there are other relationships that are not independent of the size of the length unit, even though c remains fixed.

If we go back and re-examine Equation (4-30) it is obvious that if we change the size of the length units in which r_1 is measured, we must then change the size of the compatible mass-unit in the inverse direction to keep the equation valid. This says that there is a coupling between the size of the length unit and the macro scale unit of mass. In effect there is an atomic-cosmic level inverse relationship that reduces the degrees of freedom by one. In other words, in a system of standard units for mass, length, and time, if we include the scale ratio c there is only one degree of freedom instead of the two that would appear to be present on superficial examination. Eddington was aware of this and treated the system of mass, length, and time (with c fixed) as having only one degree of freedom in his Fundamental Theory. This lack of freedom in the system of units, coupled with the fact that a local-cosmic-rest mass-unit is a fixed quantity of energy, suggests that once we have fixed upon the size of the physical macro-mass unit as grams for example, there may be a way to compute the number of mass-units in a gram (Avogadro's number).

Back in Section II, on gravitation, an Equation (2-73) was encountered that related the coefficient of gravitation (G) to N_z directly, with no other variables apparent. This equation holds only at the instant of full emergence, when obviously we cannot make a measurement of G. A modification of this, Equation (2-71), however, holds at any age, but it requires precise knowledge of the exact universe age at the instant G is measured. Examining Equation (2-73) closer from a dimensional point of view :

$$G_0 = (N_z^{5/3})\ (1.548\ 926\ 5084 \times 10^{-47}\ \text{cm}^{-3}) \text{ in dyne cm}^2\ \text{g}^{-2},$$
$$(\text{dyne cm}^2\ \text{g}^{-2} = \text{cm}^7) = [\text{g}^{-1(5/3)}\ \text{cm}^{-3} = \text{cm}^{10}\ \text{cm}^{-3}]. \qquad (4\text{-}32)$$

The implication of the dimensionality is that, if we measure the gravitational coefficient in cgs units, then we can compute the value of N_z in the cgs system of units. The two numerical values are intimately dependent upon the system of standard units and how they relate to some fundamental cosmic characteristics: specifically how our standard centimeter relates to some fundamental cosmic length.

4.4. Effects of Mass-unit Size Change

The change of mass-unit size involved is from 1/12 of a Carbon 12 atom to a unit that is 1/12 of a Carbon 12 atom divided by Δm_μ. The best estimate of the value of Δm_μ has been established as

$$\Delta m_\mu = 1.000\ 000\ 247\ 993 \pm 14 \times 10^{-12}. \qquad (4\text{-}33)$$

As a result of this change, the standard atomic mass values must be multiplied by Δm_μ to convert them to the number of new mass-units in the new system. This conversion ratio holds for all ordinary mass values determined by direct mass comparison methods, but it does not hold for electron mass expressed in mass-units.

In the case of the electron mass, the primary measurement used to determine mass is the ratio of electrical deflection force to inertial deflection, which is the ratio e^2/m_e. This is a dimensionless force ratio. It is unchanged physically by change in the size of the units in which we express electron mass and charge. It is unchanged numerically when the units in which force is measured are changed, so long as the force units are the same for each component. The mass of an electron is some fixed fraction of a fundamental mass-unit. The true electron mass is unaffected by an arbitrary assumption of mass-unit size. The charge on the electron and the true physical value of Planck's constant are unaffected by an arbitrary choice of size for the mass-unit. All of these invariant physical constants may have their numerical coefficients affected by the choice of mass-unit size, but their true sizes remain unchanged. In the case of electron mass, which is determined indirectly from the measured e^2/m_e, when using other than the fundamental mass-unit size, there may be some distortion of the implied electron mass by inclusion of some function of the difference between the fundamental mass-unit and the mass-unit in which the electron mass is to be described.

The expression for electron charge in terms of fundamental factors (Eq. 3-22) can be used to replace e^2 in the measured ratio e^2/m_e as

$$e^2/m_e = \{h\ c\ [\pi^3\ e^{-3}\ 2^{5/8}][1 - 1/(4\ k\ \pi^{1/8})]^2/(48\ k^{1/2})\}/m_e. \qquad (4\text{-}34)$$

The factors to the right of h c in the e^2 can be replaced by a pure number, since the value of k is a pure number representing the ratio of a fundamental mass-unit to the actual electron mass expressed in these same fundamental units. The equation then becomes

$$e^2/m_e = h\ c\ (1.161\ 409\ 260\ 687\ 233 \times 10\text{-}3)/m_e. \qquad (4\text{-}35)$$

Planck's constant, at a given universe age, is a fixed value, but expressed in any particular mass-unit size, it is required to fit the expression h $N_z^{5/6}$ = constant. If Δm_μ is defined as the ratio of the size of the mass-unit of measure relative to the size of the fundamental mass-unit, then the number N_z must be divided by Δm_μ to yield the observed number N_A in these units of measure. This requires then that the number for h_z be multiplied by $\Delta m_\mu^{5/6}$ to convert it to the number for h_A. This then results in Equation (4-35) requiring

$$(e^2/m_e)_A = (h_z\ \Delta m_\mu^{5/6})/(m_{ez}/\Delta m_\mu), = (h_z/m_{ez})\ \Delta m_\mu^{11/6}. \qquad (4\text{-}36)$$

Then, if measurements are made in a system of the larger mass-units, Carbon 12 units, they will overstate the electron mass (expressed in mass-units) by a factor of $\Delta m_\mu^{11/6}$. As a result, to convert Electron mass measured in the Carbon 12 mass-unit system to Electron mass in the new mass-unit system, we have

$$(m_e)_{C\text{-}12}/(m_e)_{new} = \Delta m_\mu^{11/6}. \qquad (4\text{-}37)$$

All the above is on the basis of fundamental values in a system of units with a fixed theoretical "gram" that is consistent with the specifications for the standard cm and sec, as constrained by the adopted value for c, and consistent with the definition of the unit of energy and the specification E = m c^2 relating energy in ergs to mass in grams. Our actual physical prototype gram and the theoretical gram are probably very close, but not identical. There is a possibility for a small error here.

4.5. Avogadro's Number

Determination of Avogadro's number to a precision of 1 part per million or less is just barely becoming possible. The determinations by R. D. Deslattes et al. (1976, 1980) has resulted in a value of N_A = 6.022 0973 x 10^{23} mol^{-1} (1.05 ppm). A measurement of the (220) lattice spacing in a silicon crystal by Peter Becker et. al. (1981), which is the same element used by Deslattes to determine volume count of atoms, differs by 1.8 ppm from that of Deslattes. This suggests that Deslattes value for N_A should be increased by 5.4 ppm to 6.022 1297(81) x 10^{23} mol^{-1}. The CODATA 1986 adjustment of the fundamental constants recommends a value for Avogadro's number as:

$$N_A = 6.022\ 1367 \times 10^{23}\ \text{mol}^{-1}\ (0.59\ \text{ppm}), \qquad (4\text{-}38)$$

which, when considering the $\Delta_{m\mu}$ ratio between the numbers of new mass-units relative to the number of Carbon 12 mass-units, would translate in local-cosmic-rest mass-units into

$$Nz = 6.022\ 138\ 193\ 49 \times 10^{23}\ \text{mol}^{-1}, \qquad (4\text{-}39)$$

if they both referred to the same size gram; however, for the present we must assume that they do.

At the present state of our understanding, to be able to compute a theoretical value of N_z directly, we require two independent expressions in which N_Z plays a critical part. Actually, not necessarily N_Z, but the number of local-cosmic-rest mass-units in a solar-frame gram is what should come out of the relationships. This could then be converted to N_A (a Carbon 12 based mass-unit number), if we knew the exact ratio between the two types of grams.

At the initial full emergence of the universe, the ratio of the radius of the space to the radius of curvature generator (R_{u0}) yields the sine of the time phase angle ϕ_e for emergence. This equation was derived in Section 1. as Equation (1-41):

$$\sin \phi_e = [\beta\ c^2\ \text{cm}^6/(N_p\ m_n\ N_Z)]^{1/6}\ \{1/[p^{\sin^2 f}\ (1 - \alpha\phi/\pi)^{1/3}]\}. \qquad (4\text{-}40)$$

This has the sine of the full emergence angle in implicit form, but, at emergence the angle is of the order 2×10^{-14} radians, so that the expression

$$\{1/[p^{\sin^2 f}\ (1 - \alpha\phi/\pi)^{1/3}]\} = 1\ (\text{to 16 places}), \qquad (4\text{-}41)$$

and can be ignored. The dimension of N_z/cm^6 is a pure number.

I believe that the universe emergence is also related to some probability aspects that represent a length unit divided by some large probability number. As an approach to this kind of a relationship for $\sin \phi_e$, I constructed something that I think may be correct, or at least very close. The symbol N_Z (as a theoretical value) represents the number of fundamental (ca) mass-units in the perceived theoretical gram.

Matter, as we perceive, it is of five parameters or five degrees of freedom. Here is another case where the higher dimensional nature brings other subtle aspects into play. Mass has been used as dimension cm^{-6}: it represents bounded universal field components (energy) in a unit of time, i.e. with a time extension in cm. We can thus treat matter as of 5 parameters without coming into conflict with mass being cm^{-6}. This is part of the whole experience with this project: in the absence of sufficient advance detailed knowledge of the true dimensional relationships, it is possible to stumble into simple arrangements where some unknown internal relationships remove the need to know the total proper dimensional relationships. We are dealing here with a rotational probability sense. The rotational aspect magnitude number associated with a single degree of freedom is assumed to be $e^{2\pi}$, and since we have five dimensions involved in the external aspects of perceived matter, the freedom probability should be five times as much, or $e^{10\pi}$. This then is one factor in the large probability number. Neutral matter also involves universal field interaction with 16 parameters out of the expanded mathematical group of 273. This should go with a probability actualization scaling factor of $2^{16/273}$ as the fractional probability ratio corresponding with the 16/273 bit of information. This factor, then, will be a part of the large probability number also. In computing the total probability, we need to take into account the effect of local-cosmic-rest system-velocity relative to the cosmic point of emergence. This velocity is $c/(2\pi)$. In computing the theoretical Neutron mass, this same velocity factor appeared as $[1 - 1/(2\pi)^2]^{1/3}$. To convert this to a single length-unit effect, we need the sixth root, or a factor $[1 - 1/(2\pi)^2]^{1/18}$ as a portion of the total probability number.

Finally we need to take into account the local solar-system velocity relative to local-cosmic-rest. Our observed unit of a solar-frame gram changes in mass-energy with system velocity, but the fundamental cosmic-rest mass-unit is specified to be a fixed energy unit. We need to convert from moving frame to local-cosmic-rest, but we need to do this recognizing mass as the interaction of two perceived three-space unit volumes of universal field. For this we need to multiply the local reference unit by $\cos^8\theta_p$. This value was determined in Equation (4-22) as $\cos^8\theta_p = 0.999\ 993\ 6492$. We need to take this local system velocity effect into consideration because, <u>at emergence, we are dealing with Neutrons</u>, and free Neutrons respond to local system velocity relative to local-cosmic-rest by an increase in effective mass.

Combining the above factors for $\sin\phi_e$ probability, as a dimensionless ratio, including the single dimension form of the factor β relating internal and external effects, we have:

$$\sin\phi_e = \beta^{1/6}\cos^8\theta_p/\{e^{10\pi}\,2^{16/273}\,[1 - 1/(2\pi)^2]^{1/18}\}. \qquad (4\text{-}42)$$

We equate the two independent expressions (Equations 4-40 and 4-42) for $\sin\phi_e$, raise both to the sixth power and invert. The β factors cancel, and we have:

$$N_p\, m_n\, N_z/\mathrm{cm}^6 = \{e^{10\pi}\,2^{16/273}\,[1 - 1/(2\pi)^2]^{1/18}\}^6[c^2/(\cos^8\theta_p)^6]. \qquad (4\text{-}43)$$

Replacing $N_p\, m_n$ by the total initial number of mass-units N_{u0} yields:

$$N_z/\mathrm{cm}^6 = (c^2/N_{u0})\, e^{60\pi}\, 2^{96/273}[1 - 1/(2\pi)^2]^{1/3}\,(1/0.999\ 993\ 64922)^6, \qquad (4\text{-}44)$$

$$N_z/\mathrm{cm}^6 = 6.022\ 126\ 603\ 251 \times 10^{23}. \qquad (4\text{-}45)$$

The dimensions of N_z/cm^6 is a pure number with its magnitude dependent upon the relationship of a mass-unit to the length unit(cm) in which a mass-unit radius is expressed.

A relationship between the length unit (cm) and the gram unit of mass was built into the original c g s system of units by the specification that a gram was the mass of one cm^3 of water at its temperature of maximum density (at approximately 4^o C) The subsequently constructed Kilogram Prototype replaced the water based standard of mass, without removing the implied connection between length and mass at an atomic level. Another factor was brought into possible consideration for various solids, and that is the spacing between units of structure that could have a bearing upon the numerical relationship of mass and length for a particular material. The relationship at the single mass-unit volume level is shown in Eq. (4-30) as:

$$[(4/3)\,\pi\, r_1^{\,3}]^2 = 1/(\beta\, M_g\, c^2). \qquad (4\text{-}46)$$

If the size of the unit of length is changed by a factor of x, then the scale factor or the size of the unit in that equation, in which the mass of the universe is expressed, must be changed by a factor of x^{--6}.

Equation (4-44) contains the effect of local-cosmic-rest system velocity with respect to the cosmic origin, and also contains the effect of local solar frame velocity with respect to lcr for its effect upon Neutron mass measured relative to lcr. The equation is based upon reference to a standard unit of length defined by the units in which mass and energy are defined. To be complete, this must be supplemented by the effect of solar frame velocity relative to lcr in its effect upon perceived spacing of the units of structure when making an observational determination of the number of units of structure in a given mass.

The dimensional contribution of length in the equation is in terms of abstract centimeters, rather than in the conventional perceived space centimeters, which are of dimension cm^2 in terms of the abstract units. The effective system velocity was determined from Equation (4-22) which yielded a value for $\cos^8 \theta_p$ as 0.999 993 649 22 . The eighth root of this is the velocity phase effect upon a perceived unit of length in the moving system as seen from the rest system. As a result, a unit of length in the lcr frame is equivalent to $1/\cos \theta_p$ measured in the local solar frame <u>in perceived cm</u>. Then cm^6 in Eq. (4-44) contains $1/\cos^3 \theta_p$ as a volume effect. To include this fundamental addition to the calculation of N_z, we must divide the result from Equation (4-45) by this effect upon length, which yields a theoretical value identified as N_{zt}**:**

$$N_{zt} = 6.022\,126\,603\,251 \times 10^{23}/(0.999\,993\,649\,22)^{3/8}, \text{ or} \qquad (4\text{-}47)$$

$$N_{zt} = 6.022\,140\,945\,257 \times 10^{23}\ \text{mol}^{-1}. \qquad (4\text{-}48)$$

Rounded for use in all ordinary calculations to

$N_{zt} = 6.022\ 140\ 945 \times 10^{23}$ (4-49)

The precision limits on the mass of Iron 56 and on the free Neutrons (.029 and .014 ppm respectively) would not normally suggest retaining the ninth decimal place figure, however the fact that the values for Δm_μ determined from the Landé factor for g/2 and from the Iron and Neutron mass combinations differ by slightly less than one part in 10^9 suggests that the true result could be very close to the calculated value.

The calculated theoretical value above for N_{zt} is within 0.71 ppm of the CODATA N_A and within 0.46 ppm of the $\Delta_{m\mu}$ adjusted CODATA VALUE,and I utilized it in the theoretical calculations for several years. Over time I became uncomfortable, at an intuitive level, with this usage, and considering the implications of the Landé g/2 path to $\Delta_{m\mu}$ on the potential precision of the result, I reverted to use of the $\Delta_{m\mu}$ adjusted value of N_A as N_Z for all theoretical and practical calculations. <u>This current revision of the report is based upon use of N_Z as the most dependable value.</u> Perhaps, at some time in the future, after the theoretical derivation is either verified or replaced by the work of others, we can return to use of a theoretically derived value for Avogadro's number.

4.6. Universe Cycle Time and Time Units

The cycle time of the universe from emergence to collapse is determined by a number of factors. The principle elements are the initial universe matter mass and the rate of rotation of the cosmic age angle function that affects the change of universe matter mass with age. The number of mass-units in the universe at emergence is an exact number, but when converted to grams by means of the theoretical value for N_z, the value must be reported as having limited precision. This value was indicated earlier as Equation (4-29)

$M_0 = 2.284\ 973\ 199 \times 10^{55}$ grams. (4-50)

During the life cycle from emergence to collapse, there is a gradual decrease in "probability actualization factor" for one of the component dimensions as a function of the cosmic age angle ϕ. This represents a decrease in total probability proportional to a function of the factor $2^{1/69}$, as age angle ranges from 0 to π, followed by a recovery during the period ϕ ranges from π to 2 π in a second cycle. This returns the universe to its original state. It is postulated that this loss occurs as a direct function of the cosmic age angle ϕ in radians and uniformly in proportion to this age phase angle. This was discussed earlier as Equations (1-12) to (1-13). This is an important fundamental relationship since the radius of curvature generator R_u, the mass-unit radius r_1, Planck's constant h, and other factors are affected. The value of the radius of curvature generator at emergence was derived back in Section I as Equations (1-55) to (1-57):

$$R_{u0} = [3\ m_n\ N_p\ N_z/(4\ \pi\ \beta\ c^2)]^{1/3}, \text{ or} \tag{4-51}$$

replacing $m_n\ N_p$ by the initial number of mass-units, this becomes

$$R_{u0} = [3\ N_{u0}\ N_z/(4\ \pi\ \beta\ c^2)]^{1/3}, \tag{4-52}$$

$$R_{u0} = 1.300\ 471\ 892\ 102 \times 10^{27} \text{ emergent cm.} \tag{4-53}$$

The mass at emergence is modified by the mass decrease factor at other ages, which implies

$$R_u = R_{u0}\ (1 - \alpha\phi/\pi)^{1/3}. \tag{4-54}$$

In terms of number of nominal centimeters then, the radius of curvature generator shrinks as the universe ages.

Examination of Equation (4-30) shows that mass in grams (M_g) and the mass-unit radius are inversely related at a sixth power of r_1. As a result, the dimensionality of mass is of dimension cm^{-6}. This requires that, with all other factors in the equation being constant, the size of r_1 must change in proportion to $(1 - \alpha\phi/\pi)^{-1/6}$, and r_1 is directly proportional to Planck's constant. In effect this requires that the abstract cm be proportional to $1/(1 - \alpha\phi/\pi)^{1/6}$, but a measure in spacetime is a length measure materialized in time. This latter perceived measure requires dimensionality of the cm in a perceivable radius to be abstract cm^2. Thus, the centimeters in R_u increase in size in exactly the inverse ratio to the change in number of cm in R_u. The net effect of these two factors is that, when measured in terms of emergent cm size units, the numerical value of R_u is constant during the cycle of expansion and contraction.

One of the basic postulates is that the radiation velocity factor c is a constant; this is ambiguous unless we specify also that the velocity c is a constant in terms of emergent time units and length units. Otherwise, with our specified constant ratio of c between units of length and time, there could be a range of true velocities in an absolute sense of some fixed reference value, because we use the same names for the units as their sizes change. The value c is believed to represent the unchanging velocity of the underlying universal field phase changes.

As the rate of rotation of the end of the radius of curvature generator is limited to $c/(2\ \pi)$ at any age, in a fourth dimension sense, and continues at the same constant rate of rotation in terms of emergent time units, then the endpoint describes a path with a length of π Ru in the fourth dimension in the period from emergence to collapse. The duration of this total period is $\pi\ R_u/[c/(2\ \pi)]$. The period is in emergent time units, so that the total period T can be expressed as

$$T = 2\ \pi^2\ R_u/c. \tag{4-55}$$

Using the emergent value for R_u, then a universe theoretical cycle is:

$$T = 8.562\ 685\ 796\ 31 \times 10^{17} \text{ emergent sec, or} \tag{4-56}$$

$$T = 27.134\ 090\ 028\ 12 \times 10^{9} \text{ emergent SI years.} \tag{4-57}$$

Now, we need to consider the kinds of time that we encounter or measure. There are three major kinds. The first is emergent-unit time computed using emergent size units, or current age units adjusted to emergent size units. The second type is what I call nominal time. This is measured in terms of the unit that exists at any given moment. It is the kind of time that an object or a culture encounters as it ages along with the universe. The third kind is specific epoch time, which is time that has been set as a standard at some particular age, such as 1967 when the present atomic standard was adopted for the time unit. The most fundamental of these is emergent time units, since they all are of equal size. Nominal time periods represent a count of varying length units, but they are what is generally experienced. Specific epoch time can easily be confused with nominal time, since, when time is measured by units defined by atomic relationships, the unit size automatically changes in size with cosmic age, just like nominal time. The only real difference shows up when we consciously correct the size of elapsed time units back to the size of the unit at the standard-establishment age. This yields the elapsed time in constant size time units that are different than emergent size units.

Time, as we experience it, is coupled to length, as we experience it, by the constant c. Length, materialized as we experience it, varies as the square of the rate that abstract time varies. The time units of nominal time vary as $(1 - \alpha\phi/\pi)^{-1/3}$ times the size of emergent units. Time by our ordinary experience is nominal time, but for precision in relating cosmic events separated by large intervals, we need to convert to emergent size units. Such is the case for relating estimates of the current age of the universe.

Radiation travels at the constant uniform velocity c at every instant, but the size of the units change. For a long path, the elapsed time in nominal units is not the same numerically as the time in emergent units. The nominal units are expanding so that in the later stages fewer of them are accumulated than the number of emergent units in that path. This is a cumulative effect represented by the integral of the expansion factor over the path, as defined by the two end points expressed as cosmic time angles ϕ. This effect can be computed as

$$\int_{f_1}^{f_2} (1 - \alpha\phi/\pi)^{-1/3}\, d\phi = \Big[_{f_1}^{f_2} \left(-3p / 2a\right)(1 - \alpha\phi/\pi)^{2/3}. \tag{4-58}$$

Its overall average effect is the above definite integral divided by the interval $(\phi_2 - \phi_1)$. Using the emergent point $\phi = 0$ as a starting point, the above simplifies to

$$\text{emergent/nominal} = [3\,\pi/(2\,\alpha\phi_2)]\,[1 - (1 - \alpha\phi_2/\pi)^{2/3}]. \tag{4-59}$$

The meaning is that, for the given span, there are more emergent units than nominal units in the ratio as above. (Sizes are the inverse effect.) Take the case of the full span from emergence ($\phi = 0$) to collapse ($\phi = \pi$). The integrated result is

emergent/nominal = 1.001 673 331, or (4-60)

an avg. nominal unit = 1.001 673 331 emergent units. (4-61)

Now, using the above, an observer traveling with the universe experiencing nominal time would measure the cycle T to be:

T(nom) = 27.088 761 562 x 10^9 nominal SI years. (4-62)

If we keep track of time as nominal time, then the elapsed time in terms of emergent units is a larger number. This is important because the age angle ϕ is directly proportional to the number of elapsed units of emergent-time since emergence. We need this information in comparing various indicators of the universe age. One further point; an atomic unit of cosmic time represents one universal-field-unit intersect cycle, so that a count of these cycles is a count of elapsed time in nominal-time units. Thus the uniform rate of rotation of the radius of curvature generator in emergent-size time units ($d\phi/dt$) is not uniform in terms of nominal time units. This affects calculations such as prediction of the value of the Hubble factor over vast separations. It requires conversions between nominal and emergent size units.

Back in the early stages of working on this system of structure for the universe, when it was first discovered that it was necessary for the mass of the universe to change with age, it was necessary to make a decision about the rate of change of mass with age. Then, it was necessary to decide whether it would be a uniform rate with cosmic-age phase angle or uniform with the passage of perceived time units. The selection made was, that the rate of phase angle change should be uniform with emergent time units, as though the rotation was set into motion and maintained by some control exterior to the particular structure of the universe at any moment, and that the rate of mass loss be uniform with phase angle change. There were other options available for both the rate of rotation and the rate of mass change, but the options selected seemed to fit better than others. In addition, the results seemed to conform better with respect to the numbers later encountered for the separation distance between universe emergence and collapse, that come out of the ancient Hindu writings as 4,320,000,000 years. When this latter value is treated as a distance measured in light years, and recognizing that radiation traveled at 2 π times the rate of the endpoint of the radius of curvature generator (the fourth dimension location of matter units), then the Hindu universe cycle estimate becomes

$T_H = 2\pi$ (4.320 x 10^9) = 27.143 36... x 10^9 yr. (4-63)

The difference between the Hindu cycle estimate above and the computed cycle estimate T in emergent years (Eq.4-57) is only 0.342 parts per thousand. This is so much closer than any current astronomical estimates for the universe cycle length, that I decided that it must represent a valid reference number good to at least three units in the fourth place.

4.7. Planck's Constant and Current Universe Age

Planck's constant was first encountered in this work in connection with the need to compute the magnitude of the fundamental mass-unit radius r_1 as it was involved in the derivation of the general gravitation coefficient G. In exploring the possible relationships in Section 2.3., Equation (2-41) was developed. This has turned out to be one of the critical discoveries in the whole development. When it was rearranged to include expressing the mass-unit radius r_1 in terms of its components, an expression for Planck's constant was derived in terms of Avogadro's number, the universe mass, and some constants. This is Equation (2-43), which we now need to examine more closely:

$$h = [9\ c^4\ e^6/(2\ \beta\ M_g\ N_z^6\ \pi^8\ 2^{3/4})]^{1/6}. \qquad (4\text{-}64)$$

Replacing M_g by N_u/N_z and rearranging, we have

$$h\ N_z^{5/6} = (1/N_u)^{1/6}\ [9\ c^4\ e^6/(2\ \beta\ \pi^8\ 2^{3/4})]^{1/6}. \qquad (4\text{-}65)$$

The mass of the universe (and the numerical value of N_u) changes with age in proportion to $(1 - \alpha\phi/\pi)$. Including this, and replacing the last term by its numerical value, then, based upon the theoretical N_{u0}, we have

$$h\ N_z^{5/6} = \{1/[N_{u0}\ (1 - \alpha\phi/\pi)]\}^{1/6}\ (6.716\ 713\ 951\ 061 \times 10^6. \qquad (4\text{-}66)$$

N_{u0} is also a constant, so

$$h\ N_z^{5/6} = (1 - \alpha\phi/\pi)^{-1/6}\ (4.338\ 952\ 360\ 60 \times 10^{-7}). \qquad (4\text{-}67)$$

The numerical coefficient is an exact dimensionless number that can be computed to as many places as necessary.

The value of N_z is theoretically an exact number defined by relationships in our system of standard units, so that, if we had a precise number for Planck's constant, we should be able to determine the age angle ϕ precisely, or if we knew the exact age, then predict the value of h.

At any given universe age ϕ, the product h $N_z^{5/6}$ is a constant. This is not quite the same as the conventional assumption that the product h N_A is a constant. By the conventional assumption, the changing of mass-unit size from a Carbon 12 based unit to the local-cosmic-rest size should have no effect upon the fixed product number. By the new approach, the fixed product is constant for h $N_z^{5/6}$, so changing the size of the mass-unit changes the individual numbers in such a way that the product is still constant.

The age of the universe, when expressed at the level of single years, is sufficiently large to require 11 digits. This is the level implied by some of the occult references to the current universe age. The effect of age on the value of Planck's constant is given by the relation:

$$h = h_0 \,/\, (1 - \alpha\phi/\pi)^{1/6}. \qquad (4\text{-}68)$$

The disproportionate relation between h and the age angle ϕ is the basic reason that extra digits need to be carried in the computations if we are to make comparisons with the age in years or even centuries. Because of this need for fine numerical detail, the calculations involving age in years were carried out using a 12 digit calculator, and less extensive components were assumed exact as far as they went. When we want to consider the significance of the current age in years, it is necessary to factor in the implication of the 0.60 ppm observational data limit on Planck's constant. An example of the effect of this is shown in Eq.(4-73) below.

Using the CODATA 1986 values for h and N_A to compute the product ($h\,N_A^{5/6}$) in Equation (4-38) yielded

$$(h\,N_A^{5/6}) = 4.342\ 253\ 975\ 065 \times 10^{-7}. \qquad (4\text{-}69)$$

This is the same numerical value that we would have obtained using N_Z and a value for h adjusted for $\Delta_{m\mu}$. Dividing this by Equation (4-67), raising to the sixth power and inverting yields

$$(1 - \alpha\phi/\pi) = 0.995\ 446\ 588\ 2974 \qquad (4\text{-}70)$$

$$\phi/\pi = 0.455\ 554\ 246\ 95, \qquad (4\text{-}71)$$

$$\text{Age} = 12.361\ 049\ 975 \times 10^{9} \text{ emergent SI years}, \qquad (4\text{-}72)$$

When the effect of the $\pm$ 0.60 ppm in the value of Planck's constant is computed, and the implied years rounded off to the nearest 10,000 years, the CODATA based value for the current universe age becomes:

$$\text{Current age} = 12.36105 \pm 0.00973 \times 10^{9} \text{ emergent years}. \qquad (4\text{-}73)$$

These are the values for the current universe age based upon the CODATA 1986 values for Avogadro's number and Planck's constant. These values are probably the best values that can be derived from the CODATA 1986 numbers, because the effects of errors in N_A tend to be partially canceled by the requirement that h N_A be a constant.

There is another possible value for the current universe age that can be derived from the CODATA material. This is to utilize the indirect value for N_A derived from electrical measurements, and which was an input value to the correlation matrix for the CODATA determinations. This number was based upon the Faraday value and is

$$N_F = 6.022\ 1433(80) \times 10^{23} \text{ mol-1}. \qquad (4\text{-}74)$$

Using this value with the CODATA value for h yields

$h\ N_F^{5/6} = 4.342\ 257\ 941 \times 10^{-7}$. (4-75)

Then, following the same procedure utilized for the N_A derived value, we divide by Eq. (4-67), invert, and raise to the sixth power, which yields

$(1 - \alpha\phi/\pi) = 0.995\ 441\ 1275$, (4-76)

$\phi/\pi = 0.456\ 100\ 3822$, (4-77)

$\text{Age} = (\phi/\pi)\ T$, (4-78)

$\text{Age} = 12.375\ 868\ 83 \times 10^9$ emergent SI years. (4-79)

The increase over the N_A based estimate is

$\Delta\text{Age} = 14.818\ 840 \times 10^6$ emergent SI years. (4-80)

This increment in age is probably a good indicator of the upper limit to the variability in the CODATA data based age estimates using the h and N_A values. This is a precision limit of approximately 0.12 percent of the age in years.

Now, using the value of ϕ/π from Eq.(4-71) as the age factor, we can employ Equations (2-71) & (2-73) to compute what the current age value of the gravitation coefficient G should be in terms of the CODATA units:

$G = 6.672\ 215 \times 10^{-8}$ dyne $cm^2\ g^{-2}$. (4-81)

Since the measured value of G is not affected by any of the adjustments in the CODATA 1986 analysis, it may serve as an independent estimator of the universe age, by using it together with equations (2-71 to 2-73) to estimate ϕ/π and hence the current universe age in emergent units. Using the CODATA G = 6.672 59 x 10^{-8} dyne $cm^2\ g^{-2}$,

$\phi/\pi = 0.463\ 949\ 423$, (4-82)

$\text{age} = 12.588\ 845\ 42 \times 10^9$ emergent years. (4-83)

This is so different, from the values for ϕ/π and years obtained from the product h $N_A^{5/6}$ and from the value computed using the Faraday based N_A age estimate, that it must be ignored in universe age estimates, other than for its use as a confirmation of the general magnitude of the age estimated by other means. If we assumed freedom from observational errors, and attributed the difference to be due to a difference between the prototype physical gram and the theoretical gram, we can estimate the required magnitude of the difference in the two grams. The ratio of the two G values should be proportional to the square of the relative gram masses.

$G_{(CODATA)}/G_{(Theoretical)} = 1.000\ 056 = [\text{grams(Theo.)/grams(pr)}]^2$, (4-84)

so, for a given quantity of mass the number of theoretical grams could be larger in the ratio:

Theo. grams = Physical. prototype grams x 1.000 028. (4-85)

This appears far too large an effect, but the reported precision of the CODATA G is only 128 ppm. This low precision range permits a variation that is several times as large as the value in the above equation, so this approach is not useful with the presently available measured G data.

Now I want to approach a calculation of a theoretical value for h (in local-cosmic-rest units) at the present age. To do this directly requires an accurate independent value for the present age of the universe, in nominal years, which can then be converted to an age in emergent years. This then can be divided by the cycle length, in emergent years, to yield the cosmic age angle fraction ϕ/π.

In Blavatsky's (1888) Secret Doctrine Vol. II, p. 68 - 70, some occult cycles and implied ages are discussed. The cycle representing "one day of Brahma" as 4,320,000,000 years has been decoded by multiplication by the factor $2\ \pi$ into $27.143\ 36 \times 10^9$ and identified as a close approximation to the computed universe cycle of $27.134\ 090\ 028 \times 10^9$ emergent SI years. It would seem then that there could be some others of these Hindu numbers that we might well examine. See Appendix Section 8.2. “Occult Clues to Universe Age”

Of the four possible occult age values to be decoded, I have selected case iii as the largest number shown directly in the reference. When the number is decoded by being multiplied by 2π and then having 99 years added to bring the implied date up from 1887 to the date 1986 of our current CODATA standards, It yields:

Present age - 12,343,320,836 Nominal years. (4-86)

This age in nominal years must then be corrected to emergent years by multiple application of the relationship in Equation (4-59). (This yields a final ratio number of emergent years to nominal years as 1.000 759 927 375)

Present age = 12,352,703,866 emergent years, or .(4-87)

$= 12.352\ 70 \times 10^9$ emergent years. (4-88)

This differs from the Codata based age by 8.38×10^6 years, which is less than the 9.73×10^6 years represented by a change of 0.60 parts per million in the value of Planck’s constant. Both of these numbers represent the results from rounding the computed ages to the nearest 10,000 years. I have elected to use this level of rounding ages on the basis that it retains the full potential of any likely improvement in the precision of our determination of the value of Planck’s constant, yet stays away from the excessive precision implied by the occult usage of reporting the ages in individual years in the coded format.

The comparison of the Case iii occult age number with the CODATA based age number indicates that it is within the one sigma limits for the CODATA based number.

The Case iv occult number in the appendix is even closer to the CODATA based number. In fact it is so close that I am somewhat reluctant to use the Case iv as a primary example. because it would imply that the value for Planck’s constant, adjusted for the $\Delta_{m\mu}$ change in the value of a mass-unit only differs from the implied occult value by approximately 2 parts in 10^9. This in turn could imply the date of their fixing a value for h as only 10 to 20 thousand years ago ?

Using the decoded Case iii value for the age, we compute the corresponding value for h in the new mass-unit system:

$$\phi_h/\pi = 0.455\ 246\ 660\ 323, \quad .(4\text{-}89)$$

$$(1-\alpha\phi_h/\pi)^{1/6} = 0.999\ 240\ 168\ 5561, \quad (4\text{-}90)$$

$$h = h_0/(1-\alpha\phi_h/\pi)^{1/6} = 6.626\ 070\ 72 \times 10^{-27} \text{ erg sec}. \quad .(4\text{-}91)$$

The CODATA h converted to the new mass-units is

$$h = 6.626\ 074\ 13 \times 10^{-27} \text{ erg sec (0.60 ppm)}. \quad (4\text{-}92)$$

The value of h computed from the Case iii Hindu age is within 0.515 ppm of the CODATA based value.

4.8. Planck's Constant and the Length Standard

If there is a fixed unit of length about which the universe has inverse symmetry, this unit could be related to the geometric mean of the extremes, or of conjugate pairs of factors. The extremes will involve the smallest universal field elements in a mass-unit, while the largest is the path length to maximum universe size. Rather than these extremes, we will work with a pair of values that are more accessible; the radius of a single mass-unit and the radius of the universe at the instant of full emergence.

At emergence, the radius of a mass-unit in total universe terms is

$$r_0 = \{[3/(4\pi)]^2\,[1/(\beta M_0 c^2)]\}^{1/6}. \quad (4\text{-}93)$$

The volume of the universe at full emergence is equal to N_{uo} times the volume of a single unit. As a result, the three-space radius at full emergence is

$$R_e = r_0 N_{u0}^{1/3}. \quad (4\text{-}94)$$

The proposed standard unit is the geometric mean:

$$L_S = (r_0\, r_0\, N_{u0}^{1/3})^{1/2} = r_0 N_{u0}^{1/6}. \quad (4\text{-}95)$$

Using the Equation (4-93) form for r_0, this becomes

$$L_S = \{[3/(4\pi)]^2\,[N_Z/(\beta c^2)]\}^{1/6}. \quad (4\text{-}96)$$

This is a cosmic standard for length. It is dependent upon factors that are apparently independent of the universe mass and age. This is only so at first glance, because besides yielding a fixed numerical constant, L_S implies the dimension "abstract emergent centimeters", but when materialized in time it must reflect the time unit size at that age.

Much of the analysis in this new approach has been handled in a simplistic manner related to the way we seem to perceive things. In the present case we need to depart from the simplistic approach and consider some of the higher dimensional aspects. Back in Section 1. the fundamental mathematical group nature was discussed, and it was indicated that our ordinary perceived unit vectors are actually squared units of the subspace vectors. Our ordinary perceived space is a special kind of L^2 space, where the individual squared unit vectors form an orthogonal group in the geometric sense of physical 90^o angles between components, rather than being orthogonal only in the pure algebraic sense like successive polynomial terms. It is even more involved than that, because there are paired components whose products form the individual unit vectors. A general unit vector in our perceived spacetime is of the form

$$jt + kt + lt - cwt. \tag{4-97}$$

This is its form when we treat it as a single four-space instead of its actual complex four-space sub-space product nature.

In our ordinary perceptions, when we compare the jt component with the kt component for example, we do so in an assumption of freedom from time, or we do so explicitly assuming the same time component for both. The result is that our whole perception of the world and our physics is based upon the equivalent of a j to k comparison without the t component. We have reduced what is actually an L^2 space to what appears to be a linear space. In some of the work dealing with theoretical aspects of this new approach, I have also operated in a per-unit-time mode by utilizing the minimum linear atomic-time unit. This accomplishes the same reduction in complexity, without actually totally losing the time aspect. Now, when it comes to making some physical comparisons or measurements, it must be recognized that, to be in the state of being perceivable, factors must be actualized in time. This changes the perceivable dimensionality of the entity under consideration.

The universe radius of curvature generator R_u is of dimension cm^2: it is a radius in an L^2 space. To compute the sine of the emergent phase angle ϕ_e, we compared the radius of the emerged universe R_e with the above. As a theoretical entity R_e is of dimension cm, but as the radius of an actual physical universe, it is of dimension cm sec, which is equivalent to cm^2 dimensionally. As a result, we are forming a ratio of the nature cm^2/cm^2, which is dimensionless and appropriate as a sine of an angle.

Now, the radius r_1 of a single mass-unit particle, at any age (ϕ) of the universe, is similar to the expression for r_0 (Equation 4-93), except for the replacement of M_0 by the current universe mass at the given age M_g. With M_g being related to M_0 by the expression

$$M_g = M_0 (1 - \alpha\phi/\pi), \tag{4-98}$$

then r_1 is given by

$$r_1 = r_0 (M_0/M_g)^{1/6} = r_0/(1 - \alpha\phi/\pi)^{1/6}. \tag{4-99}$$

Besides being the radius of the universe at emergence, R_e is the radius equivalent of the total mass-energy of the universe treated as a spherical volume. As such we can look at something similar (as the universe ages) for the current radius of the sum of all the mass-energy of the universe, if it were gathered into a sphere. If we did this, we would find something equivalent to Equation (4-94) with r_1 substituted for r_0 and $[N_{u0} (1 - \alpha\phi/\pi)]^{1/3}$ for $N_{u0}^{1/3}$. Combining these into a geometric mean, then simplifying yields

$$L_S = r_1 [N_{u0} (1 - \alpha\phi/\pi)]^{1/6} = r_1 N_{u0}^{1/6}. \qquad (4\text{-}100)$$

The effect of the change in universe mass with age washes out and we have the same expression at any age of the universe as we did at emergence. It has the dimension emergent cm.

A centimeter represents either a physical separation between marks on a physical prototype, or the distance in vacuum spanned by a fixed count of wavelengths of some specified fixed energy transition. If we use the radiation approach, this is something materialized in time but mediated through Planck's constant. A centimeter is some fixed number of wavelengths of the quantum-wavelength characteristic of a single mass-unit. It is a multiple of L_h. The wavelength is defined by Planck's constant. We examine this in steps, starting with the frequency approach:

$$E = h\ f. \qquad (4\text{-}101)$$

To make any progress, we need to examine the nature of Planck's constant itself. In our ordinary three-space physics, h has the dimension erg seconds; this also is an interpretation of its dimensionality in the new approach. This would make it of dimension (cm^{-6} sec) or (cm^{-6} cm) in the new approach of relationship with the universal field.

The relationship of Planck's constant to the total mass-energy of the universe was first encountered as Equation (2-43):

$$h = [9\ c^4\ e^6/(2\ \beta\ M_g\ N_z^6\ \pi^8\ 2^{3/4})]^{1/6}. \qquad (4\text{-}102)$$

A rearrangement yields

$$h\ N_Z/c = [9\ e^6/(2\ M_g\ c^2\ \beta\ \pi^8\ 2^{3/4})]^{1/6}. \qquad (4\text{-}103)$$

A further rearrangement and numerical evaluation of the constants converts this to

$$h\ c/(m_\mu\ c^2) = [1/(M_g\ c^2)]^{1/6}\ (0.696\ 000\ 7665). \qquad (4\text{-}104)$$

The right hand side is of dimension cm. Then, moving one step further,

$$h = (m_\mu\ c^2/c)\ [1/(M_g\ c^2)]^{1/6}\ (0.696\ 000\ 7665). \qquad (4\text{-}105)$$

Planck's constant then is the energy of a single mass-unit multiplied by a length in centimeters and then divided by c.

The two factors 1/c and $[1/(M_g\ c^2)]^{1/6}$ have a resultant that is cm/c, which is equivalent to time.

Continuing the examination of h, we replace $(M_g\ c^2)^{1/6}$ by its equivalent in terms of r_1, which yields

$$h = (m_\mu\ c^2/c)\ [8\ r_1^6\ e^6/(\pi^6\ 2^{3/4})]^{1/6}, \qquad (4\text{-}106)$$

which then reduces to our familiar equation for L_h:

$$L_h = h\ c/(m_\mu\ c^2), \text{ or } h = (m_\mu\ c^2)\ L_h/c\ . \qquad (4\text{-}107)$$

L_h/c is the length of a single linear atomic length-unit in cms divided by c, which converts it to the time in seconds represented by a minimum linear atomic-time-unit. <u>This then is the nature of Planck's constant: a universal field factor that is the product of the energy of a single mass-unit of field multiplied by its duration in the time direction.</u>

It is then obvious that through connection with r_1,

$$h = h_0/(1 - \alpha\phi/\pi)^{1/6}, \qquad (4\text{-}108)$$

which is the same magnitude of cosmic age effect that r_1 has.

Back now to Equation (4-101):

$$E = h_0\ f/(1 - \alpha\phi/\pi)^{1/6}, \text{ or} \qquad (4\text{-}109)$$

$$E/h_0 = f/(1 - \alpha\phi/\pi)^{1/6}. \qquad (4\text{-}110)$$

When we divide an energy by Planck's constant, we obtain the ratio of the energy to the energy of a mass-unit multiplied by the inverse of a single time unit in seconds. The result is a fraction multiplied by a count per second. This is a frequency that is proportional to the fraction of the mass-unit that the energy represents, multiplied by the frequency that is characteristic of a single mass-unit's energy.

An important point here, now, is that Planck's constant, as we evaluate it by implication from other measurements, is already materialized in time; and the length of the time interval reflects the cosmic age effect properly. Now, if we convert from the frequency f to the length equivalent to the distance that a fixed number of counts spans, in a unit of time, then the fixed numerical value of c requires that the length units be expanded by the same age factor that is in the time component. Then, if we say 1 cm equals n L_h units, the following results:

$$1\text{ cm} = n\ (L_{h0})/(1 - \alpha\phi/\pi)^{2/6}. \qquad (4\text{-}111)$$

The composite result, of all this analysis, is that a centimeter, defined by a fixed atomic-transition-energy, changes with age at a rate that is the square of the rate that Planck's constant changes with universe age (relative to emergent universe units).

This is an extremely important aspect. It says that, at any age of the universe, we can use Planck's constant to provide an estimate of the universe age, even when we use a radiation based centimeter in our system of measurements and define it as exactly 1 at the given age. Planck's constant will still contain the age factor back to the emergence value. If this difference in the power of the age factor did not exist, the result would be that, once we defined the size of the centimeter, the value of Planck's constant would then be fixed at the particular value at that age. The second important point is that the above emphasizes that we must be careful in considering how theoretical factors are affected, when they are converted to entities materialized in time.

Now, back to Equation (4-96) with the numerical values of the various constants inserted:

$$L_s = 1.834\ 835\ 406 \text{ cm.} \qquad (4\text{-}112)$$

When materialized in time at any age, the cm (in $L`_s$) will correspond to the radiation based emergent cm and will contain the simple age factor. I am not aware of any way that we could materialize this standard directly.

The only advantage for L_s as a standard, if we could materialize it directly, as compared to our present radiation based standard, is that this is a fundamental unit that any culture in the universe could arrive at for a standard; that is, if they understood the fundamental structure of the universe. Its actual physical length is a universal fixed nominal value at any given age.

If, however, we are looking for something that is an absolute and fixed value, L_s does not meet this requirement, because relative to the universe emergence point it changes in proportion to $(M_0/M_g)^{1/6}$. Any true cosmic standard is probably related to the greater system of the series of possible universes that can exist, rather than to our single example.

L_s in all these discussions is assumed to be based upon ordinary matter that responds to local system velocity relative to local cosmic rest. If we wanted a standard that was always fixed at the local-cosmic-rest value, we would need to specify that it be based upon Iron 56, and use as the fundamental unit 1/56 of an Iron 56 atom. It then would be numerically constant, and be a local cosmic-rest standard that was independent of the local system velocity in which it was measured. Comparison of this unit, with something based upon other (un-stabilized) matter units, would serve as a measure of local system velocity with respect to local-cosmic-rest.

If some culture desired to leave a record, that indicated that they understood the nature of our physical universe, then structures built using some multiple of the actual-mass Iron 56 version of L_s, or, more likely the resonance unit value. This would be

$$L_s/(N_w/N_p)^{8/5} = L_s/0.998\ 841\ 620\ 27 = 1.836\ 963\ 167 \text{ cm.} \qquad (4\text{-}113)$$

This unit is too small to utilize as a practical tool, so some larger value as a multiple would be a more likely choice, just as our practical units are meters or feet or yards.

The next question then is, what multiple to use that would tie in with the fundamental structure of the universe in an unmistakable manner? Since the fundamental mathematical semi-group is 136 elements (plus the zero vector), and the universal field excess is 16, the sum (152) is a fundamental number. The universal field excess being 16 parameters, while in matter we perceive only 4, then a fraction 1/4 would be appropriate. This would yield a multiple as

Multiplier = 152 (1/4) = 38. (4-114)

Applying this multiplier yields a unit in the range of our practical size units.

Practical Unit = 38 ($L_{res.}$) = 69.804 600 35 cm, or (4-115)

Practical Unit = 27.482 126 1 inches. (4-116)

Considering the possible limitations in the precision of the constant Nz, the value of the above measures should be reported as 69.804 600 cm or 27.482 126 inches.

The next logical question is, do we have any evidence that a past culture recognized and used such a measure to convey information about their knowledge of the universe? It seems that we do have such evidence in connection with the great pyramid in Egypt. Fix (1978), in his book Pyramid Odyssey, discusses how the ancient unit of the Mir cubit fits the structure of the great pyramid better than any other measure. He indicated that this ancient measure first came to his attention in some of the readings by the psychic Edgar Cayce, as being 27 1/2 inches. In his work on the site, using the existing survey results that were available, Mr. Fix determined that the best fit value for the measuring unit used in the construction was:

Mir cubit = 27.483 031 inches, or (4-117)

Mir cubit = 0.698 0704 meters. (4-118)

These can now be compared with the computed theoretical measuring unit:

One theoretical unit = 0.698 046 00 meters. (4-119)

The difference between the observed value for the Mir cubit and the theoretical unit computed from the fundamental factors is only 35 parts per million. This is probably as good as can be expected from our measurements, considering both the effect of weathering and some small earthquake displacements in the pyramid structure.

There are some other numbers that suggest the importance of 1/56 unit of Iron 56: both the theoretical and the actual Iron 56 atomic mass values appear to have been recognized and incorporated as ratios in the pyramid structure. Fix quotes Petrie's figures (from the existing survey) for the measurements between the outside corners of the sockets at the pyramid corners. Using these numbers, some ratios of the side extensions (in inches) can be derived:

East/South = 9130.8/9141.4 = 0.998 840 44 . (4-120

West/North = 9119.2/9129.8 = 0.998 838 97 . (4-121)

The resonance numbers representing 1/56 of an Iron 56 stabilized unit and 1/56 of observed Iron 56 mass in new mass-units are:

Iron 56 resonance unit = 0.998 841 62 . (4-122)

1/56 of observed Iron 56 mass = 0.998 838 45 . (4-123)

Then, in the numerology that has come down from ancient times, as an aid to the interpretation of the symbolism of the pyramid (Lemesurier 1979), the number 153 has the interpretation of "enlightenment, or the totality", which corresponds with the 152 plus the zero vector equaling 153 dimensions total.

The fine structure constant a^{-1} was discussed in Section 3. on the electron. It has an exact numerical value that is computable in the lcr mass-unit system, which can also be converted to an exact computed value in the Carbon 12 mass-unit system. This conversion requires only exact relationships between the relative sizes of the two mass-units to yield an exact value for a^{-1} in the Carbon 12 based system of units.

4.9. Comparison of Theoretical and CODATA Constants

Some of the CODATA values for fundamental constants and the corresponding values computed by the new approach are compared in the following table.

Table 2
Fundamental Constant Comparisons

Item	Source or reference
Atomic Mass-Unit (m_μ)	
Standard: 1/12 of a carbon 12 atom	
Computed: above divided by 1.000 000 247 993	3-37
Electron Mass (m_e)	
Computed: 5.485 796 562 852 x 10^{-4} m_μ	3-67
Computed value adjusted to conventional method of observing electron mass by use of force ratio e^2/m_e and converted to ^{12}c units (multiplied by $\Delta m_\mu^{11/6}$) :5.485 799 057 061 ... x 10^{-4} (1.4 x 10^{-11}).	
CODATA: 5.485 799 03(13) x $10^{-4} m_\mu$ (^{12}c) (.023 ppm).	Appendix

Item	Source or

	Reference
Inverse Fine Structure Constant a^{-1}	
Computed: 137.036 054 799 2527 .	3-48
Computed value converted to ^{12}c units: (divided by $\Delta m_{\mu}^{11/6}$) 137.035 992 495 1879 (1.4×10^{-11}).	3-49
CODATA: 137.035 9895(61) (.045 ppm).	3-50
Planck's Constant h	
Computed value using CODATA derived universe age estimate of 12.361 049 975 x 10^9 emergent SI years, assuming N_z exact as (N_A x $\Delta_{m\mu}$**);** h =6.626 074 130 665 x 10^{-27} erg sec(in the new mass-units).	4-71
Above converted back to ^{12}c units: (multiplied by $\Delta m_{\mu}^{5/6}$) 6.626 0755 000 54 x 10^{-27}.	
Computed value based on decoded Hindu Case iii age of 12. 352 703 866 x 10^9 emergent years: h = 6.626 070 72 x 10^{-27} erg sec	4-91
Above converted to the equivalent ^{12} c base (multiplied by $\Delta_{m\mu}{}^{5/6}$): h = 6.626 072 089 x 10^{-27} erg sec	
CODATA: recommended value: 6.626 0755(0.60 ppm).	Appendix
Electron Charge (q_e) in electrostatic units	
Computed value: [based on h computed from CODATA based age estimate Eq.(4-71)]: 4.803 205 180 x 10^{-10} esu (New unit system).	3-24
Above, converted to equivalent ^{12}c mass-unit system (multiplied by $\Delta m_{\mu}^{5/12}$): 4.803 205 676 x 10^{-10} esu.	
Computed value: using $\Delta_{m\mu}$ adjusted CODATA h and observed K: 4.803 205 718 x 10^{-10} esu (0.30 ppm).	
CODATA: recommended value converted to esu in ^{12}c system 4.803 2068 x 10^{-10} esu (0.30 ppm).	3-26
Avogadro's Number (N_A)	
Computed value in new mass-units (N_z) =N_A **x** $\Delta_{m\mu}$ = 6.022 138 193 49 x 10^{23} mol^{-1}.	4-27
CODATA value: 6.022 1367(36) x 10^{23} (0.60 ppm)	Appendix
Item	Source or reference

General Gravitation Constant (G)

Computed:, using Eq (2-59) with h as 6.626 074 131 x 10^{-27} =
6.672 215 x 10^{-8} dyne cm^2 $gram^{-2}$.
CODATA recommended value: 6.672 59(85) x 10^{-8} (128 ppm). Appendix

As a comparison, the indirect determination of N_A from electrical measurements (Faraday) that was used as an input to the matrix for determination of the CODATA values (CODATA report page 13) was:

N_A = 6.022 1433(80) x 10^{23} mol^{-1}.

I have used this value to compute a probable upper limit to the current universe age that can be derived from the CODATA numbers. It represents an increase in the age estimate of approximately 0.12 percent.

At the level of the fundamental new mass-units, the new approach provides means to compute the mass of the electron in mass-units, and to compute the value of a^{-1}, which are both based upon some exact relationships. These predicted values in the new mass-units can then be converted to the Carbon 12 based mass-unit system values, with precision limited only by the precision of the ratio between a Carbon 12 based mass-unit and the new fundamental mass-unit. The new computed values for these two elements appear to be the limits which will be approached by measurements in the conventional system as experimental techniques improve in precision.

The three sets of comparisons involving Planck's Constant, Electron Charge, and Avogadro's Number, are all interconnected and involve the difference between the computed number of new mass-units per theoretical gram (N_Z) and the conventional number of Carbon 12 based mass-units per physical prototype standard gram N_A.

The implication of the new approach is that given the characteristics of our system of standard units of measure for mass, length, time, and energy, under the constraints of a fixed value for c, the fundamental structural assumptions of the new approach permit direct calculation of many numerical values that could only be obtained by measurement using prior theory. Also implied, is a need for a complete review of the CODATA set of recommended values that are expressed in six or more figures, because the mass-unit value is changed by 0.248 parts per million. In addition, gravitation is coupled to the values of h and N_A and needs to be brought into the total system of units. The existence of the "probability actualization factor" needs to be taken into account, and the effect of the factor β upon different measurement techniques must be given consideration when combining results obtained by different measurement techniques

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5. THE HUBBLE FACTOR

5.1. General

The Hubble factor is important to astronomy and cosmology. It is an indicator of the rate of change of radiation path between a source and observer due to the change in size of the universe during the radiation transit time. In its simplest form it has the dimension time^{-1}, but its usual expression is in kilometers per second per megaparsec of separation (km sec^{-1} Mpc^{-1})

The symbol h has been used in different reports to represent either Planck's constant or the Hubble factor. Since both possible referrents occur in the present report, I have elected to continue to use h to represent Planck's constant and ***h*** in Bold Italics to represent the Hubble factor. Also, to generate a dimensionless comparison factor, it has been a practice in modern reports to employ the form H = H_0 ***h*** where H_0 = 100 km sec^{-1} Mpc^{-1} and ***h*** is the error range 0.4 ≤ ***h*** ≤ 1.

The Hubble factor is difficult to measure because it applies to the rate of separation of the local-cosmic-rest locations of the source and the observer. As a result, the observational Doppler shift velocities should be corrected for the local motions of both the source and the observer. This makes determination of the Hubble factor extremely difficult for close objects, where separation distances can be measured directly. For close source and observer locations, the magnitude of local-velocity effects so overshadows the small Hubble-value contribution to the observed Doppler shifts as to make good measurements very difficult. As a result, there is still a lot of uncertainty about the best values for the Hubble factor in the range 0 to 100 Mpc separation, and almost no agreement as to how this factor changes with vast distances. This has almost forced acceptance of a constant numerical average value that is assumed to be unaffected by distance to the ordinary galaxies.

The observational value of the Hubble factor is expressed as an average over the distance separating the source and observer. It is obtained from the Doppler red shift, after correcting for known local velocities of the source and the observer, by dividing the net relative velocity of the two by the separation distance between them. This approach involves a built-in assumption that the individual components of the separation velocity, over short intervals, add linearly to produce the total separation velocity. It has long been known that the separate relative velocities of a series of particles moving in a given direction do not add linearly, but follow the velocity addition requirements of Special Relativity. It has been suspected that this requirement should also apply to the relative velocity of the source and observer that results from the continuous expansion of space as radiation moves from source to observer. Up to now, there has been no good way to take this non-linear effect into account in the conventional measurement technique.

In the present work, I propose to develop a theoretical relationship for directly computing the values for three related factors. These are the observable average separation rate, the local expansion rate as a function of cosmic age, and the net separation velocity between observer and source as a function of cosmic ages of both source and observer. For comparison, as current observational values for H, I will use three values selected from well known books. All three are expressed in terms of kilometers per second per megaparsec (km $\sec^{-1}$ Mpc^{-1}). The first of these values is

$$H = 49 \text{ km sec}^{-1} \text{ Mpc}^{-1}, (\boldsymbol{h} = 0.49) \tag{5-1}$$

as the value of the separation rate which was utilized by Joseph Silk (1980) in his book The Big Bang.

The second reference value is

$$H = 55 \pm 7 \text{ km sec}^{-1} \text{ Mpc}^{-1}, (\boldsymbol{h} = 0.55 \pm .07) \tag{5-2}$$

as quoted and used by Misner, Thorne, & Wheeler (1973) in their book Gravitation, which value was based upon the 1972 work of Sandage and Tammann.

The third value is

$$H = 67 \pm 15 \text{ km sec}^{-1} \text{ Mpc}^{-1}, (\boldsymbol{h} = 0.67 \pm 0.15) \tag{5-3}$$

as derived by Rowan-Robinson (1985) in his book The Cosmological Distance Ladder .

These three values are a good representation of the more conservative values for H. There are other reported results that range from a low of 42 up to a maximum of 100 km $\sec^{-1}$ Mpc-1. (See Rowan-Robinson 1985.)

5.2. First Approximation

The Hubble factor is a measure of the rate of change in the radiation path length during the interval of radiation transit from source to observer. After adjustment for the known local system velocities, the observer is considered to be at rest with respect to his local-cosmic-rest state. When the radiation departs its source, after correction for the known source velocities in its local system, it is considered to represent the condition of local-cosmic-rest at the source. With both the source and the observer corrected to their states of local-cosmic-rest, then the measured relative velocity represents the change in the separation of the two different states of local-cosmic-rest during the radiation transit time. This being so, if we understand the structure of the space of the universe and its rate of expansion, we should be able to compute the rate of separation of the two points; that is, provided that we know the precise universe age at the observer's location.

Our initial assumption has been that the universe space was spherical and that the expansion was purely radial at a uniform rate. Then, if we know the radius at the present observer's age and the rate of radial expansion, we can compute H by the relationship that defines the nature of the local value of H, which is

$$H = d[R(t)]/R(t), \tag{5-4}$$

where R(t) is the radius of the universe defined as function of time.

If R(t) is a constant multiple of time we would obtain a constant local value for H, but otherwise we would have a value that changes as some function of time, (as the universe ages during the radiation transit). In the conventional approach, matter is considered to be distributed on the surface of a hypersphere that is isotropic in our three-dimensional perceptions and of uniform radius of curvature in all perceived directions. To an observer, this appears to be a spherical distribution, and the radiation path is a shortest distance between source and observer.

Back in Section I, a value for the radius of curvature generator (R_u) was derived, and it was used to compute the total life cycle of the universe on the basis of constant velocity of the radius endpoint in the fourth direction. Initially, it was assumed that this radius of curvature was the direct determinant of the instant to instant radius of the three-space universe in accordance with the simple relationship:

$$R = R_u \sin \phi \,. \tag{5-5}$$

This was the form of Equation (1-24) before it was discovered that the three-space manifestation of the radius of curvature generator involved an information-content based degree of additional freedom. The simple relationship shown in Figure 1-2 was initially believed to extend to the perceived three-space as well as to the fourth dimension. Using that basis, and the simple form of Equation (5-5) for the radius relationship in Equation (5-4) yielded

$$H = R_u \cos \phi \, (d\phi/dt)/R_u \sin \phi \text{ , or} \tag{5-6}$$

$$H = \cot\phi\,(d\phi/dt). \qquad (5\text{-}7)$$

The factor R_u can be removed, because it is a constant when expressed in emergent size units.

To evaluate the above, we require a good value for the current age of the universe. Back in Section 4. a standard value was developed as Equations (4-72) & (4-72). This value is 12.351 657 278 x 10^9 nominal years, or 12.361 049 975 x 10^9 emergent SI years, which equates to an age phase angle for the present as

$$\phi_p = 1.431\ 165\ 8755 \text{ radians}. \qquad (5\text{-}8)$$

The value of $d\phi/dt$ is given by Equation (1-61) as 3.668 933 147 x 10^{-18} rad sec^{-1}. Using these values in Equation (5-7) we obtain:

$$H_0 = 5.156\ 504 \times 10^{-19} \text{ sec}^{-1}, \text{ or} \qquad (5\text{-}9)$$

$$H_0 = 15.9013 \text{ km sec}^{-1} \text{ Mpc}^{-1}. \qquad (5\text{-}10)$$

The above value is less than one third of the lowest of the three comparison values selected for reference as observational values. There may be several things that are contributing to the discrepancy between computed and observed values. The most obvious factor is that the simple time-function radius expression for the unperceived fourth-space direction (Equation 1-22) was employed, rather than Equation (1-27) that includes the effect of the rotational degree of freedom upon the perceived three-space radius. A second factor is a possible indirect effect of a mass-like contribution of the "space-stress energy" to some of the force relationships, as the magnitude of this component changes with universe age. To keep these two different aspects clear, the whole approach to the Hubble factor is explored first from the standpoint of ignoring any effects of the "space-stress energy", and then separately bringing the latter aspect into consideration in Section 6. in connection with early universe aspects. The reason for this approach is that the proposed "space-stress energy" effects seem to be second order effects that may be confined mainly to effects upon space. The perceived-space effects may be difficult to recognize and to accept, and may only show up as small effects on the Hubble factor over vast cosmic distances. In other words, some of the suggested effects of this energy rest upon very limited data.

5.3. Space Shape and Effect on H

Although the initial assumption of isotropy in all four four-space dimensions seemed to work satisfactorily for determining universe life cycle, it did not yield a proper value for the Hubble factor. It also failed in another respect, in that it predicted a value for average mass density of the universe that appeared to be far too high to fit with the current observational estimates of its probable value.

In examining the equations for the radius of curvature generator R_u, and then considering how the universe expansion might relate to the implied rotation aspects of the time phase-angle ϕ , it was recognized that a rotational degree of freedom might be involved. The rotational freedom has two aspects: the factor 2 and a component π. The existence factor 2 is considered to already be included in the probability actualization factor aspects. The pure rotation aspect had been encountered in other relationships as $\pi^{1/8}$ or $\pi^{1/16}$. The fractional components represent the effect of fractional degrees of freedom or dimensional contributions. The age angle ϕ represents a rotation that changes coupling of one component in the system. In topology a fractional dimension can be represented by $\sin^2$ of the angle involved. Applying this to the present situation, then the rotational information content factor becomes:

$$\text{Information factor} = \left(p^{\sin^2 f}\right). \tag{5-11}$$

Inclusion of the above in the earlier expression for the instant universe radius modified it to

$$R = R_u\left(p^{\sin^2 f}\right)\sin f . \quad \text{(See Appendix 8.4.)} \tag{5-12}$$

When this relationship is inserted in Equation (5-4), the expression for the local value of H becomes:

$$H = [(2 \sin^2 \phi)(\cos \phi)\ln \pi + \cos \phi]\ (d\phi/dt)/\sin \phi \text{ , or} \tag{5-13}$$

$$H = [(\ln \pi) \sin 2\phi + \text{cotan}\ \phi]\ (d\phi/dt). \tag{5-14}$$

This expression for H differs from that of Equation (5-7) by inclusion of the component $[(\ln \pi)\sin 2\phi]$ which takes into account the additional rate of increase in three-space radius due to the rotational probability aspect. This added factor has only a very small impact in the early stages, near emergence, but is a quite considerable factor for greater ages. Now, utilizing the standard current-universe age in Equation (5-14) yields

$$H = 1.673\ 343\ 404 \times 10^{-18}\ \text{sec}^{-1}, \qquad \text{or} \tag{5-15}$$

$$H = 51.601\ 559\ 89\ \text{km sec}^{-1}\ \text{Mpc}^{-1}, \text{ in emergent size units.} \tag{5-16}$$

The units of length and time both change in the same ratio with universe age, so the effect upon km sec^{-1} cancels out, leaving the current ratio numerically the same as the emergent ratio.

This is the differential rate for small separations from the present age location. Inspection of the form of the equation shows that the differential rate should increase for earlier ages. As a result, the observational value for relatively close objects should be close to, but somewhat higher than, the computed H value. The computed value is greater than the first of the observational reference values, but well within the standard error of ± 8 to 10 percent common to similar observational values. It is less than the second reference value, but also within its indicated precision limits.

The second value, Equation (5-2), was based upon the 1972 data of Sandage and Tammann. In 1974 they reported a value of 57 ± 6 for the Virgo cluster, which ranges approximately 15 - 20 Mpc away. Using 18 Mpc as an average favoring the more remote components, we compute age of origin of the radiation as 58.67 million years ago. We then compute the value for H at that age into the past.

$$\phi_2 = 1.431\ 165\ 876 - (58.67 \times 10^{6}\ \pi/T), \text{ or} \tag{5-17}$$

$$\phi_2 = 1.424\ 372\ 767 \text{ rad.} \tag{5-18}$$

Then, using this value in Equation (5-14) yields

$$H = 1.753\ 526\ 012 \times 10^{-18} \text{ sec}^{-1}, \text{ or} \tag{5-19}$$

$$H = 54.074\ 183 \text{ km sec}^{-1} \text{ Mpc}^{-1}. \tag{5-20}$$

This value is closer to the reference value in Equation (5-2) than the present age value. The actual observational value represents some kind of an average of the value at the source and at the observers location. If we take a simple average of (5-20) and (5-16), it yields

$$H(avg) = 52.838 \text{ km sec}^{-1} \text{ Mpc}^{-1}. \tag{5-21}$$

Because of the low precision of the observational values, I drop all digits beyond 5 in the computed values. The above value is now approximately 2/3 the standard error away from the later Sandage and Tammann value.

The reference value of H, quoted in Equation (5-3), was obtained from a wide range of observational data. One of the figures in the reference text (No. 6.3, p. 271 Rowan-Robinson 1985) shows a plot for velocity vs distance for the brightest cluster galaxies. The bulk of the data points range approximately 25 to 140 Mpc. Using 80 Mpc as an average, we compute the value of H at that distance using Equation (5-14), and the equivalent age correction of 260.8 x 10^6 years.

$$H = 2.028\ 386\ 754 \times 10^{-18} \text{ sec}^{-1}, \text{ or} \tag{5-22}$$

$$H = 62.550\ 17 \text{ km sec}^{-1} \text{ Mpc}^{-1}. \tag{5-23}$$

This value then should be averaged with the H value of Equation (5-16). This yields

$$H = 57.075\ 87 \text{ km sec}^{-1} \text{ Mpc}^{-1}. \qquad (5\text{-}24)$$

This value is low compared to the value quoted in Equation (5-3), but still well within the indicated tolerance range.

The values of H in the three reference Equations (5-1 to 5-3) all assume a constant uniform value for H over the range of observations, and in their application to use in determining the distances of remote sources. By examination of Equation (5-14), it is obvious that the local values of H can vary over a very wide range. At age $\phi = \pi/2$ the local value would essentially be 0, while at ages very close to emergence it can approach the inverse of the universe age in seconds since full emergence.

During the first half of a universe cycle (the expansion phase) any radiation is passing through space that is expanding continuously. As a result, any expansion velocity effect that is detected in radiation passing from source to observer is the integrated result of the continued expansion during the radiation transit time. The conventional approach treats the velocity difference between source and observer as the product of the average velocity difference per unit of separation with the total separation distance. The continuous nature of the process involved suggests that we should properly treat the effective total separation rate as the definite integral of the process, between the point of emission and that of the observer. If velocity increments were linearly additive, the two approaches would be equivalent, but they are not. Our experience, with Special Relativity, indicates that velocity parameters in a given direction add, as the hyperbolic angles whose tangents are respectively equal to the ratios of the individual velocity components relative to c. In the present case, instead of discrete velocity elements to be added, we have a series of differential elements. The result still should be a hyperbolic angle as the resultant velocity parameter.

In generating Equation (5-14), that represents the value of the local Hubble factor as a function of age, the value of the "Radius of Curvature Generator" (R_u) was assumed to be a constant. It is not a constant in terms of our nominal units of measure, because it is also a function of cosmic age as

$$R_u = R_{u0} (1 - \alpha\, \phi/\pi)^{1/3}. \qquad (5\text{-}25)$$

There is, however, a compensating factor in that the nominal cm unit changes relative to the emergent cm unit in exactly the inverse ratio. As a result, if we measure both time and length in emergent units, then the numerical value of R_u is a constant in emergent units throughout the life cycle. This is also true of the relationship between age angle ϕ and time in emergent units: $d\phi/dt$ is a constant in terms of emergent size units. This was discussed in Section 4.6. . Using emergent size units, Equation (5-14) is valid at any universe age.

Equation (5-14) is of the form

$$H = d[R(t)]/R(t). \qquad (5\text{-}26)$$

Since we know the form of the function R(t) as a function of age angle ϕ ,

$$R(t) = R_u\,(p^{\sin^2 f}\,\sin f\,), \qquad (5\text{-}27)$$

we can put it into Equation (5-26) with time in implicit form as

$$H = d[R(\phi)](d\phi/dt)/R(\phi),\ \text{or} \qquad (5\text{-}28)$$

$$H\,dt = \{d[R(\phi)]/R(\phi)\}\,d\phi. \qquad (5\text{-}29)$$

This is in integrable form and yields

$$\int H\,dt\ = \ln\,[R(\phi)] + \text{constant, or} \qquad (5\text{-}30)$$

in definite integral form,

$$\int_{f_1}^{f_2} H\,dt = {}_{f_1}^{f_2}[\ln\,\{R(\phi)\}. \qquad (5\text{-}31)$$

In employing the definite integral form, the contribution of the constant factor R_u in Equation (5-27) is exactly the same in the two components in the numerical evaluation of Equation (5-31), so it can be ignored. As a result the above equation can be simplified to

$$\int_{f_1}^{f_2} H\,dt = {}_{f_1}^{f_2}\left[\ln\!\left(p^{\sin^2 f}\,\sin f\right).\right. \qquad (5\text{-}32)$$

The resultant value of $\int H\,dt$ is a differential rate integrated over the time difference between source and observer, in emergent units. The next question is: what are the units in which $\int H\,dt$ is expressed, when the input units are the ages in radians? It is not obvious from the form of the equation and the path that has been followed to get there, but the result is the hyperbolic angle in the radiation path between the age phase angle ϕ_1, and ϕ_2. This has been verified by computing the differential rate H at a series of points, converting the difference between adjacent points to hyperbolic angle increments as $\tanh^{-1}(\Delta v/c)$ and then comparing the sum with the results from the integrated form of the expression (Equation 5-32).
Recognizing the above, we can put the equation into a directly usable form as

$$\Delta v/c = \tanh\,[\ln\left(p^{\sin^2 f_2}\,\sin f_2\right) - \ln\left(p^{\sin^2 f_1}\,\sin f_1\right)]. \qquad (5\text{-}33)$$

Putting in the value for the present universe age (ϕ_1 = 1.431 165 875), this becomes

$$\Delta v/c = \tanh\,[\ln\left(\pi^{\sin^2 \phi_2}\,\sin\phi_2\right) - 1.112\ 775\ 968]. \qquad (5\text{-}34)$$

For all values of ϕ_2 less than the present age, the value of $\Delta v/c$ will be negative for the velocity of separation. For an observers age ϕ_1, greater than $\pi/2$ (being in the second quadrant) the value of the relative velocity can be either positive or negative depending upon the relative distances of the source and the observer from the mid point age of $\pi/2$.

The way that astronomers and cosmologists are likely to use the new expression for $\Delta v/c$, is to use the value of observed $\Delta v/c$ from the red shift measurements (as a negative value) and then solve for the cosmic age of source emission ϕ_2. This value can then be translated to the source separation from the present. The result is a time or distance in emergent size units, which can be converted to nominal units by use of the relationship discussed in Section 4. as Equation (4-58).

What is derived from observation is the observable average value for H. It is the net velocity difference divided by the separation distance between source and observer. It is not the value at either endpoints ϕ_1 or ϕ_2 computed by Equation (5-14), or the average of the endpoint values. The local value at the source age (ϕ_2) location increases continuously as the age ϕ_2 approaches emergence, but the observable average changes much more slowly. The observable averages for very small separations at the present age are close to the average value computed for 1 Mpc separation (51.93 km sec^{-1} Mpc^{-1}), but they behave very differently for larger separations from the present. The computed average value for H increases to a maximum of approximately 124.4 at approximately 1668 Mpc and then gradually declines as the age gets closer to the origin near 3792.22 Mpc. All of these distances and times are quoted in terms of emergent size units. These relationships are shown in Figure 5-1 as the observable average recession rates, plotted against total separation distance in Mpc from the present.

Different forms of this same information are shown in Figures 5-2 & 5-3, which are plots of conventional red shift factor (z) for radiation from remote sources as a function of total separation distance into the past. In examining these curves, we note that a red shift of z = 4 is very close to 2500 Mpc from the present. This value of z = 4 is greater than all but a very few recently observed objects. This in turn implies that most of the farthest objects that we currently see are less than 2/3 of the way back to the origin point of the "big bang". This distance of 2500 Mpc or 8.15 x 10^9 years into the past is much less than the value estimated by using the conventional average value for H as 50 km sec^{-1} Mpc^{-1}.

5.4. The Nature of H

If we examine an example of H expressed as km sec^{-1} Mpc^{-1}, as derived from observations, it has the dimension of sec^{-1}. The inverse of the Hubble value H at the present universe age is the Hubble time, which is considered to be a rough estimator of the horizon distance. This value is used in cosmology as a minimum estimate of the universe radius. The new approach usage of H tends to support this earlier usage, but with some limitations added.

If we examine the new equation for predicting the value of H as a function of the universe age angle ϕ, we can acquire additional information about H.

$$H = [(\ln \pi) \sin(2\,\phi) + (1/\tan \phi)]\, d\phi/dt. \qquad (5\text{-}36)$$

At any given universe age (t_s) in seconds, the value of ϕ is given by $t_s\,(d\phi/dt) = \phi$. When ϕ is small, both $\sin \phi$ and $\tan \phi$ can be replaced by the angle in radians. Doing this yields

$$H = [(\ln \pi)2\,\phi + (1/\phi)]\, d\phi/dt. \qquad (5\text{-}37)$$

For small values of ϕ, the second term dominates and we have

$$H = (1/\phi)(d\phi/dt), \text{ or} \qquad (5\text{-}38)$$

$$H = [1/(t_s\, d\phi/dt)]\, d\phi/dt = 1/t_s. \qquad (5\text{-}39)$$

On this basis, the value of H calculated by use of Equation (5-36) is exactly equal to the inverse of the age of the universe in seconds for ages corresponding to small values of the angle ϕ. For larger values of ϕ, greater than approximately 10^{-2}, it begins to deviate from precise correspondence to $1/t_s$. For example, in a cyclic universe such as ours, the value of H at $\phi = \pi/2$ must be exactly zero at the instant of change from expansion to contraction. By the simple expression form of Equation (5-39), this would imply infinite Hubble time, but, by the full equation, a specific time is associated with the instant when H = 0. The full Equation (5-36) has been explored over the range from the time of full neutron emergence to maximum universe size. The numerical value of H^{-1} in seconds is exactly equal to the universe age in seconds at early ages, and slowly becomes slightly the smaller of the two with age. This decrease continues until it differs by one part in 10^3 at age 3 x 10^{15} seconds. The numerical value of H^{-1} continues to become progressively less than the age up to an age approximately 2.5 x 10^{17} seconds, and then it starts to increase faster than the age. At 3.65 x 10^{17} seconds, the two values are once again very close. Beyond this point, the numerical value of H^{-1} is increasing much more rapidly than the age. These relationships are shown in Figure (5-4). The dotted-line curve extension represents what would be the form that the curve would have if the numerical values for age and H^{-1} remained equal.

5.5. Maximum Observable Separation Rate

Except for a few of the most recent observations, the maximum red shift for individual stellar objects has been less than z = 4, but we also have a red shift in the form of the microwave background radiation. This radiation is assumed to originate from dust and gases at approximately 3030 ^{o}K. The value 3030 ^{o}K was selected for the recombination temperature to be the same as the value used by Kolb & Turner (1990) in their book The Early Universe. This is the temperature at which the ionization of the hydrogen gas in space is believed to approach close to zero, and space becomes transparent to optical-wavelength radiation. A question at this point arises as to whether the 2.726 ± .005 ^{o}K radiation (Mather 1994) is the result of radiation cooling of decoupled radiation due to the change in volume of space occupied by the radiation, or is simply the Doppler shift result from observer velocity relative to the source? We would not expect the two approaches to yield the same answer, unless there is some very particular coupling between volume change and separation velocity.

By the conventional approach, radiation that is filling space, and which is not coupled to matter temperature, decreases in equivalent black body temperature in inverse ratio with the radius of the containing space. With a source temperature of 3030 ^{o}K and a minimum observed radiation temperature of 2.726 ^{o}K, the space radius ratio would be 1111.5187. Then, using this observed wavelength ratio in a form of the relativistic Doppler shift equation yields a velocity ratio as:

$$\Delta v/c = -(1111.5187^2 - 1)/(1111.5187^2 + 1), \qquad (5\text{-}40)$$

$$\Delta v/c = -\ 0.999\ 998\ 381\ . \qquad (5\text{-}41)$$

This is the apparent Doppler shift from treating the volumetric change related wavelength as though it was a relative velocity derived effect for the given radius ratio:

$$R(\text{observe})/\ R(\text{source}) = 1111.5187\ . \qquad (5\text{-}42)$$

In the subsection 5.3., Equation (5-33) was derived as relating the integrated difference between source and observer velocities due to the expansion of the universe, under a particular expansion law.

$$\Delta v/c = \tanh\ [\ln\left(p^{\sin^2 f_2} \sin f_2\right) - \ln\left(p^{\sin^2 f_1} \sin f_1\right)]. \qquad (5\text{-}43)$$

The radius of the universe at a given age is given by Equation (5-12) as

$$R = R_u\left(p^{\sin^2 f} \sin f\right). \qquad (5\text{-}44)$$

Considering this, then Equation (5-43) can be re-expressed as

$$\Delta v/c = \tanh\ [\ln\ (R_2/R_1)], \qquad (5\text{-}45)$$

where R_2 is the source radius of the universe and R_1 is radius of the universe at the observers age. For observations of past sources from the present age, the value of ln (R_2/R_1) is negative, representing a velocity of separation. The observed Doppler red shift is attributed to a velocity of recession, hence is negative.

Now, using the observed shift velocity as negative and putting it into Equation (5-45) yields a radius ratio by the new approach.

$$\tanh^{-1}(-0.999\ 998\ 381) = -7.013\ 486\ 90, \qquad (5\text{-}46)$$

$$\ln (R_1/R_2) = 7.013\ 485\ 90, \tag{5-47}$$

$$R_1/R_2 = 1111.5224\ . \tag{5-48}$$

This is the same as the value of relative radii assumed for the radius ratio from thermodynamic reasoning (within the precision limits of the calculator used and the closeness of the velocity ratio to 1). In essence this validates the new relationships, for computing universe radius and for the Hubble factor, from a thermodynamic point of view. This being so, we can utilize either or both of these approaches in trying to understand what is occurring in the early universe.

The above comparisons also demonstrate something that was under question concerning the continuous loss mechanism of the universe. This mechanism reduces the total mass-energy, of the matter component of the universe, in proportion to age in accordance with Equations (6-73 to 6-75). Since the deduction of the effects of the radius-change upon wavelength is based upon energy conservation in the radiation, it then is obvious that this continuous loss mechanism is not removing energy from free radiation that is uncoupled from matter. Also, this makes it plain that any other energy absorbing mechanism, such as gravitation, is not having any major effect on the energy of free uncoupled radiation in the expansion process. This fact can be helpful in studying the thermal history of the universe. This also helps to account for the reason that we have not discovered effects of this continuous loss mechanism in our experimental results, in addition, of course, to the low level of the effect in terms of ordinary laboratory time intervals.

The long-range cosmic red-shift effect represents a geometric relationship between the universe radius at the source age and the universe radius at the observers age, after correction for local velocity effects at both locations. It is possible that the observed red-shift for vast separations is appreciably less than the value that represents the actual ratio of the universe radii at the two endpoints, because of a small blue-shift effect due to “space stress energy” differences at the two locations. This shift can partially compensate for some of the red-shift. Discussion of the magnitude of this possible effect is deferred to Section 6..

5.6. A Gravitational Limit

It is commonly assumed that the effects of gravitation upon structures of matter extends to the far limits of the universe from any given source, decreasing in intensity in proportion to the inverse square of the distance. In effect this is true, but the observable results are complicated by the effect of universe expansion (or contraction) in interaction with the gravitational effect. For a particular source, at some distance, the expansion action can neutralize the gravitational field effect with respect to the gravitational source as a reference point for measurement of motion. This limiting distance is called the gravitational limit. For separations greater than this, the expansion change in position dominates, but reduced somewhat in velocity by the residual gravitation effect. For separations less than the limit, the gravitational force must equal the sum of the expansion force and any orbital or inertial response requirements of the particle involved.

The separation force due to expansion, potentially, acts continuously. At maximum, when a particle is restrained from following the expansion motion relative to some specific local-cosmic-rest reference source, the magnitude of the apparent force is given by Equation (1-79) as

$$f = H\ c\ m. \qquad (5\text{-}49)$$

Initially, I thought this apparent force to be too large, so, I also tested an alternate value where the propagation velocity of radiation (c) in perceived space was replaced by the general matter velocity ($c/2\pi$) in the fourth space direction. In this section there are calculations made by using both intensity levels for comparison purposes. The end result being that I have accepted the full value of Equation (1-79) as providing the most consistent results and a more restrictive gravitational limit.

The gravitational limit is defined as the separation distance at which the gravitational force per unit mass is exactly equal and opposite directed relative to the expansion force relative to the gravitational source location. The simple derivation of the relations based upon Equation (1-79) follows:

$$f = H\ c\ m = -G\ M_S\ m/d^2, \qquad (5\text{-}50)$$

$$d_0 = [G\ M_S/(H\ c)]^{1/2}, \qquad (5\text{-}51)$$

$$d_0 = M_S^{1/2}(1.153\ 27)\ \text{cm, or,} \qquad (5\text{-}52)$$

$$d_0 = M_S^{1/2}(1.219\ 03 \times 10^{-18})\ \text{light years,} \qquad (5\text{-}53)$$

with M_S = source mass in grams, and d_0 is the distance at which the two forces become equal.

$H = 1.673\ 34 \times 10^{-18}\ \text{sec}^{-1}$ (at present age),

$G = 6.6722 \times 10^{-8}$.

As an example of a gravitational limit, our sun, at 1.989×10^{33} g, has a limit at

$$d_0 = 0.054\ 367\ \text{light years.} \qquad (5\text{-}54)$$

Even with the less restrictive force factor of ($1/2\pi$) the computed solar limit would only be

$$d_0 = 0.13628\ \text{light years.} \qquad (5\text{-}55)$$

When an object is restrained from following normal expansion at the current universe age, the expansion force away from the restraint source is given by

$$f_0 = H\ c\ m = 5.016\ 56 \times 10\text{-}8 \text{ dyne g}^{-1}. \qquad (5\text{-}56)$$

The magnitude of the solar gravitation effect at the distance of the planet Pluto, at 5.90×10^9 km is

$$f_g = 3.812 \times 10^{-4} \text{ dyne g}^{-1}. \qquad (5\text{-}57)$$

At this distance the expansion force is only one part in 7599 of the gravitational force, but at the limit distance of 0.054 367 light years, it is completely equal. Thus, the nearest star, Alpha Centauri at 4.3 light years, is far beyond any significant gravitational influence of our sun.

As a comparison value for a possible gravitational limit, I am aware of only one other value. That is, a limit proposed by Larson (1984) in his book The Universe of Motion. His value is calculated in a somewhat different manner, and is given in his Chapter 14 on limits as

$$d_0 = M^{1/2}(8.0714 \times 10^{-17}) \text{ light years}. \qquad (5\text{-}58)$$

For the solar mass, this equates to

$$d_0 = 3.60 \text{ light years}. \qquad (5\text{-}59)$$

This is a much less restrictive limit, but I believe it to be inadequate.

The existence of a gravitational limit will influence the dynamics of galaxy and stellar interactions, and will also have an effect upon the estimated mass of gravitational sources when the calculations are based upon orbital data for objects that are close to the limiting distance from the source. As a check upon the magnitude of this effect, some calculations have been made with respect to our Milky Way galaxy. The data for the calculations are based upon galaxy rotation curves in two texts. These are Rowan-Robinson (1985),The Cosmological Distance Ladder, Figures 2.42 and 2.44, and Kaufmann (1985), Universe, Figure 25-15. The basic reference datum is the orbit of the sun about the galaxy core at 250 km sec^{-1} at a radial distance of 30,000 light years. The extreme distance values taken from Figures 2.42 and 25-15 were read off as 215 km sec^{-1} at 15 kilo parsec (48,900 light years) from 2.42, and 300 km sec-1 at 60,000 light years from 25-15.

Using the standard gravitational orbit approach and the theoretical value of G as 6.6722 x 10-8, the implied source mass was calculated for each condition. Then, the implied adjusted mass (M_a) for each of these conditions was calculated using both the full expansion force and with the alternate involving the reduced ratio of $1/(2\pi)$. The results are summarized in Table 3. In calculating the adjusted mass, the procedure followed, is illustrated by a sample calculation for the basic reference orbit at 30,000 light years. First, the orbital force requirement per gram was calculated:

$$f = v^2/d = 2.2021 \times 10^{-8} \text{ dyne g}^{-1}. \tag{5-60}$$

Then, to this is added the expansion force (Eq. 5-49) to yield the total gravitational force required to maintain the observed orbit:

$$f = 7.219 \times 10^{-8} \text{ dyne g}^{-1}. \tag{5-61}$$

Then, the mass required to produce this force at the indicated distance is computed.

$$M_a = f\, d^2/G = 8.715 \times 10^{44} \text{ g, or} \tag{5-62}$$

converted to the number of solar mass equivalents,

$$M_a = 4.382 \times 10^{11} \text{ solar masses.} \tag{5-63}$$

Table 3
Required Local Galaxy Mass
(in Units of 10^{11} Solar Mass)
Based on rotation rates at various distances in light yr.

Gravitation condition	30,000 lt yr.	48,900 lt yr.	60,000 lt yr.
Conventional	1.3366	1.611	3.850
Reduced limit*	1.821	2.899	5.788
Full grav. limit	4.382	9.7015	16.029

* Gravitational limit distance increased by factor of $(2\pi)^{1/2}$

Then, using the above masses, the implied mass densities of the two galaxy halo regions were computed.

Table 4
Space Mass Density in Units of 10^{-25} g cm^{-3}
(for shell orbital radius ranges in kilo lt yr.)

Gravitational condition	30.0 to 48.9	30.0 to 60.0
Conventional	1.7110	7.4576
Reduced limit*	6.722	11.771
Full grav. limit	33.171	34.558

* Gravitational limit distance increased by factor of $(2\pi)^{1/2}$

The use of the full gravitational limit yields the most consistent answers for the apparent halo density. This was a factor in encouraging the utilization of the full gravitational limit.

If we accept the two Magellanic clouds as being satellite galaxies to our local galaxy, this requires that the small cloud at 67 kpc be within the local galaxy's gravitational limit, that is, that the gravitational force be at least equal to the current-age expansion force. In turn, this requires that the local galaxy with its associated halo have a mass that is at least of the following magnitude:

$$M_a = (67{,}000 \times 3.08374 \times 10^{18})^2 (5.0166 \times 10^{-8}/G). \tag{5-64}$$

$$M_a = 3.2095 \times 10^{46} \text{ g, or } 1.614 \times 10^{13} \text{ solar masses.} \tag{5-65}$$

Then, using the adjusted mass for the part of the galaxy inside the 60,000 light year radius (1.6029×10^{12} solar masses), and assuming the average density as 3.456×10^{-24} g cm^{-3} for the halo beyond, we compute the total halo radius. This yields

$$r_{max} = 1.3706 \times 10^5 \text{ light years, or } 42.05 \text{ kpc.} \tag{5-66}$$

This is 62.8 percent of the distance to the smaller Magellanic cloud.

If the average density of the dark matter contribution to the halo mass is less than implied above, then the halo would need to extend farther toward the region of the small cloud. Conversely, if more dense on the average than indicated, it would not need to extend as far, but the total mass requirement for the gravitational limit must be met for the small Magellanic cloud to be under control of the local galaxy.

For our local galaxy to exercise a hold on the small Magellanic cloud in the presence of a full gravitational limit effect, requires that it have a total mass 10.095 times its adjusted value computed for the 60,000 light year radius, and 41.72 times the mass conventionally computed for that radius by not taking the gravitational limit effect upon the orbits into account. These may not be unreasonable numbers, when it is recognized that recent studies suggest that the contribution of the nonluminous matter, to the total universe mass, may raise the estimated total from observational radiant matter estimates by a factor of as much as one hundred.

Gravitational control, as utilized in these discussions, implies that the gravitational effect is strong enough to stabilize orbits about the source mass, or to attract matter toward the source despite the expansion of space. In cases where matter is beyond the gravitational control limit of a given source, the source can still have a gravitational effect in the form of perturbations of the matter motion, or simply decreasing the magnitude of relative velocity resulting from universe expansion. Being beyond the gravitational limit of a given source does not mean beyond influence by the source, but only beyond dominant influence by the source.

The galaxy rotation curve for a galaxy that is more open and which spreads farther out than the local galaxy was also selected for examination and comparison . This was the galaxy M 101, using rotation data from the reference Figure 2.44. The results are contained in Tables 5 and 6.

Table 5
Required Mass for Galaxy M 101 Based on Rotation Rates
Mass in units of 10^{11} solar mass

Radius kpc	Velocity km sec^{-1}	Conventional	Grav. limit adj.
10	180	.753	4.384
20	220	2.2496	16.63
30	228	3.624	35.98
40	220	4.4990	62.01
50	211	5.173	95.04
60	195	5.301	134.70
70	177	5.096 ?	181.23

In a manner similar to that used for the milky way galaxy, the implied density of matter in the surrounding space was computed for shells inside of the given orbit radius, under conditions for conventional gravitation effects, and for conditions taking into account the full gravitational limit effects.

Table 6
Matter density of the 10 kpc radial space inside the given radius
Mass density in grams x 10^{-25} cm^{-3}

Radius kpc	Conventional	Grav. limit adj.
20	3.461	28.41
30	1.172	16.49
40	.383	11.39
50	.179	8.767
60	.0228	7.057
70	.(- ?)	5.933

In empty space, the existence of a gravitational limit implies that the conditions for the existence of orbits changes very rapidly for distances near the limit distance. Also, it requires a much greater increase in mass of the source to extend the gravitational reach than assumed in the conventional approach. The sharp cut-off in gravitational effect for near solar size objects at only a fraction of a light year is probably a major contributor to the stability of both globular and open star clusters. Also, if the predicted magnitude of the gravitational limit effect holds up, it probably means that our galaxy’s velocity toward the Virgo cluster is a remanent velocity from some other cause and not due to gravitational attraction of the Virgo super cluster. (Note: See Section 4.2..) The implications are that the solar system velocity of 378 km sec^{-1} is the net velocity relative to local-cosmic-rest after removal of all velocity effects due to gravitational fields

Most of the discussion and calculations involving the gravitational limit have been concerned with conditions during the expansion phase of the universe cycle. At maximum expansion, the gravitational limit goes out of existence, and during the collapse phase, the space contraction force adds to any gravitational forces thereby tending to increase local collapse effects in galaxies**,** and dust or gas clouds. .

5.7. Space-Stress Energy

The expansion of the universe is a fundamental process that appears to be externally driven. Matter particles are uniformly distributed in the early stages, and our perceived three-space appears to be uniformly distributed such that any selected point appears to be the center of the universe viewed from that point, and space is closed. As a result, there is no net long range gravitational force upon any particles at any stage of the expansion while the matter distribution remains uniform. This being so, gravitation is not absorbing much energy from matter particles during the early uniform matter distribution part of the cycle. Yet, later in the expansion, local condensations can occur and these yield up large quantities of energy in the condensation process. Where, then, is the source to supply the gravitational energy involved?

As the universe expands, this process appears to be driven by the expansion of space. This represents a stretching of the connectivities between the mass-unit volumes responsible for the space volume. The expansion process results in a velocity of separation of reference points in one period relative to their positions at an earlier period. This appears to be resolvable into a net force effect per unit of mass, derived earlier as Equation (1-79), which is

$$f = H\, c\, m, \ \text{(dynes)} \qquad (5\text{-}67)$$

with H in sec^{-1} at the particular age involved, and m in grams. This force represents an interchange reaction between matter particles and the structure of space. It represents an on-going process, where the force acts over the three-space expansion distance, and the energy appears to be stored in some kind of non material form in the structure of space. I have called this “Space-Stress Energy”. This energy associated with the uniform distribution of matter particles is the source for any energy resulting from reductions in matter particle separations, such as gravitational condensations.

If we integrate the expansion force over the particle separation distances relative to the starting point, we should obtain the change in energy per unit mass between the two positions. The change in rest positions represents the change over the time interval between the instants of comparison.

It has been shown that the Hubble factor can be integrated between any two ages (with ages in radians) as Equation (5-32), which is

$$\int H\,dt \;=\; {}_{f_1}^{f_2}\left[\ln\left(p^{\sin^2 f}\,\sin f\right)\right. . \tag{5-68}$$

This is not quite in the form for an energy integration, so we multiply both sides by the constant factors (c, m,) to convert to force integrated over time, and then replace dt on the left hand side by its equivalent as ds/c, and (H c m) by force (f). Then,

$$\int f\,ds = c^2 m\;{}_{f_1}^{f_2}\left[\ln\left(p^{\sin^2 f}\,\sin f\right)\right. . \tag{5-69}$$

becomes the energy change due to individual gram mass-units for the age change between ϕ_1 and ϕ_2 This then can be converted to total energy by replacing the gram mass-unit by total universe emerged neutron mass (M_e). To be more exact, it is necessary to take into account the small change in total universe mass with age. This effect, applied to the emerged neutron mass, is given by the relation

$M = M_e\,(1 - \alpha\,\phi/\pi)$, (5-70)

where $M_e = M_0$ (0.999 275 855).

Note: For all ordinary purposes, use of M_0 in place of M_e should be adequate.

By itself, this is a linear effect that could be closely approximated by an average over the age range. The integrated portion involved in the total expression, however, contributes more effect per unit of ϕ in the early stages than later, so there is a bias toward the lower values of ϕ, which should decrease the effect of the declining mass to something less than the linear average. Considering the two components as being independently affected by the integration, the effect of the ϕ portion in Eq. (5-70) becomes $\phi/2$ after integration. The total “space-stress energy” change between ages ϕ_1 and ϕ_2 can be expressed as

$$\Delta E = M_e\,c^2\;{}_{f_1}^{f_2}\left[[1-\left({}^{af}\!\big/_{2p}\right)]\ln(p^{\sin^2 f}\,\sin f)\right. , \tag{5-71}$$

where the minimum possible value of ϕ_1 is not zero, but rather the value (ϕ_{en}) at full emergence of all the neutral structural units, and (α) is given by Equation (1-14) as 9.995 322 693 x 10^{-3}.

There are some small approximations involved in the above equation form, which involve lack of information on how thermal and positional energy may affect the space-stress energy. Ignoring these small effects, then, the total space-stress energy at a given age ϕ_2 becomes

$$E_{f_2} = M_e\, c^2\, [31.455\ 239 + (1 - \alpha\, \phi_2/\{2\, \pi\, \})\ \ln\left(p^{\sin^2 f} \sin f\right)]. \quad (5\text{-}72)$$

At maximum universe expansion, at age $\phi = \pi/2$, the maximum "space-stress" energy becomes

$$E_{max} = (M_e\, c^2)[31.455\ 239 + (\ 0.997\ 501 \times 1.144\ 730)], \text{ or}$$

$$= 32.597\ 108\ M_e\, c^2. \quad (5\text{-}73)$$

The maximum "space-stress" energy is close to 32.6 times the total initial mass-energy complement of the universe.

An age of 24 million emergent years has been selected for some energy comparisons. This is the first approximation to the age of decoupling of matter and radiation, rounded to the nearest million years, estimated from the temperature of the microwave background and the assumed source temperature of 3030 ^{o}K. The high degree of uniformity in the CMBR temperature implies freedom from local gravitational condensations at the age of emission of the radiation. It may be possible that condensations start to form shortly thereafter, so we need to examine any limits to the availability of gravitational condensation energy. The available "space-stress" energy at this age, which gravitational condensations can potentially draw upon, would have reached

$$E = (M_e\, c^2)(31.455\ 239 - 5.885\ 728), \text{ or, } = (M_e\, c^2)(25.569\ 502). \quad (5\text{-}74)$$

An estimate of the energy requirement of a condensation at this age can be obtained by ignoring any possible long range gravitational force and treating a local mass as a quantity of uniform diffuse matter under self gravitation only. Then, collapse this from some diffuse state to a more dense state and smaller volume. Treating the change in potential energy at the surface of the spherical volume as the required energy, and utilizing the standard expression for the potential energy yields

$$\Delta E = (G\, m^2)(1/r_c - 1/r_0), \quad (5\text{-}75)$$

where r_c is the final condensed mass radius (assuming uniform density),and r_0 is the initial diffuse mass radius, on a uniform density basis.

Using a solar size mass as an example, at the universe age 24 million years, with the present age value for G, yields an energy release in the condensation process as

$\Delta E = 3.3834 \times 10^{48}$ ergs. (5-76)

Solar mass = 1.989×10^{33} g,

Initial density = 1.161×10^{-19} g cm^{-3}.

Final density = 1.0 g cm^{-3}.

The equation (5-75) is not applicable to the universe treated as a single whole condensation, because there is no net gravitational field extending over the large distances by reason of closure of the space and uniform matter distribution. The nearest approach is to divide the universe into a large number of smaller regions, and sum up the energy of these condensations. In doing this at a given age, the average mass distribution remains unchanged over the large scale. Condensation to very large stars of mass many times solar mass are unstable, so we use solar mass as an initial test unit, and an average final individual-unit density 1.0 g cm^{-3}. Doing this yields a total condensation energy at age 24 million years as

$\Delta E = (2.2849 \times 10^{55}/1.989 \times 10^{33})\ 3.3834 \times 10^{48}$, or (5-77)

$\Delta E = 3.8867 \times 10^{70}$ ergs. (5-78)

Theoretically, condensation could go on to a density at least equal to that of close packed spheres at a density of 0.74048 of total space filling at initial full emergence of the structural units. This would be a density of

$\rho = 0.74048 \times 2.380594 \times 10^{14} = 1.7627823 \times 10^{14}$ g cm^{-3}. (5-79)

A solar size mass of 1.989×10^{33} grams represents a volume of

$V_s = 1.128\,331 \times 10^{19}$ cm^3, or a (5-80)

Radius = $1.391\,391 \times 10^{6}$ cm. (5-81)

The condensation energy change in going from 1.0 g cm^{-3} to close packed spheres is an energy change per solar mass of

$\Delta E = 1.897\,063 \times 10^{53}$ ergs. (5-82)

For the full universe, this amounts to an increment of $1.148\,804 \times 10^{22}$ times the above, or

$\Delta E = 2.179\,363 \times 10^{75}$ ergs. (5-83)

This yields a total energy change for the universe in going from uniform diffuse matter to uniform-spaced close-packed, neutron-density, solar mass, units amounting to

$\Delta E = 2.179\,402 \times 10^{75}$ ergs. (5-84)

This represents only a fraction of the total matter mass-energy as

$\Delta E = 0.106\,124\ (M_e\, c^2)$, (5-85)

for condensation from a diffuse state at 1.16×10^{-19} g cm^{-3} to solar size masses at a density of $1.762\,781 \times 10^{14}$ g cm^{-3}. This is a small quantity compared to the total "space-stress" energy of 25.569 ($M_0\, c^2$) accumulated by age 24 million emergent years. If we continue the process and have the condensed masses gather together into galaxies of 10^{12} uniformly spaced solar masses, where the condensed galaxies are specified to occupy 10^{-9} of their original dispersed volumes, then we add approximately 1.69 x 10^{75} more ergs to the gravitational energy release. From this, it appears that the accumulated "space-stress" energy can supply the energy needs for any likely condensations of dispersed matter to dust, gas clouds, stars, galaxies, etc. during universe evolution in the expansion phase.

There is a possible secondary effect of the difference in the mass equivalent of the "space-stress" energy between the universe at the age of radiation emission and its value at the age of the radiation detection (the present age), which may make the actual age difference be larger than we would assume from the normal age & red-shift relationship. This is a small possible "Blue Shift" effect upon free radiation in space, due to the differences in space-stress levels between the source and observer locations. The effect can be large for large red shifts, but at the level of $z = 1$, its effect would only be to increase the estimated separation of source and observer to that which we would ordinarily compute for a value of $z = 1.04$. By the time the observed red shift attains the value for the age of decoupling at an observed value of $(1 + z) = 1111$, the effect would increase to a multiplier of 1.26. This potential effect is discussed in Section 6.4. and illustrated in Figures 6-3 and 6-4.

6. THE EARLY UNIVERSE

6.1. General

Sufficient information on the proposed new approach to the universe structure, and its evolution, has been accumulated to serve as a good basis for comparison with the standard "Big Bang" approach that is associated with the standard Friedman-Robertson-Walker (FRW) model for universe evolution. The principal sources for the data and theoretical extrapolations associated with the standard model are:

The First Three Minutes, Weinberg, 1977
The Cosmological Distance Ladder, Rowan-Robinson, 1985
The Anthropic Cosmological Principle, Barrow & Tipler, 1986
The Early Universe, Kolb & Turner, 1990
Principles of Physical Cosmology, Peebles, 1993
The Early Universe, Börner, 1993

The proposed model and the standard model of the universe evolution are fundamentally quite different. The standard model assumes a start from a singularity that is at extremely high density of energy, with matter units evolving as the universe expands and cools. The expansion process is assumed to be under control of gravitation and the mass density. To an ordinary reader, the explanations of the standard model "Big Bang" approaches fail to mention some of the subtle assumptions that make it possible to set up the problems. These involve the assumed nature of space, and evasion of the limitations upon the effects of gravitation in a closed space under uniform matter distribution or in an infinite open space. It is recognized that gravitation functions in our present age to yield energy in the formation of condensations, yet, if the limitations to gravitation effects in a closed universe with uniform matter distribution are considered in the early stages, there is a serious problem. This is: where does the energy of condensations originate? Gravitational control of the expansion is assumed, which would provide the necessary energy, but that is a direct contradiction of the extrapolation of gravitational effects to uniform matter distribution filling a finite closed space. Another problem is the source of the vast quantity of energy represented by the mass of our perceived universe, and where the balancing negative matter and energy, if any, exists.

The new model assumes an expansion process governed by the formation of space, which process is under control of some external rotation function that is coupled to matter-unit volume and to the flow of time. The process is symmetric for the perceived universe and its companion negative universe. Matter appears in the universe as there is space for it. Matter appears in the form of Neutrons crowded into contact at 0 ^{o}K. This process takes approximately 5951.458

Figure 6-1

Early universe temperature estimates: to show on the same graph, an offset of one curve is necessary. The standard-model time zero has been set to coincide with the time for full Neutron emergence in the new model. This is an offset of 5951 seconds.

seconds, during which time the whole system remains at 0 ^{o}K. At the end of this period, the initial energy, that can not be accommodated in matter form in our universe, appears in the form of thermal motion as there is free space available in which the Neutrons can move. This process brings the matter up to the high temperature starting phase in about 1.437 seconds. The universe continues to expand while picking up some energy from the process of Neutron decay, and then a little later from Helium formation. The universe continues to expand and cool, but the space expansion process is under control of the expansion driving rotational function rather than being under gravitational control as postulated in the standard model.

Because of the initial cold emergence phase in the new model, when comparing the two models for what takes place in the high temperature phase, and subsequent cooling, the time zero of the standard model is set to coincide with the end of the cold Neutron emergence phase in the new model. (See Figure 6-1.) In examining the temperature plots, the new model universe attains a maximum of approximately 5.6 x 10^9 ^oK, while the standard model goes off-scale up into the region where nothing but radiation exists. Both models pass through the region below 1.0 x 10^9 where nuclear reactions converting Hydrogen to Helium can occur, but the assumed density and composition at the high end of the range differs in the two approaches.

Checking the ages in Figure 6-1 for each model, and then entering these ages into the chart in Figure 6-2: the standard model passes through 10^9 ^oK at about 100 seconds age, with a density down to about 10 g cm^{-3}, while the new model passes through 10^9 ^oK at an age 1.3 x 10^7 seconds (plus the offset) at a density about 3.8 x 10^3 g cm^{-3}. The new model passes through the temperature region for nuclear reactions at a higher matter density and a slower rate than occurs in the standard model. As a result, a different set of reactions may govern the potential product mix, but the temperature probably sets the final composition that persists into the lower temperature phase that extends up to the decoupling age. The new model provides the necessary temperatures and times to produce the product mix that we attribute to the age of decoupling, with the slower rate of cooling governed by the time phase angle regulated expansion rate and with the fixed rate of continuous energy loss replacing the adiabatic expansion effect.

6.2. Present Universe Age

In comparing the new approach and the standard FRW model, conditions as they exist at the present age must fit reasonably well with both models, at least in terms of some of our observational data. The first two observational criteria are the present rate of expansion as measured by the Hubble factor H_0 and the mass density of the universe at present (ρ_0), both of which can be computted for the new model and used for comparison in the standard FRW model.

In the new model, the current universe age is computable directly from the current-age value of Planck's constant. This value is

t_0 = 12.361 049 975 x 10^9 emergent SI years, (6-1)

t_0 = 1.431 165 876 radians. (6-2)

The value of H for the new model universe is computable directly from Equation (5-14), using the current age above, as

H = 1.673 343 404 x 10^{-18} sec^{-1}, or (6-3)

H = 51.601 560 km sec^{-1} Mpc^{-1}. (6-4)

The observational values for H vary over the range 40 to 100 km sec^{-1} Mpc^{-1}. Turner & Kolb, and Rowan-Robinson handle this in the standard model equation as (H_0 ***h***) with H_0 set at 100 km sec^{-1} Mpc^{-1} and h as the error range being $0.4 \le \boldsymbol{h} \le 1.0$. The value of H_0, being inverse time units, is related to the current age of the universe. With the value of H_0 computed in Section 5. as 51.6 km sec^{-1} Mpc^{-1}, then the value of ***h*** becomes 0.516. This value is then applied to the standard model. In Turner & Kolb and other texts the relationship for a matter dominated universe is expressed (if $\Omega_0 = 1$), and using H_0 in the form sec^{-1}, as

$t_0 = (2/3)\,(H_0\,\boldsymbol{h})^{-1}$, (6-5)

where Ω_0 is the ratio of the current-age matter density ρ_0 to the critical matter density ρ_c that is necessary to close the universe,and assumed to be 1.0. For the FRW model the critical density, which is the maximum density the universe can have at the present age and still continue to expand forever, is defined as

$\rho_c = 3\,H^2/(8\,\pi\,G) = 1.88 \times 10^{-29}\,\boldsymbol{h}^2$ gram cm^{-3},

$\rho_c = 5.01 \times 10^{-30}$ gram cm^{-3}, ($\boldsymbol{h} = 0.516$). (6-6)

Using Equation (6-5) and the computed value of (H_0 ***h***) in sec^{-1} from Eq.(6-3) yields an FRW model estimate for the current age to as

t_0 = 12.6249 x 10^9 SI years (current). (6-7)

This only differs by about 2.2 percent from the directly computed nominal year value for the new model. In this sense the two models agree, provided that $\Omega_0 = 1$ for FRW model.

There have been a number of different efforts to determine the probable universe age from independent observational data. Three such values that are relatively close to the two predicted values of Eqs. (6-1) & (6-7) are indicated below.

$t_0 = (10.3 \pm 2.2) \times 10^9$ years, (6-8) computed from the cooling rate for white dwarfs (Winget et al) as quoted by Kolb & Turner, P.13.

$$t_0 = (11 \text{ or } 12) \times 10^9 \text{ years}, \tag{6-9}$$

based upon the thorium content of class G dwarf stars (Butcher 1987), quoted by Waldrop (1987).

$$t_0 = (11 \pm 1.6) \times 10^9 \text{ yr.}, \tag{6-10}$$

by a calculation of Fowler, quoted by Waldrop (1987). The upper limits for all three of these independent values are close to the two predicted values.

6.3. Mass Density

The actual mass density is very important to the use of the FRW model, which implies gravitational control of the expansion. The value of the factor Ω_0 is critical to determination of which of the three major types of FRW models corresponds most closely to our perceived universe. Briefly, the three types are regions separated by boundary values for the curvature factor in the equations. This factor k can have a continuous range of values. The dividing line values are +1, 0, and -1. The value k = +1 or greater is a component of the equations for a universe with positive curvature geometry: one that goes through cycles of expansion and collapse, and where the local geometry is one of positive curvature. The value k = 0 is midway between the two extreme types and represents a universe with local Euclidean geometry that expands at a decreasing rate, but never quite slows sufficiently to reach a state of reversal of the expansion. In this situation, gravitation is not quite strong enough to totally halt the expansion. The third type has k = -1 or a more negative value. Expansion continues forever at some pace greater than zero, but under gravitational control, and the local geometry is one with a negative curvature. Intuitive preference is for a model with k close to zero, but on the positive side, and having a relatively long cycle with local geometry being very close to Euclidean. These three model dividing lines are all based upon the assumption that the extra cosmological constant Λ is set at zero. (See Appendix, end of Section 7.3. for comment on Λ.) Among the various relationships, there is one relating the value of k to other factors when the extra cosmological constant $\Lambda = 0$, and where the pressure of matter and radiation take very little part in the expansion dynamics. This is

$$k\, c^2 = R^2\, H^2\, (\Omega - 1), \tag{6-11}$$

where, for a matter dominated universe, R is the radius as a function of time. This implies that k = +1, 0, and -1 correspond to $\Omega > 1$, 1, and -1 respectively. Our intuitive preference then limits the required value of Ω to 1, or slightly more (a few) in the FRW model.

Observational determination of Ω_0 is a difficult task that has not been adequately solved. It is an area of continuing interest and filled with opportunities for speculation in cases where the composition of some of the contributing mass components differ from the standard situation of being only ordinary (baryonic) matter. This area takes up much of the Kolb & Turner text, in terms of what the various possibilities may imply about the nature of what goes on in the period between the first few minutes and the Planck time of 10^{-43} second. Considering uncertainties and the unanswered questions in the standard model, this exploratory material in the text is extremely valuable and is an excellent guide to references on the related theories being considered. In the present comparison of the new model with the possible FRW model, our attention is confined to the situation where the mass density is principally confined to ordinary baryonic matter particles, with some possible supplementary contribution of vacuum space energy in the form of "space-stress energy".

The limiting value of the critical mass density for our perceived universe, as applied to the FRW model, is that obtained in Eq. (6-6) by use of the computed value for (H_0 ***h***) in $\sec^{-1}$. This is

$$\rho_c = 5.01 \times 10^{-30} \text{ gram cm}^{-3}. \qquad (6\text{-}12)$$

On a very large scale our universe appears to have a high degree of uniformity of matter distribution, but, at the present age, it is not uniform on small scales. This is a problem in the determination of the average mass density of the universe. There are a wide variety of answers depending upon the measurement technique used and the scale of the area sampled. A typical set of values is quoted by Barrow & Tipler (1986), and expressed as measures of Ω_0.

Table 7
Values of Ω for Various Typical Stellar Regions

Region	Ω_0 Range
Solar Neighborhood	0.004 -- 0.007
Galaxies	0.006 --0.014
Binary Galaxies and Groups	0.04 -- 0.13
Clusters of Galaxies	0.2 -- 0.7

These values are based upon using $H_0 = 75 \pm 25$ km $\sec^{-1}$ Mpc^{-1}. The value of ρ_c for $H_0 = 75$ becomes 1.058×10^{-29} gram cm^{-3}. Using this value to convert the Ω_0 to a ρ_0 value for galaxies yields

$$\rho_0 = 6.3 \times 10^{-32} \text{ to } 1.48 \times 10^{-31} \text{ gram cm}^{-3}. \qquad (6\text{-}13)$$

A similar treatment of the Ω_0 for clusters of galaxies would yield

$\rho_0 = 2.1 \times 10^{-30}$ to 7.4×10^{-30} gram cm^{-3}. (6-14)

The above are values determined from the dynamics of relative velocities in orbits about galaxy cores. The resulting densities are all too low to provide an FRW universe with the desired properties. In Section 5.6., it was shown that by employing the new concept of a gravitational limit, the usual value for the computed galaxy mass must be increased. In Table 4, for the Milky Way galaxy, at 60,000 light year radius, the implied mass increase factor was 3.66. Then, in

Figure 6-2

The curve for the standard model has been set with its time zero coinciding with the time for Initial full Neutron emergence in the new model. This represents 5951 seconds of offset.

Table 6, for the galaxy M 101, at a radius of 70 kpc, the mass increase ratio was shown to be 35.6. Assuming that the average increase factor for the universe as a whole is at least as great as 10, for the effect of the gravitational limit, then the adjusted observational value for the mass density range for clusters of galaxies would become

$$\rho_0 = 2.1 \times 10^{-29} \text{ to } 7.4 \times 10^{-29} \text{ gram cm}^{-3}. \qquad (6\text{-}15)$$

The expected mass density for the new model at the present age is a directly computable value. It is the initial mass complement (M_0) adjusted for the continuous loss ($1 - \alpha\, \phi/\pi$) to the age in question, and then divided by the universe volume (as a 3-sphere). This yields a value as

$$\rho_0 = 8.76 \times 10^{-29} \text{ gram cm}^{-3}. \qquad (6\text{-}16)$$

This value is higher than the values in Equations (6-13) and (6-14), but quite close to the upper limit in Equation (6-15). On this basis, I assume that the gravitational-limit adjusted observational values for ρ are consistent with the computed value by the new model, at the present age.

In using Equation (6-5) to compute a universe age, based upon the conventional FRW model, a value of Ω_0 was set at 1 as the mass density ratio relative to the critical mass density. If we accept the density multiplier factor due to the use of the gravitational limit as 10, then the age computed as Equation (6-7) is consistent with a standard observational value as $\Omega_0 = 0.1$. This value is compatible with the value used by Kolb and Turner as $\Omega_0 = 0.2 \pm 0.1$ that is based upon dynamical determination of cosmic mass density. Their analysis of primordial nucleosynthesis suggests limits for baryonic Ω as $\leq 0.015\, \boldsymbol{h}^{-2} \leq 0.15$, and with $\boldsymbol{h}$ = 0.516 this represents $\Omega_b \leq 0.056$. With other evidence this suggests the presence of a relatively large component of dark matter (not associated with light emissions). Silk (1991), in a recent article suggests that the dark matter, if it is baryonic, may plausibly consist of compact stellar remanents including neutron stars and some long lived low-mass stars, some of which may be associated with x-ray signals from dark matter in galaxy halos. A comparison of early universe theoretical densities for the standard model and for the new model is shown in Figure 6-2, which also contains a plot of the "space stress" energy density as a function of early universe age.

All of these results point to the unsettled status of universe mass density determinations at present, insofar as the FRW model and its variations are concerned. When we take into account the increase in implied mass, when the gravitational limit is taken into consideration, the present observational data on mass density seems adequate to fit the new model requirement. In turn, this also suggests that the mechanism for generation of the early Hydrogen-Helium ratio may differ in the new approach from what is assumed in the conventional model.

This situation of uncertainty about the critical factors has not changed very much recently. The data from the Hubble telescope and other satellite based equipment, plus the new large ground based telescopes, have decreased the range of variations in the observational data. This has not removed the uncertainty about the cosmic fundamentals or the implied changes in nuclear structure. This is illustrated by a recent "Science" magazine issue of 28 May 1999 (Number 5419) that contains two news items, a review article, and a technical report on the general subject of Cosmology.

6.4. Age of Decoupling of Matter and Radiation

The cosmic microwave background radiation (CMBR) is our view into the earliest available part of the past of our universe. Anything earlier is obscured by the loss of transparency to radiation. Its present observed temperature value of $2.726 \pm 0.005\ ^{o}K$ (Mather 1994) is the result of the expansion of the universe from its size at the surface of last scattering of radiation. Kolb and Turner have adopted 3030 ^{o}K as the best estimate of the temperature at that time, and I have used this value in my calculations. We need to examine and compare the FRW model and the new model for their implied condition at that period.

For the conventional model at decoupling, assuming it was matter dominated, Kolb and Turner gives an equation for the age as

$$t_{dec} = (2/3)\ H_0^{-1}\ \Omega_0^{-1/2}\ (1 + z)^{-3/2}, \tag{6-17}$$

which, using $\boldsymbol{h} = 0.516$ and $(1 + z) = 1100$, evaluates to

$$t_{dec} = 1.092 \times 10^{13}\ (\Omega_0^{-1/2})\ \text{sec}. \tag{6-18}$$

If we set $\Omega_0 = 1$, this becomes

$$t_{dec} = 3.46 \times 10^{5}\ \text{years}. \tag{6-19}$$

Kolb & Turner use 2.75 ^{o}K for the CMBR. Adjusting to 2.726 ^{o}K only revises the above to

$$t_{dec} = 3.409 \times 10^{5}\ \text{years}. \tag{6-20}$$

Even reducing the value of Ω_0 to only 0.1 would only extend the age estimate to

$$t_{dec} = 1.078 \times 10^{6}\ \text{years}. \tag{6-21}$$

To calculate the decoupling age for the new model we utilize the (1 + z) value determined from the CMBR temperature of 2.726 ^{o}K. This is 1111.52. Then, the current age radius divided by 1111.52 should be the radius at decoupling

$$R_{dec} = R_{u0}\left(p^{\sin^2 f}\sin f\right)/1111.52\ . \tag{6-22}$$

This yields

$$\left(p^{\sin^2 f_p} \sin f_p\right)/1111.52 = \left(p^{\sin^2 f_{dec}} \sin f_{dec}\right). \qquad (6\text{-}23)$$

Solved by multiple approximation, this yields/

$\phi_{dec} = 2.737\ 485 \times 10^{-3}$ radians, and (6-24)

$t_{dec} = 23.643\ 792 \times 10^{6}$ emergent SI years. (6-25)

This first approximation to the decoupling age is vastly different than any of the standard FRW model estimates for the age at decoupling. It implies that the new-model universe radius expands at a much slower rate in the early stage than is assumed for the FRW model.. This is a significant difference between the two models. The FRW model assumes that the radial expansion velocity starts out close to the radiation velocity c, with all slowing down being the result of gravitational forces. In the new model, the initial radial expansion velocity starts out at $c/(2\pi)$, and changes in accordance with control by the external rotation function, in proportion to the rate of change of the component $\left(p^{\sin^2 f} \sin f\right)$.

This is:

$$dR = R_{uo} \left(p^{\sin^2 f} \sin f\right)(2 \sin \phi \cos \phi \ln \pi + \text{cotan}\ \phi)\ (d\phi/dt), \text{ or} \qquad (6\text{-}26)$$

$$dR = R\ (H). \qquad (6\text{-}27)$$

The rate of expansion is proportional to the radius at the given age and to the local Hubble value at the given age. The radius increases with age, but the Hubble factor decreases with age and becomes zero at age $\phi = \pi/2$, and then reverses direction for values between $\pi/2$ and π.

In computing the age at decoupling using the CMBR temperature, the starting point is the present age and the present physical conditions for both models. For both models it is assumed that the free space radiation temperature varies as R^{-1}, and that the reference radius at the present age R_0 is the same for both models. As a result, at decoupling the matter density should be the same for each model. For the conventional FRW model, to obtain a present age radius near that computed for the new model we need to start with an assumption of the same matter density as computed by Eq. (6-16) for the new model:

$$\rho_0 = 8.76 \times 10^{-29} \text{ gram cm}^{-3}. \qquad (6\text{-}28)$$

When this is divided by the critical value from Equation (6-6) we obtain an adjusted value as $\Omega_0 = (17.485)$ which is much greater than the intuitively preferred $\Omega_0 = 1$ for the conventional FRW model. Then applying this to the FRW expression, with H in $\sec^{-1}$,

$$R(t) = H(t)^{-1}/[\Omega(t) - 1]^{1/2}. \qquad (6\text{-}29)$$

$$R(t) = 1.3538 \times 10^{17} \text{ sec, or} \qquad (6\text{-}30)$$

$= 4.0586 \times 10^{27}$ cm at present age. (6-31)

This compares reasonably well with the radius computed for the new model at the current age as

$R(t) = 3.957 \times 10^{27}$ cm. (6-32)

Considering the differences in the models, and the fact that H^{-1} overstates age at the present age, this is relatively good agreement between the models, but requires a value of Ω_0 in the standard model as 17.485. (This causes the computed age for the conventional FRW model to diverge considerable from the new model age and from the observational estimates.) Converting equation (6-30) to years yields, a present age estimate for the FRW model as

$t_0 = 4.290 \times 10^9$ years. (6-33)

Kolb and Turner have a more complex equation for estimating present age in a matter dominated universe, as their equation 3.24.

Using $\Omega_0 = 17.485$ in their equation, (6-34)

$t_0 = 5.4276 \times 10^9$ years. (6-35)

this is a small improvement, but still a long way from the new model estimate of Equation (6-1) as $12.361\,049\,975 \times 10^9$ emergent SI years.

The purpose of some of these rearrangements of conditions applied to the FRW model is to show that some of the answers can be forced to be close to selected new model values, but in doing so other results are forced into wider deviations. Basically the two models are incompatible in some of their fundamental assumptions.

There is an aspect of structure that is given very little attention in the conventional FRW model approach, and that is Vacuum Energy. It is something that must be taken into account in the new approach. It is considered in the conventional approach at the nuclear reaction stage as the source of the temporary energy involved with virtual particles lasting less than a single time unit. It is given some consideration in the variations of the standard model that involve higher dimensional aspects and in some of the modifications involving large contributions to the matter density in non baryonic form. It is also recognized that if there was appreciable vacuum energy, it would alter the computed rate of universe expansion from that usually assumed for the conventional FRW model.

At several places in the new approach it has been mentioned that space has structure, and that there is some sort of stress involved with the expansion of this structure. The continued existence of a stress as the universe expands, results in a buildup of "space-stress energy" in the system. This energy is associated with whatever is the source of the universe expansion, but is also associated with the initial matter and energy complement of the universe. The "space-stress" is associated with matter units and their average separation, and thus can serve as a source for the energy of local gravitational collapse of matter dispersions. In other words, it is the source of the gravitational energy of the early universe.

I believe that this "space-stress" has a small effect on free radiation in space, that is no longer in equilibrium with matter, by some change in fundamental wavelength of the radiation in proportion to the total quantity of "space-stress energy" at a given age. By analogy, as the tension in a vibrating string is increased, the resultant frequency increases. This is in effect a wave length decrease if the propagation velocity remains constant. In effect then, the result during the expansion phase of a universe cycle, would be to contribute some blue-shift to any radiation emitted at one time and detected at some later time. This effect is confined to free uncoupled radiation in space, and does not affect the value of Planck's constant, which is dependent upon the initial matter-energy complement of the universe and its probability alteration by the continuous loss mechanism only.

It is proposed that this "space-stress" related effect is a result of interdependence between free space radiation wavelengths and the sum of the matter energy equivalent of the universe plus the "space-stress" energy. The suggested form of the dependence, in the absence of a velocity difference effect, is:

$$\lambda\,[(1 - \alpha\,\phi/\pi)M_0\,c^2 + \text{"space-stress" energy}]/(M_e\,c^2) = \text{Constant}, \qquad (6\text{-}36)$$

where M_0 is the initial matter complement and M_e is the effective emergent value.

The net effect is that as the "space-stress" energy increases, the relative wavelength of a given (decoupled) energy radiation decreases.

With universe expansion, there is an increase in space occupied by the radiation energy, which results in a decrease in the energy level of free uncoupled radiation. This is the normal red-shift effect. As a result of the existence of the "space-stress" energy effect, what we actually observe is a composite of the two separate effects: an expansion red-shift reduced by a partial blue-shift to produce an observed red-shift that is less than that which would occur for the age difference between the source and the observer. The red-shift ratio that would normally be associated with a given age separation and its associated universe radius ratio between the observer and the source is the geometric red-shift ratio. Then, since the only observational data is the red-shift, to obtain the true source age, we need to determine the total age dependent red-shift component (the geometric ratio) by a series of approximations.

The existence of the "space-stress" energy effect, from a thermodynamic viewpoint, implies a limited coupling between "space-stress" energy total and the energy level of free uncoupled radiation in space. For the proposed effect to operate, there must be a small energy transfer to the free radiation that partially offsets the decrease with space expansion. Obviously then, this process must reverse direction after the universe passes maximum size and begins to contract.

The primary determinant of any radiation wavelength is the energy level change at the radiation source for the particular atomic transition involved, or the equivalent "black body" temperature of the source for thermal radiation. In proposing the existence of the "space-stress" energy effect, it is postulated that the limit to the effect is such that the observed red shift effect is the actual ratio between the source temperature and observed temperature, or the source energy level and the detected level. Then, the increase in actual red-shift represents a relative energy increment by the "space-stress" that results in the source and detection points being actually separated by a greater time than would be attributed to the observed red-shift value alone.

The process of approximating the true age difference red-shift ratio from the observed red-shift at the present age can be approached in the following general manner. The "space-stress" energy E, by Equation (5-72) at a given age, is

$$E = (M_e\, c^2)[(1 - \alpha\, \phi/2\pi)\mathrm{Ln}\left(p^{\sin^2 f} \sin f\right) + 31.455\ 238\ 83]. \qquad (6\text{-}37)$$

With the current universe age of 1.431 165 875 radians, which is the observation point, this becomes

$$E = M_e\, c^2\ (32.565\ 481). \qquad (6\text{-}38)$$

This is system "space-stress" energy, relative to the starting point of full Neutron emergence of the universe, that has been added as a result of the matter particle spacing force. It is based upon a uniform particle separation basis. Insofar as the space is concerned, this is the "space-stress" energy. The difference in energy between an early age (ϕ) and the present as a reference point (ϕ_p) represents a positive quantity of energy ΔE that has been added to the perceived universe since the radiation source age.

$$\Delta E = E_p - E, \text{ or}$$

$$\Delta E = (M_e\, c^2)\ (32.565\ 481) - E\ . \qquad (6\text{-}39)$$

The component $\left(p^{\sin^2 f} \sin f\right)$ in Equation (6-37) represents the universe radius size factor relative to the radius generation element R_{u0} at the particular age. In calculating the difference in "space-stress" energies at two different ages, the difference between the natural logarithms of the above components for each age appears. This difference between the two natural logs is the ln of the radius ratio, which is the ln of the geometric red-shift ratio between the two ages, when the differences are expressed in the proper order.

The observable red-shift ratio is equal to the geometric red-shift ratio divided by the "space-stress" blue-shift ratio. In this, the "space-stress" blue-shift ratio is the ratio of system energy at the present age (the detection age) relative to the system energy at the radiation source age. The system energy is the quantity in parentheses in the numerator of Equation (6-36). It includes the "space-stress" energy plus the energy represented by the matter content.

Referring back to Equation (6-37), there is an effect of the continuous loss mechanism as factor $(1 - \alpha\,\phi/2\pi)$, which is an average integrated effect, in the "space-stress" energy, of the age based mass modifying component $(1 - \alpha\,\phi/\pi)$. <u>The "space-stress" energy involves the separation of matter units, so the implication is the involvement of the emerged matter units M_e rather than total mass M_0.</u> For many ordinary calculations the difference between this and the total matter-energy equivalent M_0 would be small and could be ignored, but I have expressed the equations in terms of M_e for maximum precision.

$$M_e/M_0 = N_w/N_p = 0.999\ 275\ 855... \,. \qquad (6\text{-}40)$$

The presence of the two different age angle modifiers in some expressions complicates the process of working back from the observed red-shift to the geometric red-shift, so that a series of approximations must be used to solve the relationship.

The effective system energy (SE) at the present age becomes

$$E_p = M_0\, c^2\, (1 - \alpha\,\phi/\pi) + M_e\, c^2 (32.565\ 481), \text{ or}$$

$$E_p = M_e\, c^2 (33.561\ 649). \qquad (6\text{-}41)$$

The "space-stress" blue-shift effect between a source and a present age observer is derived from the ratio of the expressions in the square bracket portion of the numerator in Equation (6-36) at the two ages as

$$\lambda_s/\lambda_p = 33.561\ 649/[(1 - \alpha\,\phi_s/\pi)(M_0/M_e) + E_s]. \qquad (6\text{-}42)$$

The component E_s at the radiation source can be expressed as the "space-stress" energy at the observer's age (the present age) and a difference component. This change in form is advantageous since it can involve the geometric red-shift ratio as a component, and help to simplify the mathematics.

The "space-stress" blue-shift effect in Eq. (6-36) can be expressed differently if we recognize that, for a given characteristic atomic transition wavelength at a source, the uncorrected wavelength at a given remote location will be proportional to the geometric space radius at the detector location relative to that at the source. This is the usual red-shift ratio $\Re = (1 + z)$. Identifying the observed red-shift ratio as $\Re_0$, and the implied full geometric ratio, that includes the portion that is offset by the blue-shift, as $\Re_1$; then the inverse relationship between system energy and the wavelength effect implies

$$\Re_1/\Re_0 = E(\text{present age})/E(\text{source age}), \text{ or}$$

$$\Re_1 = (E_p/E_s)\, \Re_0. \qquad (6\text{-}43)$$

Then, expressing the source age system energy as a difference from the observer's age energy, we have

$\Re_1 = [E_p/(E_p - \Delta E\ )]\ \Re_0$. (6-44)

Using Equation (5-71) as the general form for the quantity of energy ΔE between two ages ϕ_1 and ϕ_2, with ln $\Re$ as the implied ln ratio of the two universe radii, plus addition of a term representing the change in universe matter mass over the period of age change, the problem of obtaining a solution by approximation is simplified.

$$\Delta E = \{\ln \Re - [\alpha\ \phi_p/(2\pi)]\ \ln\left(p^{\sin^2 f_p} \sin f_p\right) + [\alpha\ \phi_s/(2\pi)]\ \mathrm{x}$$

$$\ln\left(p^{\sin^2 f_s} \sin f_s\right) + [\alpha(\phi_p - \phi_s)/\pi]\ (M_0/M_e)\}\ M_e\ c^2, \text{ or}$$

(6-45)

$\Delta E = [\ln \Re - \delta_1 + \delta_2 + \delta_3]\ M_e\ c^2$. (6-46)

We know that the effect of the blue-shift is to move the decoupling age to a period a little earlier than that implied by the observed red-shift alone. On this basis, we can use an angle ϕ_s from our first estimate by Eq. 6.24 as an approximate for a starting point for the estimating equation that includes the blue-shift effect. This value is

$\phi_s = 2.737\ 483 \times 10^{-3}$ rad. (6-47)

Using this, we calculate the values for the small δ factors as:

Initial value	Recomputed after Eq. (6-55)	
$\delta_1 = 2.533\ 463 \times 10^{-3}$,	$= 2.533\ 463 \times 10^{-3}$	(6-48)
$\delta_2 = -2.569\ 642 \times 10^{-5}$,	$= -2.092\ 743 \times 10^{-5}$	(6-49)
$\delta_3 = 4.547\ 995 \times 10^{-3}$.	$= 4.549\ 897 \times 10^{-3}$	(6-50)

Then, using the value of the multiplier for ($M_e\ c^2$) from Equation (6-41), together with the computed value for ΔE above, in Equation (6-44):

$\Re_1 = [33.561\ 649/(33.561\ 649 + \delta_1 - \delta_2 - \delta_3 - \ln \Re)]\ \Re_0$, or

$\Re_1 = [33.561\ 649/(33.559\ 6605 - \ln \Re)]\ \Re_0$. (6-51)

In the above, the factor ln $\Re$ is the implied ln of the ratio of the universe radius at the present age divided by the universe radius at the radiation source age. To start the series of approximations we equate $\Re$ inside with $\Re_0$ and calculate a value for $\Re_1$. Then use this $\Re_1$ value for $\Re$ in the next calculation, etc.

Starting with ($\Re_0$) the observed red-shift ratio (1 + z) as 1111.52, the first result becomes

$\Re_1 = 1405.266$. (6-52)

After several cycles, the result settles to

$\Re_1 = 1418.2684$. (6-53)

Using this value for R_1 we estimate ϕ_S from the relation

$$\left(p^{\sin^2 f_p} \sin j_p\right)/\Re_1 = \left(p^{\sin^2 f_s} \sin f_s\right), \text{ or} \quad 6\text{-}54)$$

$\phi_S = 2.140\ 180 \times 10^{-3}$ rad. (6-55)

Recomputing δ_2 and δ_3 from the above yields

$\Re_1 = [33.561\ 549/(33.559\ 658 - \ln \Re)]\ \Re_0$. (6-56)

Continuing the approximation process to a stable result yields

$\Re_1 = 1418.2872$. (6-57)

The "space-stress" blue-shift ratio effect then is

$1418.2872/1111.52 = 1.27600 = (1 + Z_B)$ (6-58)

Then, using Equation (6-54) a value for ϕ_S can be determined:

$\phi_S = 2.145\ 400 \times 10^{-3}$ rad, (6-59)

$\phi_S = 5.847\ 476 \times 10^{14}$ emergent seconds, (6-60)

$\phi_S = 1.852\ 993 \times 10^{7}$ emergent SI years. (6-61)

In this calculation of the age at decoupling of matter and radiation, I have utilized the observed microwave background temperature value and the assumed decoupling temperature of 3030 ^{o}K as though they were exact. They obviously are not, but their use helps to show the sensitivity of some subsequent results of other calculations.

I have elected to use the above values in the calculations to develop the required universe composition at the decoupling age, assuming that only Hydrogen and Helium are present. An alternative approach to the age and red-shift, employing the calculator program used to generate the data for Figures 6-3 & 6-4, differed by only a few parts per million. This is completely adequate, given the limited precision in the CMBR temperature and the uncertainty in the present universe age.

The above adjusted decoupling age estimate (ϕ_S), that takes into account the "space-stress" effect, is considerably earlier than the first uncompensated estimate of 2.364 3796 x 10^{7} years, which did not fit very well with an estimated early universe composition of 80% Hydrogen and 20% Helium and a decoupling temperature of 3030 ^{o}K. Even the new lower age estimate for the decoupling age by the new model approach is still many times the decoupling age estimated by the standard FRW model and some of its modifications.

One point of reminder, the "space-stress" energy effect acts upon free uncoupled radiation in space. When matter temperature is above the decoupling temperature, there is frequent short transit time interaction between matter and radiation that maintains the system radiation temperature in equilibrium with the available matter energy and the available space volume. When space transparency is lost, the "space-stress" energy blue-shift effect is no longer identifiable as a separate effect. Thus, for ages earlier than the decoupling age, we have no observable temperature information in the radiation we can perceive.

It was mentioned earlier that this secondary blue-shift represented an interaction between free radiation and the "space-stress" energy that implied a coupling and energy transfer. At an ordinary separation of 100 Mpc, which is several hundred times the probable diameter of our local galaxy, the normal predicted geometric red-shift ratio would be

$$(1 + z) = 1.019\ 688, \qquad (6\text{-}62)$$

for the condition where both source and observer are at their respective local-cosmic-rest states. Using the basic data tables that were employed in the construction of Figures 6-3 & 6-4, for this separation, that is near the present age, the blue-shift effect would be a factor 1.000 575.

After taking the "blue-shift" factor into account, the observable red-shift would become

$$(1 + z) = 1.019\ 102. \qquad (6\text{-}63)$$

This small change over a separation of 326 million light years is probably too small for us to ever detect directly, since It only amounts to 1.8 parts in 10^{12} per light year of separation.

Figure 6-3
The blue shift effect is very small, being less than 2 % for separations up to 1400 Mpc.

Figure 6-4
Blue Shift factor(Z_B) at remote distances begins to be a significant quantity as the distance to the decoupling age is approached.

The existence of this "space-stress" energy effect upon the free radiation in space brings up an interesting point, for some future exploration, which may help to improve our understanding of the processes in the new approach. In adding up the increments of relative velocity over large distances, the effective total velocity between the two endpoint locations is less than the linear sum of the individual component relative velocity increments. The "space-stress" effect implies that the actual age separation between two widely separated points is greater than indicated by the observed red-shift effect. This is an adjustment in the opposite sense to the contraction effect of adding the relative velocity components as hyperbolic angle tangents. The age differences are circular angle differences. There may be some other subtle relationship between these effects that has not yet been recognized.

In the next section we will explore the relationship between the age at which the universe reaches the decoupling temperature of 3030 ^{o}K and the necessary quantity of energy that must be provided by the nuclear reactions in the early high temperature phase of the expansion process, since the uniformity of the CMBR suggests the absence of any significant gravitational condensations by that age.

6.5. From Emergence to Decoupling Age

The emergence of our perceived universe, in its present cycle, starts at some instant. This instant is defined as time zero for the present cycle. The emergence and expansion process is governed by some cyclic rotation function that creates the space of the perceived universe as an interaction between the volume of each potential structural-unit with every other potential structural unit in the opposite energy sign portion, in a dual fashion, involving both positive and negative energy systems. Most of the discussion will be confined to the ordinary matter half which we perceive, but a similar situation exists for the negative energy half.

The volume of space is the sum of the cross product volumes as determined by the effect of the sine of the cosmic age phase angle ϕ upon the products of the corresponding three-space dimension pairs. The perceived three-space volume of space is the interaction product of the two separate three-space structural unit volumes. The fourth direction component is only one time-length unit in extent and is only perceived ordinarily as time. The magnitudes of the fundamental component elements were developed in Section I. As the fundamental driving-function angle (ϕ) progresses, the volume of space forms and increases in accordance with Equation (1-32)

$$V_{sp} = N_p^2\, m_n^2\, V_0^2 \sin^3 \phi \left(p^{\,3\sin^2 f} \right) (1 - \alpha\, \phi/\pi), \qquad (6\text{-}64)$$

where N_p = the probable number of pre-emergence structural units (Neutrons),

V_0 is an emergent mass-unit volume;

m_n in this usage is the numerical value of the mass of a Neutron in mass-units,

$m_n\, V_0$ = the three space volume of a Neutron.

In the very early stages, the numerical value of the last two factors in parentheses in Equation (6-64) can be treated as identically one to at least fifteen places, and can be ignored. Also, sin ϕ is numerically equal to ϕ (in radians) at the start, to many places. Structural units occupy space. They can exist in our perceived universe only as there is space to contain them. They cannot move until there is excess space. As a result they must be at a temperature 0 ^{o}K until there is some excess space. The time for full emergence of all the potential matter units and the initial energy complement was derived as Eq. (1-49) on the basis of the theoretical values for M_0 and N_z:

$$\phi_e = 2.184\ 077\ 677 \times 10^{-14} \text{ radians.} \qquad (6\text{-}65)$$

The full number of permitted wave-function structural units had emerged first at 0 ^{o}K at a slightly earlier time given by Eq. (1-72) as

$$\phi_{en} = 2.183\ 550\ 354 \times 10^{-14} \text{ radians.} \qquad (6\text{-}66)$$

The time difference between these two stages is given by Eq. (1-74):

$$\Delta t = 1.437\ 266 \text{ sec.} \qquad (6\text{-}67)$$

There are fewer structural units probable in wave-function space than in the pre-emergence probability state. The modest difference can appear in perceived space as energy instead of matter. This amounts to

$$\Delta E = (N_p - N_w)\ m_n\ c^2/N_z, \qquad (6\text{-}68)$$

$$\Delta E = 1.487\ 125\ 600 \times 10^{73} \text{ ergs.} \qquad (6\text{-}69)$$

To this must possibly be added a small contribution from Neutron decay during the heat-up time. The composite equates to sufficient energy to raise the Neutron temperature to

$$T_0 = 5.267\ 43 \times 10^{9}\ ^{o}\text{K}, \qquad (6\text{-}70)$$

which is less than the threshold temperature 5.930 x 10^9 ^{o}K required for electron-positron pair formation. The cumulative effect of the continuous loss mechanism, if it created an energy deficit in the period from the time zero at the start of emergence to full Neutron emergence, could amount to a total of only 1.427 0479 x 10^{60} ergs. The effect of this upon the emergent temperature would only amount to approximately one part in 10^{12}. As a result, the new model starts out in a state where it is matter dominated, and the initial matter is all in the form of Neutrons.

At this stage, the most likely first change is the decay of neutrons to protons and electrons. Recent work indicates a time constant for Neutron decay as

$$t_n = 887 \pm 2 \text{ seconds,} \qquad (6\text{-}71)$$

as the time to decay to 1/e of its initial value (Mampe 1994). Conventional practice for radioactive materials is to report the half life as the time to decay to half its initial value. The above observation converts to a half life as t = 614.8 seconds -72)

I have used a low end value as 612 sec in computing decay energy release. The emergence temperature is below that at which neutrinos could be in thermal

ignore any energy assigned to the neutrinos in the decay process when computing temperatures.

Figure 6 1 shows a comparison of the temperature of the universe as a

computed for the new model, with the computed temperature for the standard FRW model. For comparison purposes, the two curves are offset so that time

emergence completion in the new model. The temperature data for the FRW model curve is a composite, based upon data from Weinberg (1977), and from olb & Turner (1990). The new model curve shows the effect of the initial energy complement plus the energy from Neutron decay, assuming no other nuclear ^{o}K and then rises

^{9} K in the first 1.44 seconds, and then rises slowly to

a peak of approximately 5.6484 x 10 ^{o}

slowly falls until a time approximately 3 x 10^{5}

rapidly after Neutron decay is complete and no longer contributes energy to the

increased volume, it would drop to 3.059 x 10^{8} ^{o}K by 10 seconds after emergence if no other nuclear reactions occurred.

The continuous loss mechanism is postulated to operate at all times. It

units, and when matter temperatures are all reduced to 0 ^{o}

operate by producing an energy deficit that must be overcome before matter can

between the initial emergence mass-

collapse value, at a uniform rate in terms of emergent time units. The rate is

dE/dt = - $_{0}$ M_f ^{2}/T, -73)

dE/dt = (2.283 904 446 559x 10^{53} ^{2}/8.562 685 796 31 x 10 , -74)

dE/dt = 2.397 227 923 472 x 10^{56} (6 75)

Neutron decay plus the initial energy complement would not provide ^{o}K at the CMBR source

^{7} emergent SI yr. In fact, the Neutron decay energy plus the temperature to age 1.516 133 x 10^7 emergent SI yr., a shortage of approximately 3.375 million years.

To achieve the required 3030 ^{o}K at the decoupling age would require more energy: approximately 2.730 x 10^{73} ergs. This can be supplied by nuclear reactions that yields a final composition of 82.11 percent Hydrogen and 17.89 percent Helium 4 by weight at the decoupling age. This is a little lower level of primordial Helium formation than predicted by the standard big bang model, and likewise a little lower than observations on metal poor stars and hydrogen gas clouds would seem to indicate. It must be recognized however that in the new model, this composition prediction is dependent upon the amount of extra energy necessary to attain the selected decoupling temperature at the age determined by the cosmic microwave background radiation (CMBR).

If, for example, it is specified that there is no effect of the "space stress energy" upon the measured Doppler shift involved in the CMBR, then for a 3030 ^{o}K decoupling temperature, the universe would attain this value at the unadjusted age of 23.643 80 x 10^6 emergent SI years. This would require an increment of energy approximately 7.4 x 10^{73} ergs above the initial complement plus the Neutron decay energy. This would require a final composition at decoupling as 60.68 Helium and 39.32% Hydrogen, which is far outside the range that could fit with the observed data on the composition of stellar objects and gas clouds, etc. This is all on the assumption of uniform matter distribution at the decoupling age, so that there could be no early universe contribution of gravitational condensation energy to the required increment. The following table illustrates the temperature dependence, at the decoupling age, for some changes in final composition.

Table 8
Temperature at Decoupling for Several Compositions

Composition in % Mass		Age 1.852 993 x 10^7 Yr.
% H	% He	^{o}K
83	17	3011.7
82.11	17.89	3030.0
82.0	18.0	3032.1
81.50	18.50	3041.6
81.3	18.7	3045.4
80.0	20.0	3069.6
76	24	3140.7
39.32	60.68	3638.0

The above table shows the sensitivity of the system to changes in composition at the implied decoupling age of 1.852 993 x 10^7 years, which was computed from the observed CMBR temperature and a specified decoupling temperature of 3030 ^oK by including the "space-stress" energy blue-shift effect. The composition 39.32% H, 60.68% He is included as the composition that would be required to yield a temperature of 3030 ^oK at the decoupling age (2.364 38 x 10^7 years) computed from the observed CMBR and the specified 3030 ^oK temperature at decoupling, without considering the "space-stress" energy blue-shift effect.

An additional table is included to show the effect of composition upon the age at which the universe would have a temperature of 3030 ^oK.

Table 9
Variation of Decoupling Age with Composition

Composition in % mass		Age in years at which
% H	% He	temperature is 3030 ^oK
83	17	1.838 05 x 10^7
82.11	17.89	<u>1.852 993 x 10^7</u>
81.5	18.50	1.862 46 x 10^7
81.3	18.7	1.865 56 x 10^7
80.0	20.0	1.885 39 x 10^7
76.0	24.0	1.943 78 x 10^7
39.32	60.68	2.364 38 x 10^7

The temperatures were calculated using the simple relationship:

Available Energy = (Radiation Energy in space plus Thermal Energy of matter particles.)

The available energy at any instant consists of the initial complement (1.487 126 280 x 10^{73} ergs), plus the contribution from Neutron decay as an exponential decay function of elapsed time from the instant of full Neutron emergence, <u>less the continuous loss component as a linear function of total time since the start of emergence</u>, plus the energy made available in the Hydrogen to Helium conversion.

The radiation energy content is a function of the fourth power of the absolute temperature and the volume of the universe at the given age, less the matter particle volume.

The thermal energy content is a function of the temperature and the number of mols of all matter species at the given temperature (Neutrinos excluded). At temperatures near the decoupling temperature, the Hydrogen and

Helium are both treated as monatomic neutral gases. The energy from the Hydrogen - Helium transformation, is treated as a lump sum quantity added at some time after the temperature drops below 10^8 ^oK.

With the above in mind, we re-examine Figures 6-1, and 6-2. As mentioned earlier, the time zero for the conventional FRW model has been placed in coincidence with the end of the cold Neutron emergence phase in the new model. The conventional model has a rapid rate of fall in temperature so that the system spends very little time at the high temperature stage, while for the new model, the universe spends considerable time at a plateau near maximum temperature. For example, the conventional FRW model implies the time above 10^8 ^oK is approximately 10^4 seconds, while for the new model, the time above 10^8 ^oK, is almost 5 x 10^8 seconds. This is a vastly longer time above 10^8 ^oK.

Now, looking at Figure 6-2 on density, there is also a vast difference in early universe conditions. For the conventional FRW model, by age ten seconds, the combined matter-energy density has dropped to approximately 2 x 10^3 gram cm^{-3}. In contrast, the new model remains near 2 x 10^{14} gram cm^{-3} for the first 100 second, and stays above the FRW model 10 second density for approximately 2 x 10^7 seconds. The data for the curve representing total matter and energy density in the early stages of the standard FRW model is based on a composite of information from Weinberg (1977) and from Kolb & Turner (1990). The conditions in the early high temperature stages of the universe are vastly different in the two models, and will require further study.

In addition, in the new model, there is the existence of the "space-stress" energy. Its' most visible effect, during the expansion phase of the universe cycle, is the introduction of the blue-shift effect upon radiation energy that is decoupled from matter and traveling great distances between source and observer. This effect is shown in Figures 6-3 and 6-4 for two ranges of separation. When the quantity of this energy is expressed in terms of the equivalent number of grams, by the age 10^4 seconds after full emergence, the density of "space-stress" energy has equaled or surpassed the matter density. This is something that could have an influence upon the course of nuclear reactions in the high temperature phase, but we have no experience upon which we can base our estimates of the magnitude of probable influence. The reason being that at the present universe age the "space-stress" energy density is only about 30 times the average matter density of the universe, so that we have no high "space-stress" energy density regions available for experimental study. The only thing at all comparable to this in the standard FRW model would be the gravitational field, but when corrected for closure of the universe space, and for the uniform distribution of matter, this should pale into

insignificance relative to the "space-
density portion of the period prior to decoupling.

The "space-
have considered its effect as a source for the energy released in gravitational condensations, its possible effect upon the wavelengths of decoupled radiation
aracteristics
in high density "space stress" energy. As an additional aspect, I would suggest that the "space stress" aspect is what is responsible for the propagation of some kinds of shock waves in space.

In making the calculations related to the decoupling age and the universe

exact number, and the estimated decoupling temperature as though it was also an exact temperature value of a sharply defined boundary. Neither of t
assumptions can properly be accepted as exact. The most recent CMBR temperature has a stated uncertainty of 0.005 ^{o}
measured value. This in turn implies a similar level of uncertainty in the red-
factor z. An uncertainty in z introduces an associated uncertainty in the precise universe age implied. Uncertainty in the decoupling temperature implies an

and this in turn implies an uncertainty in the required Hydrogen Helium ratio required to provide the necessary energy level.

To make the energy requirements, and the implied universe composition
- Helium ratio), compatible with our observational data on early
-
stress" energy effect upon decoupled radiation in space. If the magnitude of the

will be different. This will in turn imply a different Hydrogen Helium ratio than I have derived. Examination of Tables 8 and 9 will suggest something of the

-related, so that the numbers developed

only be considered as a best estimate of probable values. The estimates are limited by the accuracy of the CMBR temperature measurement, the accuracy of the
^{o}K decoupling temperature, and also the accuracy of the

constant. If the actual thermodynamic temperature at decoupling is higher than the assumed value of 3030 K, this will make a significant difference in both the computed age at decoupling and the required fraction of Helium in the mix. Some

gasses should be appreciably higher , approaching 4000 ^{o} or even above. Using

4000 ^{o}K as an example, with the present CMBR temperature of 2.726 ^{o}K would imply a ratio of 1467.4 (unadjusted). Using this would yield a first estimate decoupling age as 17.91 x 10^{6} years. If this were the adjusted for the approximate "Blue Shift" ratio of 1.277, the adjusted age would become 14.0238 x 10^{6} years. Then, assuming the early estimate of 17.89% Helium, the computed temperature at the adjusted age would be approximately 3735 ^{o}K, which implies a need for a higher percentage of Helium formation. Testing 30% Helium in the calculator program yields an estimated temperature 3985 ^{o}K. It would require approximately 30.6% He to yield the 4000 ^{o}K at the implied decoupling age. If we assumed that there was no "Blue Shift" effect, then it would take a much larger increase in Helium content to provide the 4000 ^{o}K temperature at the later age of 17.91 x 10^{6} years. If we assumed 100% Hydrogen to Helium conversion, This would yield an estimated 4010 ^{o}K at this late decoupling age. These numbers seem to indicate that something acting like the proposed "Blue Shift" is necessary to be included in the analysis.

6.6. Early Condensation Tendency

The problem of explaining how large structures, such as groupings of galaxies are formed, is not well handled by the conventional approach. The addition of a gravitational limit, and indication that the matter at decoupling is mainly baryonic (ordinary matter) brings in additional complications. As a result, it appears that the whole process of formation of galaxies and groups of galaxies needs to be re-studied.

The continuous loss mechanism and the differences in the computed universe ages at decoupling, between the conventional and the new approach, markedly alters the probable course of the condensation process after decoupling. In the conventional approach, matter cooling after decoupling follows in proportion to the inverse square of the universe radius, with thermal motion of the particles resisting gravitational condensation tendencies. Condensation then is a slow process dependent upon considerable elapse of expansion time to initiate collapse into individual stars and gas clouds, etc. In contrast, with the continuous loss mechanism in the new approach, and its action being limited to energy loss from matter particles, the cooling process is greatly speeded up. In fact, in a period of approximately 1139 years, the matter content could approach close to a temperature 0 ^{o}K just past the decoupling age 1.852 993 x 10^{7} emergent SI years. Assuming about 1400 years past decoupling, the matter density is 2.466 x 10^{-19} gram cm^{-3}. At 273 ^{o}K standard temperature this would be equivalent to a partial pressure of the Hydrogen in the mix as 1.697 x 10^{-12} mm Hg with a mol ratio H =

0.8981, He = 0.1019. At 2.53 ^{o}

should be close to 1.57 x 10^{-} mm Hg. At this temperature, the vapor pressure of solid Hydrogen should be 1.36 x 10^{14} mm Hg. This pressure over solid Hydrogen

equation (Scott 1959),

log P (mm Hg) = 4.624 38 - -76)

for Hydrogen with the equilibrium ortho- ^{o}K.

The vapor pressure over solid Hydrogen at temperatures below this point

temperature decrease. As a result, the Hydrogen would tend to accumulate as solid particles as temperature dropped below the 2.53 K. This process of solid Hydrogen formation would tend to be oppose

however, the rate of energy loss through the continuous loss mechanism would override any pickup by absorption from the free radiation in space.

The continuous loss mechanism is coupled to the matter complement of the

-

function state units of structure. Its normal rate is 2.397 227 923 x 10^{56} $^{-1}$

At the decoupling temperature of 3030 ^{o}

has a thermal energy content of approximately 8.5545 x 10 ergs. This would be exhausted by the continuous loss mechanism in approximately 3.5685 x 10 seconds, or 1130.8 years, to yield a matter temperature very close to 0 K. Beyond this point, the continuous loss mechanism can not remove energy, so it

specified that the mechanism removes energy from the highest energy matter components. It does not remove energy from free radiati

radiation transfers energy to matter units. As a result of the operation of the continuous loss mechanism, the matter temperature approaches close to 0 K, removing any small energy transferred from the free radiation and building up an

^{o}K, solid Hydrogen

of these also form into much larger particles that can supplement the atomic forces

particles, remaining all the time at near 0 ^{o}

mechanism and the energy deficit removal of energy released in the gravitational condensation process. This continues until the rate of gravitational energy release

this can the condensation process start to raise the temperature of the condensed matter a

the first few large condensations reach a temperature sufficient to start nuclear reactions in their cores. This is sufficiently different from the scenarios proposed in connection with the conventional big bang approach to suggest that a whole new study of the possible formation of galaxies and clusters of galaxies needs to be undertaken.

6.7. Discussion

Up to this point, the material presented has been concentrated upon the physical structure of our perceived universe from an unconventional point of view. The findings have been compared with those of the conventional approach, and have been found to give as good or better answers than the conventional approach. The new approach is self consistent and implies coherence in the fundamental carrier radiation.

As a piece of technical progress. this report can be either a representation of an ordinary item in a series of ordinary events, or a landmark item representing our point of departure from the conventional path of pure physical materiality in our approach to the structure of our perceived universe. It depends upon how we view the implied connections with a higher level of knowledge. My personal view is that it represents the discovery, or rather the re-emergence, of knowledge about the fundamental structure of our perceived universe as it was utilized by an ancient high level technological and spiritual culture. Further, that the great pyramid in Egypt represents a message carrier to us as implied by some of the mythology associated with it.

In Peter Lemesurier's[19] book The Great Pyramid Decoded there is a message constructed on the basis that a coding language had been based upon architecture and mathematical relationships plus some ancient numerology to represent the concepts usually expressed in words. The message is essentially one related to mankind's physical and spiritual history, and to the projected future alternatives in that area. Briefly it is classed as a Messianic message.

The units of measurement used in the construction of, pyramid appear to be based upon ancient Egyptian units of measure that had reference to some fundamental properties of the earth such as its diameter, the circumference in the polar direction, and circumference at selected latitudes. These are numbers that we only recently have been able to verify with high precision, suggesting that they were derived at some past period of high technological skills.

Some of the ancient mythology about the pyramid suggests that a second level message was also included. This information was reported to be included for the specific purpose of aiding the receiving culture to get through some difficult technological steps and thereby shorten the time to reach a high level of understanding of the fundamentals as understood by the sending culture. This is the part of the message that we have not yet recovered, except for the few pieces of correspondence with fundamentals in the proposed new approach to Physics and Cosmology.

Most of the technical material in the early sections of this report represent the development of ideas and assumptions that stand on their own. There are, however, two implied message items that seem to have more subtle connections; that seem to be intended as check points to convince us of the validity of our approach, if it leads us to recognizing a new approach to Physics and Cosmology. The first of these is the Mir Cubit as discussed in Section 4.8.

The psychic Edgar Cayce had indicated in one of his readings that in the days when the great pyramid was under construction, there had been a unit of length in use that was no longer in use. This was identified as the Mir cubit, which was approximately 27 1/2 inches in length. Wm. R. Fix[12] carried our extensive examination of the survey data on the great pyramid and the reported fit of various measurement units to the pyramid dimensions. He concluded that a unit of 27.483031 inches (0.6980704 meters) fit the structure better than any other proposed construction measure unit. The relationship of the Mir cubit to the various other units in use was examined, and all seemed to indicate that they were tied to the same earth-based length reference system and were based upon the size of the same degree of latitude. There seemed to be no specific identifiable reason or relationship for the existence of the Mir cubit as a unit of measure.

If we assume that there had to be a reason for the use of this particular length unit; it must connect to some specific ratio that they wanted incorporated into the information content of the pyramid measurements. This had to be something that a sufficiently advanced culture would consider to be a fundamental relationship to some universal constant of measurement. On the basis of this, what the receiving culture would consider to be fundamental, would depend upon their understanding of the fundamentals of Physics and Cosmology.

In our present concept of Physics, the size of a fundamental unit of matter, a mass-unit, would be a basic unit of measure. Even without a theory of structure that went any further, we would have a fairly good estimate of the radius of a mass-unit as a sphere. This number is so small that it wouldn't be expected to be detectable as a deliberately included ratio. Some large multiple function of this would be required to be detectable in macro measurements. A significant product size might be the multiple of the mass-unit radius times the total number of mass-units in the universe. This turns out to be too large a number to be involved in any practical physical embodiment as a length ratio in the total pyramid size. Recognizing that we have both very large and very small involved in our universe, something like a geometric mean might be a more useful test ratio.

Back in Section 4.8. the concept of a standard of length that any culture familiar with our universe structure might determine was explored. This was developed as the value L_s of Equation (4-49) and then modified to the stabilized value expected if the theoretical mass of 1/56 of an Iron 56 atom was used as the size of the reference unit of mass. This is the value $L_s/(N_w/N_p)^{8/5}$ in Equation (4-116) This results in a length measurement as 1.836 963 167 cm.

The value of the Mir cubit of 27.5 inches in the Cayce Reading is 38.024 times as large as the above length unit. The actual value of the Mir cubit as determined from pyramid measurements is 27.483 031 inches , or 38.001 251 times the standard unit. Due to the possible effects of weathering over the ages, and the effect of some small displacements due to earthquakes, it is assumed that the intended ratio was supposed to be exactly 38. The question then is, from where would the 38 be derived?

The basic mathematical group is 8 x 17 plus the zero vector, or 137 elements for the purely materialistic physical sense of structure. The culture that left the pyramid was not interested in leaving something as a help in the purely physical, but they had interests in their future both in the present and their implied hereafters. Most of what they designed and left was intended as clues or reinforcement in the spiritual or metaphysical. An interpretation of the message of the pyramid in a messianic form is given in Peter Lemesurier's[19] book The Great Pyramid Decoded. Among the details of the ancient numerology reported to have been employed is the number 153 relating to a major or final step as signifying transcendence and ultimate enlightenment. This is 137 plus 16, where I place the 16 as the 16 wavelength or frequency components of the universal field as interacting with the humanity or life aspects of existence in addition to their purely materialistic involvement in physical structure.

Removing one from the 153, as removing the unmaterializable zero vector , yields 152. Then, the physical plane of earth represents one of the four regions of the physical totality, or 38 elements of the totality. A significant implication of the inclusion of both the physical and the life and/or metaphysical aspects would seem to be that we need to recombine the knowledge of the materialistic with the spiritual into a single body of knowledge as it appears to have existed in the ancient culture responsible for the great pyramid.

The second special item is the existence of our unit of linear measurement, the inch, with its specified magnitude. It appears that the ancient culture responsible for the pyramid was also the architect responsible for the particular size of the inch. It was deliberately related to a cosmically significant length; one that any culture acquainted with the fundamental relationships could recognize as a cosmic standard. This significant standard is the geometric mean of the shortest contributing universal field wavelength component in the of a mass-unit radius and the largest measure in a cycle of the universe, which is the diameter of the universe

There are several equation forms for expression of the mass unit radius at a given age . The one of interest is the form containing the component e [1] that is related

be expressed in the form of Eq.(2- ϕ.

$r = h\ \pi^{-1}\ 2^{5/8}\ \ {}_{\mu}\, c)$, or

${}_o = \ {}_o\ \ 2^{5/8}\ \ {}_{\mu}\, c)]\ e^{1}$. -77)

${}^{-1}$ is a sum of 16 terms (See Eq. 3-

can be represented by the fraction

$(1/17!)/e^{-}$. (6 78)

radius (r_o can be combined into

$r_o\ e^{-}$. (6 79)

-unit radius can be represented by

$r\ \ e\ /17!$. (6 80)

${}_o e\ /17!)\ x\ 2R_{uo}{}^{1/2} =$ -81)

in terms of the three- ^{2} .

Our conventional inch is defined as 2.54 cm exact. This is greater than the is that the reference value for the ordinary inch was established at some age after emergence,

larger than the emergent value as:

$L = L_o\,(1 - \alpha\phi\ \pi)$. -82)

At ϕ $\pi/$, this results in

$L = L_o\,(1 - \alpha/\ )^{1/3}$ ${}_o(1.001\ 671\ 459)$. (6-

The ratio of 2.54 to the geometric mean is 1.003 680 429 so the natural expansion e message intended to be conveyed by comparison with our standard value of 2.54 cm in an inch.

Considering the reported purpose of the pyramid to also convey important

understanding of the universe, I would not expect them to pass up the opportunity to use the actual ratio to convey some particular point of information. The

mass- in accordance with Eq. (1- ${}_g = M\,(1 - \alpha\phi\ \pi)$.

the aged mass and then solve for the apparent $\phi\ \pi$ value, we obtain an age

${}_o/\ \ {}_g = (1.003\ 680\ 429) = 1/(1\ \ \alpha\phi\ \pi)$, (6-

$\phi/\pi = 0.366\ 864\ 904$, (6-85)

ϕ/π x cycle length = 9.954 545 33 x 10^9 emergent years. (6-86)

Subtracting the implied age from the present age and rounding to four decimal places yields:

Age into the past = 2.4065 x 10^9 years. (6-87)

This is less than the full geologic age of the earth, but it could represent the start of the life evolution path on the earth that was intended to result in mankind?

There is a second number related to the size of an inch that can also have an implied connection to the ancient system. This is the relation of a "pyramid inch" to the standard British inch as 1.001 06 British inches. If we take this to represent the expansion of the fundamental emergent inch (the geometric mean of emergence extreme values) by some particular age that they want to call to our attention, and solve for the implied ϕ/π, we obtain the following:

$1.001\ 06 = 1/(1-\alpha\phi/\pi)^{1/3}$, (6-88)

$1 - \alpha\phi/\pi = .996\ 826\ 7297$, (6-89)

$\phi/\pi = 0.317\ 475\ 523$, (6-90)

ϕ/π x cycle length = 8.614 409 x10^9 emergent years. (6-91)

Then subtract this from the current age and round off to four decimal places.

Age into the past = 3.7466 x 10^9 emergent years. (6-92)

The measured age of the oldest Precambrian rocks is (3.7 ± 0.1) x 10^9 years (Börner[48] 1993). This is a number that they would expect an adequately advanced receiving culture to have measured..

Now, accepting the implications in the early portion of this report, that the proposed new approach to Physics and Cosmology is more fundamental than our existing analysis-based approach, and accepting the implications of the "Mir Cubit" and "Inch" items, to the effect that we are rediscovering the same foundation that was employed by the ancient culture responsible for the great pyramid, we face the task of reconstructing our concepts of Physics and Cosmology and their connections with life aspects and the spiritual level.

The task ahead belongs in other hands, but, I do have a few thoughts that may have a bearing on the direction for some of the new research.

1. Some of the work to be done will probably yield to continued work with our existing materialistic tools, but there is obviously a large region near the mass-unit diameter scale and below that will require new tools, or the paying of attention to phenomena that have been ignored or bypassed as not repeatable under controlled conditions.

2. In discussing the electromagnetic field of the Electron, it was indicated that electrons have their main involvement with the universal field limited to fourteen of the sixteen wavelength components of the field. The two longest wavelength components exceed the diameter of the electron. These components are part of the basic field flow that is the usual carrier for electromagnetic effects. The quantity of unbalance in these two components induced by the formation of electrons is probably transferred to the associated protons (not to positrons). That is where we should probably look for means to monitor these components for evidence of amplitude variations or phase modulation. This may be a transition region between the purely materialistic level and that of the spiritual and life element inter communication region. It may be possible to develop some materialistic tools to work in this wavelength region as detectors of amplitude of flow, or as demodulators, using specially designed crystal arrays to resonate at subharmonics of the particular wavelengths. Perhaps some of the ancient lore about natural crystals and their properties will be useful in the search for detectors that can couple to people.

3. To go beyond the present materialistic approach will require first of all an open mind, one willing to look at the marginal effects that have generally been ignored in the past. Such things as the exploratory works of Cleve Baxter[49] on plant sensing of human intent. Or, for example, the work of successful practitioners in the U. S. Psychotronics Association[22]**.**

   The effective practitioners use devices or so called "machines" that are constructed in such a way as to have gaps or circuit interruptions such that they could not operate using conventional electronics or electromagnetic energy flows, yet they seem to obtain the desired effect of the interaction of human intent in improving plant functioning and/or deflection and minimization of plant pest attacks.

   Michael Talbot[39] in his book "The Holographic Universe" explores effects that seem to indicate the singular unity of the universe and the existence of a coherent energy flow below the level of our perceptions. This flow is responsible for the holographic patterns in structure of matter. space, life, time and our perceptions of existence. This fits closely with the nature of the proposed new approach foundation elements, and particularly with the existence of the flowing universal field of multiple components at the level of wavelengths below a mass-unit radius. I consider the Talbot book to be required reading for anyone attempting to work with the new approach.

The numerological reference to 153 has deep significance in the interpretation of the pyramid message. This message is about mankind and is intended for their information and concern. The purely materialistic technology is only a small part of man's future problems. An understanding of the relationship of life and mankind to the materialistic foundation is necessary. This is the reason that the implied meaning of "totality" includes both the purely material element group number of 137 components plus an additional 16 to represent the interaction of the components of the universal field with the nonmaterial life aspects of existence. These sixteen components have wavelengths below the shortest that we can normally perceive by use of ordinary material substances, hence have escaped detection in past tests of psychic activities and in comparisons of electromagnetic activity differences between live and dead matter.

In the "Seth Material" series of books by Jane Roberts, there are references to other senses than our usual five that can bring us other information about our environment. The individual components of the universal field can be carriers for this kind of information, and it would not be detectable by our ordinary instrumentation, as the matter-unit boundaries are normally transparent to these wavelengths. Typical of this material is the two volume set "<u>The Unknown Reality</u>" by Jane Roberts[51].

4. In 1959 Dewey Larson[18 49] published the first part of his "Reciprocal system" for describing the structure of the material aspects of our perceived universe. The fourth volume in the series describing the "reciprocal System" and its implications was published posthumously in 1995 as "<u>Beyond Space and Time</u>". This fourth volume extends the concepts presented in the first three volumes to the realms of metaphysics, religion, the paranormal, and ethics. Much of this material is just as relevant to the extension of the new approach proposed in the present report as it was to the original "Reciprocal System". Consideration of this expanded area of knowledge is important to the new approach also, in bringing knowledge of the universe into a unified whole.

5. The good fit of the proposed new approach to existing measurements and to ratios in the great pyramid suggests a close correspondence to

the system of Physics and Cosmology in use by the pyramid builders.

need for new energy technology that is less hazardous to the environment than our present major techniques. Ancient myths suggest

hazardous access to adequate power to meet their needs. Study of the new system may also lead to clues to the critical conditions fo duplicating results in the documented, but unexplained production of low levels of energy in the so called ”Cold Fusion” system experiments

[50] 1997 ______ July/August, p 53 -

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8. APPENDIX

As a convenience, and because of the scope of the text with its many equations, this appendix has been constructed as a combination Appendix and Index. It contains most of the distinctly new equations together with some variations of a few important ones, but only about one fourth of the total number. The equation number as it appears in the main text is indicated, this may be as it is first used or where it is derived. In part 8.3. are some references to fundamental constants, such as the 1973 and 1986 CODATA values for some fundamental constants, together with some standard relationships used in the text. This revision is based upon a value for N_Z of 6.022 138 193 49 x 10^{23}, new mass-units per theoretical gram, as the product of the CODATA N_A and the derived correction factor $\Delta_{m\mu}$ of 1.000000248, and is assumed exact, but rounded off to 6.022 138 193 x 10^{23} for use in all ordinary calculations. In general, the theoretical numerical values were computed to 12 places. Some of the early fundamental values that were pure theoretical numbers were computed to 16 places. The results recorded in this appendix are generally the full twelve places for use in continuing complex calculations (except in the few cases where the sixteen place values would be appropriate).. It is recommended that the values be rounded off to a maximum of 9 or 10 digits to the right of the decimal point for any calculations of probable values for dependent factors. This is better than the precision of any measured values except the Landé g/2 value. For comparison values computed from the CODATA 1986 tables, it is recommended that these only be computed and rounded to a maximum of 8 or 9 digits to the right of the decimal point in scientific notation (except for the Landé g/2 value).

8.1. New approach equations

	Page	Eq. No
Probable number of abstract pre-emergence structural units:		
$N_p = (61!/8!)\ 2^{8/69} = 1.364\ 225\ 582\ 852\ 287... \text{x}\ 10^{79}$	10	1-10
Probable emerged number of wave-function-state structural units:		
$N_w = (3/4)\ 2^{256}\ (132)\ 2^{1/4} = 1.363\ 237\ 686\ 182\ 259... \text{x}\ 10^{79}$	21	1-18
Ratio of the two probability states:		
$N_w/N_p = 0.999\ 275\ 855\ 340\ 6084...$,		
$(1\text{-}Nw/Np) = 7.241\ 446\ 593\ 916\ \text{x}\ 10^{-4}$.		
Theoretical Iron 56 resonance unit:		
$(N_w/N_p)^{8/5}$ = lcr Iron 56 mass / 56 = 0.998 841 620 274 3166		1-20
Observed Iron 56 mass / 56 = 0.998 838 2018 (carbon 12 units)	122	4-5
Theoretical $1/(N_w/N_p)^{8/5} = 1.001\ 159\ 723\ 125\ 439...$	105	3-31

		Page	Eq.No
The inverse of the Iron 56 resonance factor, when combined with the mass factor Δm_μ provides the precise value for the Landé g factor:			
	$g=(\mu/j)(2\ m_e/q_e)$ (Theoretical)	105	3-28
	Landé g factor = 2 [1.001 159 652 188(4)](observed)	105	3-30
	(Dehmelt, Hans Science, 247, 2, Feb. 1990, p 539.		
Δm_μ is the ratio of the mass of a carbon-12 based mass-unit to the theoretical fundamental mass-unit at local-cosmic-rest.			
	Δm_μ = 1.000 000 247 993 474 lcr units per C-12 mass-unit, or 1.000 000 248 for ordinary usage.	107	3-37
	(Determined from the Landé g factor and $(N_w/N_p)^{8/5}$).		
	Δm_μ = 1.000 000 247 (0.032 ppm).	126	4-25
	(Based on Iron 56 & Free Neutron).		
Solar frame velocity relative to lcr:			
	$\text{Cos}^8\ \theta_v$ (lcr) = 0.999 993 649 22	126	4-22
Theoretical number of mass-units in an lcr Neutron in lcr mass-units:			
	$m_n = (N_p/N_w)^{1/10}/[1-1/(2\ \pi)^2]^{1/3}$,	125	4-14
	m_n = 1.008 661 950 291 588...	125	4-15
	$N_{uo} = m_n\ N_p = M_0$ (in lcr mass-units),	128	4-27
	N_{uo} = 1.376 042 437 037 466... x 10^{79} lcr mass-units,	128	4-27
M_o (grams) = N_{uo}/N_z,		10	1-11
	$N_Z = N_A$ (CODATA) $(\Delta_{M\mu})$		
	N_Z = 6.022 1367 x 10^{23} (1.000 000 2480)		
	N_z = 6.022 138 193 49 x 10^{23} mol^{-1}, assumed exact.		
	M_o = 2.284 973 198 597 x 10^{55} lcr grams.	10	1-11
Emerged perceived space quantity of Neutrons at initial full emergence:			
	$M_c = M_o\ (N_w/N_p)$,		
	M_c = Initial wave function mass (cold) = 2.283 318 547 458 x 10^{55} new grams,		
	Mols (initial) = 2.263 710 400 495 x 10^{55} (Neutrons).		
Initial mass-difference energy that can heat up the emerged wave-function space Neutrons:			
	$\Delta E = (M_o - M_c)c^2$ = 1.487 126 279 835 x 10^{73} ergs	22	1-19
Thermodynamic temperature at initial full emergence:			
	t_e = 5.267 433 521 374 x 10^9 °K.		

Final mass at end of collapse:

$M = M_o^{1/69} = 2.262\ 134\ 154\ 131 \times 10$ lcr grams.

$(M_o - 1/(2^{69})) = 2.283\ 904\ 446\ 6 \times 10$ g.

Equivalent energy loss $= 2.052\ 670\ 948\ 122 \times 10^{74}$

Continuous energy loss rate:

$dE/dt = (M_o - M)c^2$ ^{17}, 201 -73

$dE/dt = 2.397\ 227\ 923\ 057 \times 10^{56}$ $^{-1}$ -75

Mass at a given age (M_g

$_g = M\ (1 - \ - 1/2\ ]\ \phi\ \pi),$ 11 -12

$M = M_o\ - \alpha\phi\ \pi).$ 11 -13

$\alpha\ - 1/2\ ) = 9.995\ 322\ 693\ 322\ 665... \times 10^{-}$ 1 14

β was derived as the ratio G/G*:

$\beta\ \pi)\ 2$ 66 2-

$= 1.000\ 805\ 353\ 672\ 043...$, 2 55

$\beta^{1/2}$

$^{1/3} = 1.000\ 268\ 379\ 190\ 181...$,

$\beta = 1.000\ 134\ 180\ 592\ 875...$,

ϕ) (After full emergence):

$V = N_p\ m_n\ V_1\ \sin^3 \phi$, or

$V = N_p\ m_n\ V_0\ (\sin^3 \phi)(1\ \ \alpha\ /\pi$

Space volume in general form for all levels of (after full emergence):

$$V = N_p\ m_n\ V_o \left(p^{\sin^2 f}\right)^3 \sin^3 \phi\ (1 - \alpha\phi/\pi).$$ 23 1-22

In computing the age for full emergence of all the pre-emergence structural units as ϕ_e, and for just the permitted wave-function state structural units as ϕ_{en}, the pre-emergence units are treated as being spherical and the sum of the space volume effects as spherical and being the sum of the true volumes of the spherical contributors. That is, neglecting the possible difference between full space filling and the the less than complete space filling effect of close spaced spheres in touching contact with (0.74048)of total volume.

Maximum space-filling matter density:

$\rho_{max} = 2.380\ 594\ 088\ 286 \times 10^{14}$ g cm^{-3}. 93 2-158

Maximum matter density as close packed spheres:

$\rho_{max}\ (0.74048) = 1.762\ 782\ 310 \times 10^{14}$ g cm^{-3}.

Page Eq.No

Age for full universe emergence (ϕ_e), and for just all Neutrons (ϕ_{en}):

$1 = N_p\, m_n\, V_o \left(p^{\sin^2 f}\right)^3 \sin^3 \phi\, (1 - \alpha\phi/\pi)^{1/2}$. 29 1-34

Then, taking the dimensionality aspect cm^6 into account,

$cm^3/\sin^3 \phi = N_p\, m_n\, V_o \left(p^{\sin^2 f}\right)^3$ or, 29 1-36

For very small ϕ, the factor $\left(p^{\sin^2 f}\right)^3$ approaches one, and

$\sin \phi_e = [\beta\, c^2\, cm^6/(m_n\, N_p\, N_z)]^{1/6}$, or 29 1-43

$\phi_e = 2.184\ 077\ 677\ 402 \times 10^{-14}$ rad. 30 1-49

(Theoretical, assuming N_z and m_n exact)

$\sin \phi_{en} = (N_w/N_p)^{1/3}\, [\beta\, c^2/(N_p\, m_n\, N_z)]^{1/6}$, 33 1-71

$\phi_{en} = 2.183\ 550\ 354\ 034 \times 10^{-14}$ rad. (Theoretical) 33 1-72

$\Delta t = (\phi_e - \phi_{en})/(d\phi/dt) = 1.437\ 265\ 917$ emergent sec. 34 1-74

Corresponding Δt difference, in angle form, is:

$\Delta\phi = 5.273\ 233\ 368 \times 10^{-18}$ rad.

Universe vol. at $\phi_e = 9.598\ 331\ 819\ 103 \times 10^{40}\ cm^3$,

Universe vol. at $\phi_{en} = 9.591\ 381\ 238\ 377 \times 10^{40}$ cm3.

Radius of curvature generator (Ruo) at full emergence.

$R_{uo} = [3\, N_p^2\, m_n^2\, V_o^2/(4\pi)]^{1/3}$. (In abstract cm^2.) 23 1-24

$R_{uo} = \{[3/(4\pi)][N_z^2\, M_o/(\beta\, c^2)]\}^{1/3}$ in cm^2, 23 1-25

$R_{uo} = \{[3/(4\pi)][N_z\, N_{uo}/(\beta\, c^2)]\}^{1/3}$,

$= R_e^2\, (4\pi/3)^{1/3}$,

$= r_o^2\, N_{uo}^{2/3}\, (4\pi/3)^{1/3}$,

$R_{uo} = \underline{1.300\ 471\ 892\ 102 \times 10^{27}}$ emergent cm^2.

(Using N_z Exact) 23 1-26

Radius of total quantity of matter and energy, as a three-space volume, at emergence (R_e):

$R_e = r_o\, N_{uo}^{1/3}$, 144 4-97

$R_e = \{[3/(4\pi)]^2\, [N_z\, N_{uo}/(\beta\, c^2)]\}^{1/6}$,

$R_e = 2.840\ 331\ 629\ 763 \times 10^{13}$ emergent cm.

Radius of curvature generator (R_u) at a given age:

$R_u = R_{uo}\, (1 - \alpha\phi/\pi)^{1/3}$ (in nominal cm,) 23 1-27

	Page	Eq.No
Fourth dimension aspect of radius at any age:		
$R_4 = R_{uo} (\sin \phi)$ in emergent units.	27	1-30
Three-space aspect of radius at a given age:		
$R = R_u\left(p^{\sin^2 f} \sin f\right)$ in nominal cm.	22	1-28
Mass-unit volume and radius at emergence:		
$V_o^2 = 1/(\beta\ M_o\ c^2)$, or		
$V_1^2 = 1/(\beta\ M_g\ c^2) = (4\pi\ r_1^3/3)^2$.	64	2-41
$V_o = 6.975\ 316\ 720\ 439 \times 10^{-39}\ cm^3$.		
$r_o = \{[3/(4\pi)]^2 /(\beta\ M_o\ c^2)\}^{1/6}$ emergent cm.	144	4-96
$r_o = 1.185\ 291\ 329\ 561 \times 10^{-13}$ cm (emergent).		
Mass-unit radius (r_1) at any given age ϕ:		
$r_1 = \{[3/(4\pi)]^2/(\beta\ M_g\ c^2)\}^{1/6}$ in nominal cm,		
$r_1 = h\ N_z\ \pi\ e^{-1}\ 2^{5/8}/(2\ c)$.	61	2-30
$r_1 = L_h\ (\pi/e)(2^{5/8}/2)$, or $(L_h\ \pi\ e^{-1}\ 2^{5/8}\ /2)$,	61	2-28
$r_1 = (h\ N_z/c)(\pi/e)(2^{5/8}/2)$, or $(h\ N_z\ c^{-1}\ \pi\ e^{-1}\ 2^{5/8}/2)$,		
$r_1 = h\ \pi\ e^{-1}\ 2^{5/8}/(2\ m_\mu\ c)$.	61	2-29
r_1 = (Present) $= r_o/(1 - \alpha\phi/\pi)^{1/6,}$ or	53	1-112
$= 1.186\ 193\ 247\ 624 \times 10^{-13}$ cm.		
Linear atomic length unit (L_h) at any given age:		
$L_h = h\ N_z/c$,or $[h\ c/(m_\mu\ c^2)]$ nominal cm as materialized in time.	146	4-110
Cosmic standard units of length: L_s, $L_{(iron),}$ & $L_s/(N_w/N_p)$:		
$L_s = (r_o\ R_e)^{1/2} = (r_o\ r_o\ N_{uo}^{1/3})^{1/2} = r_o\ N_{uo}^{\ 1/6}$,	144	4-98
$L_s = \{[3/(4\pi)]^2/(\beta\ m_\mu\ c^2)\}^{1/6}, = \{[3/(4\pi)]^2[N_z/(\beta\ c^2)]\}^{1/6}$,	145	4-99
$L_s = 1.834\ 835\ 266\ 146$ emergent cm.	148	4-115
L(iron) = L_s/(Iron 56/56) = 1.836 969 453 977 Solar cm.		
$L_s/(N_w/N_p)^{8/5} = 1.836\ 963\ 167\ 035$ at lcr in theo. cm.	149	4-116
Theoretical MIR cubit = $38 \times L_s/(N_w/N_p)^{8/5}$, or		
= 69.804 600 347 33 cm.	149	4-118
Theoretical standard for ancient emergent inch:		
Geometric mean of the shortest wavelength component in a mass-unit radius and the greatest diameter of the universe at maximum size.		
$[(r_o\ e^2/17!) \times 2R_{uo}]^{1/2}$ = 2.530 685 990 517 emergent cm.	210	6-84

Page Eq.No

Life cycle (T) of universe from emergence start through collapse:

Cycle in emergent size seconds T (sec) = 2 π^2 R_{uo}/c , or

= 8.562 685 796 31 x 10^{17} emerge. sec, 32 1-66

T (yr.) = 27.134 090 028 x 10^9 emergent SI years, 32 1-67

T (yr.) = 27.088 761 563 6 x 10^9 nominal SI years.

Age for decoupling of matter and radiation based on CMBR temp of 2.726 ± 0.005 ^{o}K and assumed 3030 ^{o}K at source:

First Approximation, on a pure red shift basis:

= 2.364 379 x 10^7 emergent size years. 189 6-25

Best Estimate, including the “Space-Stress” Blue Shift:

= 1.852 993 x 10^7 emergent SI yr. 196 6-61

Geometric red-shift ratio:

Present universe radius / source universe radius

Ratio = $\left(p^{\sin^2 f_p} \sin f_p\right) / \left(p^{\sin^2 f_s} \sin f_{s_s}\right)$. 195 6-54

"Space-Stress" blue-shift ratio:

Source geometric red-shift / Observed red-shift.

Recommended standard for the present observer's age:

Age = 12.361 049 975 x 10^9 emergent SI years. 141 4-71

(Based on observed value for (h $N_A^{5/6}$) from CODATA 1986 report.)

Present age in nominal years = 12.351 657 278 x10^9**.**

Conversion ratio (emergent/nominal) = 1.000 760 441 866

ϕ_p/π = 0.455 554 246 95 141 4-70

ϕ_p = 1.431 165 875 53 radians.

$(1 - \alpha\phi_p/\pi)$ = 0.995 446 588 2974 . 141 4-69

$(1 - \alpha\phi_p/\pi)^{1/6}$ = 0.999 239 654 1996 .

$d\phi/dt = c/(2\ \pi\ Ru \cos \phi_e)$ at emergence; 31 1-56

$d\phi/dt$ = 3.668 933 706 46 x 10^{-18} rad sec^{-1} (emergent) 31 1-61

Present universe mass (M_p) in theoretical grams (also called (M_g):

$M_p = M_o (1 - \alpha\phi_p/\pi)$ = 2.274 568 774 894 x10^{55} grams.

Planck’s constant at present age

$h_p = h_o /(1 - \alpha\phi_p/\pi)^{1/6}$ in lcr units;

h_p = 6.626 074 130 665 x 10^{-27} erg sec (based on N_Z)**,** *

(in theoretical units in Table 2), or 151

$h_p = h_{CODATA} /\Delta_{m\mu}{}^{5/6}$ = 6.626 0755 x 10^{-27} /(1.000 000 $248^{5/6}$**),** or

Page Eq.No

h_p = 6.626 074 130 611 x 10^{-27} erg sec (Compare with * above)

Gravitation at current age:

$G_p = G_o /(1 - \alpha\phi_p/\pi)^{2/3}$, 70 2-71

G_p= 6.672 215 010 993x 10^{-8} dyne cm^2 g^{-2} (Table 1) 68

Present universe radius:

$R_p = R_{uo} \left(p^{\sin^2 f_p} \sin f_p\right)(1 - \alpha\phi_p/\pi)^{1/3}$ 24 1-29

R_p = 3.951 052 069 58 x 10^{27} nominal cm, or

Rp = 3.957 067 260 848 x 10^{27} emergent cm^2. 190 6-32

$\left(p^{\sin^2 f_p} \sin f_p\right)$ = 3.042 793 377 448 (pure number)

$h\, N_A^{\ 5/6}$ = 4.342 253 975 065 x 10^{-7}, 141 4-68

(Using CODATA h and N_A).

Planck's constant at emergence (h_o):

$h_o = [9\, c^4\, e^6/(2\, M_o\, \beta\, N_z^{\ 6}\, \pi^8\, 2^{3/4})]^{1/6}$, 65 2-43

h_o = 6.621 036 023 027 x 10^{-27} erg sec (emergent units).

$h_o\, N_z^{\ 5/6}$ = 4.338 952 360 605 x 10^{-7},

(Assuming h_o & N_z exact). 140 4-67

General gravitation constant (G):

$G = 2^{1/4}\, \pi\, N_z\, r_1^{\ 4}\, c^2/(6\ cm^3)$, 59 2-23

$G = 2^{3/4}\, h^4\, N_z^{\ 5}\, \pi^5/(24\, c^2\, e^4\, cm^3)$, 68 2-58

$G_o = [3\, c^2\, N_z^{\ 3}/(4\, \pi\, M_o^{\ 2}\, \beta^2)]^{1/3}\, 2^{1/4}/(8\ cm^3)$,

$G_o = N_z^{5/3}$ (1.548 926 508 519 x 10^{-47} cm^{-3}), 71 2-73

G_o = 6.651 945 380 888 x 10^{-8} dyne cm^2 $gram^{-2}$.

$G = (h\, N_z)^4\, N_z$ (4.370 099 095 305 x 10^{-22})/cm^3. 68 2-59

Alternate unmeasurable theoretical expression for G as G*:

$G^* = 2^{5/8}\, \pi^2\, N_z\, r_1^{\ 4}\, c^2\, e^{-1}/(9\ cm^3)$. 66 2-52

Gravitational field as a phase shift:

The intensity of a gravitational field can be expressed as an angle -i θ_g for which the cosine is the negative inverse of a velocity phase angle cosine. The net effect upon matter unit velocity is dependent upon the field potential remaining after deduction of the potential energy of the particular matter units with respect to the field source. See Section 2.5., 2.6., & 2.7.

Light deflection in a gravitational field. Sec. 2.7.

	Page	Eq.No
Wavelength change in a gravitational field:		
$\Delta\lambda/\lambda = (G\ M/c^2)\ (1/R_{source} - 1/R_{detector})$.	88	2-152
Matter escape limit (R) from a grav. field (Schwarzschild radius):		
$2\ G\ M/(R\ c^2) = 1$.	82	2-126
Radiation escape limit (R) from a gravitational field:		
$G\ M/(R\ c^2) = 1$.	82	2-128
The factor β was derived as the ratio G/G* :		
$\beta = G/G^* = (3/4)(e/\pi)\ 2^{5/8}$. = 1.000 805 353 672 043... .	67	2-55
Inverse relationship between mass-unit volume and total universe mass:		
$(4\ \pi\ r_1^{\ 3}/3)^2 = 1/(\beta\ M_g\ c^2)$,	64	2-41
$M_g = 9\ c^4\ e^6/(2\ \beta\ h^6\ N_z^{\ 6}\ \pi^8\ 2^{3/4})$,	64	2-42
$N_\mu = [\beta\ m_\mu\ c^2\ (4\ \pi\ r_1^{\ 3}/3)^2]^{-1}$. (A form of Eq. 2-41)		
Electron related factors:		
$K = m_\mu/m_e$ =1822.889 326 176 941... (to 1 part in 10^{14}),	113	3-61
$K\ [1 + 1/(K+1)]^{1/3} = e^{-3}/[(1/3)^{1/8}\ (e^{-1} - 1/3)]^3$	112	3-58
$a^{-1} = 24\ K^{1/2}\ e^3/\{2^{5/8}\ \pi^4\ [1 - 1/(4\ K\ \pi^{1/8})]^2\}$,	110	3-47
a^{-1} = 137.036 054 799 2527... for system in theoretical* lcr units. *(Based on e^{-1} series terminated with 17! term.)	110	3-48
a^{-1} = 137.036 054 799 2528..., using std series value for e^{-1}.	110	
$e^2 = h\ c\ \pi^3\ e^{-3}\ 2^{5/8}\ [1 - 1/(4\ K\ \pi^{1/8})]^2\ /(48\ K^{1/2})$.	103	3-22
$e^2 = h\ c\ (1.161\ 409\ 260\ 687\ 233 \times 10^{-3})$, for $\Delta_{m\mu}^{\ 5/6}$ adjusted h in new units, and implying theoretical K.		
$e^2 = h\ c\ (1.161\ 409\ 520\ 567 \times 10^{-3})$ for use with adjusted h, (but implying observed K as $1/m_e$).		
$e_o^{\ 2} = 2.305\ 323\ 823\ 254 \times 10^{-19}\ (esu)^2$ (Theoretical).		
$e_o = 4.801\ 378\ 784\ 53 \times 10^{-10}$ esu.		
e^2 (Present age) $= e_o^{\ 2}/(1 - \alpha\phi_p/\pi)^{1/6}$,		
$(1 - \alpha\phi_p/\pi)^{1/6}$ = 0.999 239 654 1996,		
$e^2 = 2.307\ 078\ 000\ 322 \times 10^{-19}\ (esu)^2$ in new units.		
$e = 4.803\ 205\ 180\ 213 \times 10^{-10}$ esu, new units, present.	104	3-24
Calculated CODATA value of e using observed h adjusted for size of the new mass-unit (divided by $\Delta m_\mu^{\ 5/6}$)and using the observed value for K as 1822.88851 yields:		
$e = 4.803\ 205\ 718 \times 10^{-10}$ esu.	104	3-25

	Page	Eq.No
Hubble factor relations:		
$H = (H_0 \boldsymbol{h})$	154	
H_0 set at 100 km sec^{-1} Mpc^{-1}, and error range $0.4 \le \boldsymbol{h} \le 1$.	154	
$H = (2 \sin^2 \phi\ (\cos \phi) \ln \pi + \cos \phi\ )(d\phi/dt)/\sin \phi$,	158	5-13
$H = [(\ln \pi) \sin 2\phi + \cot an\ \phi]\ (d\phi/dt)$	158	5-14
H (Present age) = $1.673\ 343\ 404 \times 10^{-18}\ sec^{-1}$.	158	5-15
$H = 51.601\ 559\ 89$ km sec^{-1} Mpc^{-1}	158	5-16
$\int H\, dt = \ln [R(\phi)] + constant$,	161	5-30
$\int_{f_1}^{f_2} Hdt = \Big[_{f_1}^{f_2} \ln\left(p^{\sin^2 f} \sin f\right)$.	161	5-32
$\Delta v/c = \tanh [\ln \left(p^{\sin^2 f_2} \sin f_2\right) - \ln\left(p^{\sin^2 f_1} \sin f_1\right)]$,	168	5-43
$\Delta v/c = \tanh [\ln \left(p^{\sin^2 f_2} \sin f_2\right) - 1.112\ 775\ 968]$,	161	5-34
(A form of 5-45 for observations made from our present age and solar location and corrected to the lcr state.)		
$\Delta v/c = \tanh [\ln (R_2/R_1)]$	168	5-45
Expansion force (Space Stress) at gravitational limit distance:		
$F = H\ c\ m = -G\ M_s\ m/d^2$**,**	170	5-49
where H is the local Hubble factor in sec^{-1} at the particular age, and m is the object mass in grams and M_s is source mass.		
Gravitational limit effect of expansion force:		
$d_o = M_s^{1/2}\ [G/(H\ c)]^{1/2}$	171	5-51
$d_o = M_s^{\ 1/2}(1.153\ 273\ 449)$ in cms, or,	171	5-52
$d_o = M_s^{1/2}(1.219\ 034\ 252 \times 10^{-18})$ light years.	171	5-53
d_o is the separation distance at which gravitation and expansion forces are equal and opposite.		
Solar d_o value: 0.054 366 741 light years.	171	5-54
Space-Stress energy is the integrated expansion force over the separation distance. With this distance converted to the equivalent age difference, the expression for the universe as a whole becomes:		
$\Delta E = M_e\ c^2\ \Big[_{f_1}^{f_2}\ (1 - \alpha\phi/2\pi) \ln \left(p^{\sin^2 f} \sin f\right)$.	178	5-71

(Simplification of the integrated effect is obtained by approximating the integrated effect upon $(1 - \alpha\phi/\pi)$ with $(1 - \alpha\phi/2\pi)$, as being adequately close, considering the small size of the factors involved.) In evaluating the above definite integral form, the minimum value for ϕ_1 is ϕ_{en}, and not zero.

8.2. Occult Clues to Universe Age

In the occult records , it is claimed that important numbers are coded for the protection against their use by persons of inadequate knowledge and of improper motivation with intent to rediscover ancient means to dangerous powers. It is indicated that the material is coded in such a way that initiates will be able to extract the useful values.

Toward the end of Section 1.3. it is shown that we have attained sufficient knowledge to be able to predict the length of a universe cycle from start of emergence to the end of collapse. Using this, we discover that the number 4.320×10^9 in occult usage referring to a "Day of Brahma" represents the physical separation distance from emergence to collapse expressed directly in radiation transit light years of physical distance, and then the duration of the cycle in years when multiplied by 2π, if we round off to the nearest million years.

The set of numbers 4320 followed by various different numbers of zeros is utilized in a variety of different situations, which suggests its usage as a common mnemonic factor to reduce the quantity of numbers to be memorized. The expectation then is that when decoded the result is close to the proper value, but not exact. The assumption being that those using the decoded material will have sufficient knowledge to recognize that the decoded result is not exact, but only sufficiently close to verify its usefulness as a check point but not as a specific exact pointer to other data.

In H. P. Blavatsky's The Secret Doctrine, Volume 2, pages 68 - 69, there are three quoted values for the universe age, and a possible fourth value implied. Listed in the order of increasing age, these values are:

Case i	1,955,884,687 years
Case ii	1,960,852,987 years
Case iii	1,964,500,987 years
Case iv	1,965,821,287 years

All four values are implied as representing the age up to the calendar year 1887.

The Case iv represents a possible additional level of coding on the assumption that the true age is the age that when averaged with Case i, equals the Case ii value. (As a secondary coding beyond the 2π factor.) This possibility is suggested by the fact that all three of the directly indicated values, when carried through the process of conversion to nominal years, conversion to emergent years, and corrected to the present calendar age, yield age values appreciably less than the current age value we derive from the current value of Planck's constant.

Each of the four coded age values are converted to ages in nominal years by multiplication by the factor 2π, then adding 99 years to bring the implied calendar age of 1887 up to 1986 (as the age of our standards), and then converting the result to the fixed length emergent years by use of the conversion factor derived from multiple application of Equation(4-59) that relates the number of nominal years to the number of emergent years in the given age span. Then convert the ages to age angles (ϕ/π) by dividing by the number of emergent years between start of a cycle and the end of collapse. The period 27.134 090 028 x10^9 equates to age angle π. The following tabulation indicates the results, including the age and age angle representing our direct calculations using our CODATA 1986 based measurements.

Case	Age In Emergent Years	Age Angle ϕ/π
I	12,298,483,842	0.453 248 435 049
ii	12,329,747,953	0.454 400 642 905
iii	12,352,703,866	0.455 246 660 323
iv	12,361,012,186	0.455 552 855 113
1986	12,361,049,975	0.455 554 246 95

The observational data tolerance limits on the CODATA value for Planck's constant, when adjusted to the new value for a mass-unit remain unchanged at 0.60 parts per million at the one sigma level. When the effect of this on $h\ N_Z{}^{5/6}$ is converted to emergent years, this results in an uncertainty of approximately 9,728,300 years at the one sigma level. On this basis both Cases iii and iv are within the limits based upon our observational data and our interpretation of its meaning in terms of emergent years.

In keeping with what was mentioned in the opening few paragraphs, I don't believe that we are justified in making comparisons between the implied occult ages and our computed age on the basis of numbers extending to individual years. The occult value 4.320 x 10^9 is obviously reported to a round-off value of 1 million, which equates to 2π x 10^6 years when decoded. This is an adequate check point for those persons with sufficient understanding of what is going on.

Similarly, I think we need to treat the current ages of the universe reported in years as check points when rounded off significantly. Perhaps not as far as the 2π x 10^6, but at least to the nearest 10,000 emergent years. This would be about 1000 times better than our present level of observational precision of 0.60 parts per million on the value of Planck's constant could justify, when using the present method of computing the current universe age. Using the suggested round-off to the nearest 10,000 years in age, the comparison case relations become:

Case	Age In Emergent Years
I	$12.298\ 48 \times 10^9$
ii	$12.329\ 75 \times 10^9$
iii	$12.352\ 70 \times 10^9$
iv	$12.361\ 01 \times 10^9$
CODATA	$12.361\ 05 \times 10^9 \pm 0.00973 \times 10^9$

Cases iii and iv are both within the observational tolerance limits for age set by the CODATA derived age and range.

A more conventional method of comparison would be to use the computed values for Planck's constant as a basis. The following table shows the computed values for Planck's constant rounded to nine places to the right of the decimal point, based on the relation $h = h_0/(1 - \alpha\phi/\pi)^{1/6}$

Case	Computed Planck's Constant
i	$6.626\ 048\ 562 \times 10^{-27}$
ii	$6.626\ 061\ 339 \times 10^{-27}$
iii	$6.626\ 070\ 720 \times 10^{-27}$
iv	$6.626\ 074\ 115 \times 10^{-27}$
CODATA	$6.626\ 074\ 131 \times 10^{-27}$

8.3. Auxiliary Data and Equations

CODATA 1973 values

$c = 299{,}792{,}458(1.2)\ \mathrm{m\ s^{-1}}$

$e = 1.602\ 1892(46) \times 10^{-19}$ C

$h = 6.626\ 176(36) \times 10^{-34}$ J Hz^{-1}

$N_A = 6.022\ 045(31) \times 10^{23}$ mol^{-1}

$m_e = 5.485\ 8026(21) \times 10^{-4}\ \mu$

$m_n = 1.008\ 665\ 012(37)\ \mu$

$G = 6.6720(41) \times 10^{-11}$ N m^2 kg^{-2}

$a^{-1} = 137.03604(11)$

CODATA 1986 values

$c = 299{,}792{,}458\ \mathrm{m\ s^{-1}}$ specified exact

$e = 1.602\ 177\ 33(49) \times 10^{-19}$ C

$h = 6.626\ 0755(40) \times 10^{-34}$ J s

$N_A = 6.022\ 1367(36) \times 10^{23}$ mol^{-1}

$m_e = 5.485\ 799\ 03(13) \times 10^{-4}\ \mu$

$m_n = 1.008\ 664\ 904(14)\ \mu$

$G = 6.672\ 59(85) \times 10^{-11}\ m^3\ kg^{-1}\ s^{-2}$
$a^{-1} = 137.035\ 9895(61)$

Molar gas constant $R = 8.314\ 510(70)\ J\ mol^{-1}\ K^{-1}$
Boltzmann constant R/N_A $k = 1.380\ 658(12) \times 10^{-23}\ J\ K^{-1}$
Electron volt $eV = 1.602\ 177\ 33(49) \times 10^{-19}\ J$

The digits in parenthesis following a numerical value represent the standard deviation of that value in terms of the final listed digits.

ATOMIC MASSES

From "Atomic Mass Evaluation" A. H. Wapstra, G. Audi, Nuclear Physics A, Vol. 432, 1, 1985:
All in carbon 12 based mass-units.

Iron 56	55.934 9393(16)
Neutron	1.008 664 904(14)
Proton	1.007 276 468(12)
Hydrogen	1.007 825 035(12)
Deuteron	2.014 101 779(24)
Helium	4.002 603 24(5)
Electron	See CODATA 1986 values

General Data

Threshold temperatures of formation:

Electron-positron pairs	5.930×10^9 °K
Protons	1.0888×10^{13} °K
Neutrons	1.0903×10^{13} °K

Neutron decay constant t_n as time to decay to 1/e of initial value
$t_n = 887 \pm 2$ sec (Mampe et. al. 1993)
Neutron half life 10.14-10.30 min. (Börner 1993 p 421)

Mega light year (SI)	$9.460\ 55 \times 10^{23}$ cm.
Mega parsec (SI)	$3.083\ 74 \times 10^{24}$ cm
Mega parsec (SI)	3.259 578 Mega light Years
SI tropical year	$3.155\ 693 \times 10^7$ sec
Obs. tropical year	$3.155\ 692\ 599 \times 10^7$ sec
Std tropical yr. 1900	$3.155\ 692\ 599\ 47 \times 10^7$ sec
Mayan tropical year	$3.155\ 6920 \times 10^7$ sec

General use equations

Thermodynamic temperature:

$T = (2/3)(E/R)$ in °K,

E = energy in ergs per gram mol,

R = gas constant 8.314 510 x 10^7 erg $^oK^{-1}$ mol^{-1}.

Effect of space expansion upon uncoupled radiation:

T' = T/F,

F = relative radius of T' universe to T universe.

Energy density of black body radiation in space
(Stefan-Boltzmann law):

ergs $cm^{-3} = 8 \pi^5 (k T)^4/[15 (h c)^3]$, (kT = temp in ^oK)

= 7.565 91 x 10^{-15} $[T(^oK)]^4$.

Relativistic Doppler effect:

$f/f^* = [1 + (v/c)(\cos \theta^*)]/[1 - (v/c)^2]^{1/2}$,

f = observed frequency,

f* = source frequency,

$\theta^* = 0^o$ for motion toward observer,

$\theta^* = 180^o$ for motion away from observer,

v/c is relative velocity of observer in terms of c, with source assumed stationary.

Back solution form for relativistic Doppler equation, to obtain ratio between relative velocity and radiation velocity (v/c), given the red shift ratio R.

$(v/c) = (R^2 - 1)/(R^2 + 1)$,

where R is the ratio of source frequency to observed frequency, or observed wavelength to source wavelength, or source temperature to observed radiation temperature in ^oK (equivalent black body temperatures).

Radiation pressure on a containing surface, in dynes cm^{-2}, is given by energy density, in ergs cm^{-3}, multiplied by 1/3.

The extra cosmological constant Λ was originated and employed by Einstein to stabilize his equation so as to result in a stationary solution instead of an expanding universe. This constant is now generally set at zero, yielding an expanding universe solution, but non zero values are still sometimes considered in alternative solutions to yield different expansion limits and to alter the effective expansion rates in the proposed solutions.

8.4. Fractional Dimension Contribution to a Rotational Probability Factor

In deriving the final form for the three-space radius of the universe as a function of cosmic age, a factor has been included to represent the effect of the cosmic age angle as a rotational freedom contribution in addition to its direct geometric projection effect. Inclusion of this new factor yielded Equations (1-25), (1-26), and (5-12), in variations of the form:

$$R = R_{uo}(1 - \alpha\phi/\pi)^{1/3} (\sin \phi) \left(p^{\sin^2 f}\right).$$

The component $R_{uo}(1 - \alpha\phi/\pi)^{1/3}$ represents the radius of curvature generator in emergent size units adjusted to the length units at age ϕ. The second component ($\sin \phi$) represents the effect of age upon the radius as a direct geometric effect of projection at the angle ϕ. The third component represents an additional contribution of a partial rotational degree of freedom, which appear as a power of π such as π^k. For the maximum effect at maximum universe size, the exponent $k = 1$, represents a full degree of freedom contribution due to $\phi = \pi/2$. This yields $\pi^k = \pi$ as a multiplier. At minimum age, $\phi = 0$, the factor $k = 0$, which yields a multiplier value $\pi^k = 1$. In essence, the rotational degree of freedom factor exponent ranges from $\sin^2 \phi = 0$ to $\sin^2 \phi = 1$.

In topology*, when accounting for a dimensionality (D) in the range 0 to 1, a fractional dimension can be expressed in the form $Dk = \sin^2 \varphi$; $0 \le k \le 1$, $\varphi \le \pi/2$. The implication of this effect is that in considering the rotation effect of the cosmic age angle combined with any one three-space direction, the net effect is the single three-space dimension plus a fractional dimension contribution from the age phase angle ϕ. This effect holds true for any of the three-space radius magnitudes, hence for all three when computing effective magnitude as a modified three-space volume of the universe. In the equation for space volume, then, the effect of the rotational freedom aspect appears as $\left(p^{3\sin^2 f}\right)$.

* Muse's, Charles, 1991 Journal of the United States Psychotronics Association No 5, p 9. "The Resonant Universe: Time Waves and Consciousness".