Nonstandard Analysis Applied to Special and General Relativity - The Theory of Infinitesimal Light-Clocks [Part II]

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Abstract

[Part II of this work presents] Special Theory Effects, General Theory Effects, Relativistic Alterations, Gravitational Alterations, (Nonstandard Photon-Particle Medium) NSPPM Analysis, Applications, Expansion, Pseudo-White Hole Effects.

SPECIAL EDITION

Foundations and Corrections to Einstein's Special and General Theories of Relativity, Article 3.*

Abstract: In part 2 of this paper, based upon a privileged observer located within a nonstandard substratum, the infinitesimal chronotopic line-element is derived from light-clock properties and shown to be related to the propagation of electromagnetic radiation. A general expression is derived, without the tensor calculus, from basic infinitesimal theory applied to obvious Galilean measures for distances traversed by an electromagnetic pulse. Various line-elements (i.e. "physical metrics," not obtained via tensor analysis) are obtained from this general expression. These include the Schwarzschild (and modified) line-element, which is obtained by merely substituting a Newtonian gravitational velocity into this expression; the de Sitter and the Robertson-Walker which are obtained by substituting a velocity associated with the cosmological constant or an expansion (contraction) process. The relativistic (i.e. transverse Doppler), gravitational and cosmological redshifts, and alterations of the radioactive decay rate are derived from a general behavioral model associated with atomic systems, and it is predicted that similar types of shifts will take place for other specific cases. Further, the mass alteration expression is derived in a similar manner. From these and similar derivations, the locally verified predictions of the Special and General Theories of Relativity should be obtainable. A process is also given that minimizes the problem of the "infinities" associated with such concepts as the Schwarzschild radius. These ideas are applied to black holes and pseudo-white holes.

1. Some Special Theory Effects

Recall that it does not appear possible to give a detailed description for the behavior of the NSPPM. For example, Maxwell's equations are based upon infinitesimals. Deriving these equations using only the NSP-world language gives but approximate NSP-world information about infinitesimals for they would be expressed in terms of $\approx$ and not in terms of $=$. These facts require that a new approach be used in order change $\approx$ into $=$ within the NSP-world and to determine other properties of the NSPPM, properties that are originally approximate in character and gleaned from observations within the natural world. This is the view implied by the Patton and Wheeler statements and taken within this research. The view is that space-time geometry is but a convenient language and actually tells us nothing about the true fundamental causes for such behavior. As mentioned and as will be demonstrated, this "geometric" language description is but an analogue model for properties associated with electromagnetic radiation. In most cases, Riemannian geometry will not be used for what follows. However, certain Riemannian concepts can still be utilized <u>if</u> they are properly interpreted in terms of light-clock behavior.

The so-called "Minkowski-type line-element" is usually defined. But, using this new approach, it is derived relative to light propagation behavior. As shown in Herrmann (1992) (i.e. article 2), there is in the NSP-world a unit conversion u and, further, it is shown that $c = \mathtt{st}(L/u) = L/u$, where c is a *local* measure of the velocity (i.e. velocity) of electromagnetic radiation *in vacuo.*

Suppose a timing infinitesimal light-clock is at a standard point in the NSPPM and Π_s counts have occurred, where a subscript or superscript s denotes "standard laboratory measurements" (measurements not considered as affected by the physical processes being considered). A *potential velocity* is a velocity that *may be* produced by a physical process. Whether or not motion actually occurs depends upon the physical scenario. If the same light-clock is moved with a standard relative

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(potential) velocity v_E as infinitesimal light-clock measured in the natural world, then the (8.1) and (8.2) scenario dictates that the infinitesimal light-clock intervals, $u\Pi_s,\ u\Pi_m$, are related as follows,

$$\mathtt{st}(u\Pi_s)\gamma = \mathtt{st}((\gamma u)\Pi_s) = \mathtt{st}(u\Pi_m),\ \gamma = \sqrt{1 - v_E^2/c^2}. \tag{1}$$

[See note [12] before proceeding.] The numbers $u\Pi_s,\ u\Pi_m,\ \gamma,\ L/u$ being finite in character allows the standard part operator to be dropped and $=$ to be replaced by $\approx$. This yields the following NSP-world statement.

$$u\Pi_s \approx u\Pi_m\gamma^{-1} \approx \tag{2}$$

$$\frac{L\Pi_m}{(L/u)\gamma} \approx \frac{L\Pi_m}{c\gamma}, \tag{3}$$

where a subscript or superscript m denotes potential "velocity" relative to the s-point. It is assumed that v_E^s is generalized to a type of velocity $v+d$ (i.e. has velocity units) and satisfies, in the NSPPM, the Galilean definition for uniform velocity. Then $(v+d)^2 = (\Delta r^s)^2)/(\Delta t^s)^2 = ((\Delta x^s)^2 + (\Delta y^s)^2 + (\Delta z^s)^2)/(\Delta t^s)^2$ and $\mathtt{st}(u\Pi_s) = \Delta t^s$. Combining (2) and (3) yields $L\Pi_m \approx c\,\gamma\,u\Pi_s$. This can be re-written as

$$(\mathtt{st}(L\Pi_m))^2 = (1 - ((v+d)^2/c^2)(\Delta t^s)^2c^2 = ((\Delta t^s)^2c^2 - ((\Delta x^s)^2 + (\Delta y^s)^2 + \Delta z^s)^2). \tag*{$(4)_a$}$$

$$(\mathtt{st}(u\Pi_m))^2 = (\Delta t^s)^2 - (1/c^2)((\Delta x^s)^2 + (\Delta y^s)^2 + (\Delta z^2)) \tag*{$(4)_b$}$$

The left side of equations $(4)_a$ and $(4)_b$ are only relative to electromagnetic properties as being analogue modeled by Einstein measures and equivalent infinitesimal light-clocks. The well-known right hand side of $(4)_a$ has been termed the *chronotopic interval*, a term that indicates its relationship to electromagnetic propagation. It is important to always keep in mind, that statements such as $(4)_a,\ (4)_b$ and the forthcoming statements $(5)_a,\ (5)_b$ refer to the use of infinitesimal light-clocks, or an approximating device, to measure time.

Although $(4)_a$ is similar to expression (21) in Ives (1939), this interpretation is completely distinct from the Ives' assumption that ℓ is altered within the N-world by relative motion. To measure the velocity of light by means of infinitesimal light-clocks and the Euclidean length expression, simply consider $(4)_a$ written as $0 = (\Delta t^s)^2c^2 - ((\Delta x^s)^2 + (\Delta y^s)^2 + (\Delta z^s)^2)$. Expressions such as $(4)_a$ and $(4)_b$ always incorporate both the length and time infinitesimal light-clocks due to the definition of (scalar) velocity.

For nonuniform motion and its local effects, one passes $(4)_a,\ (4)_b$ to the infinitesimal world, where $v+d$ is considered not a constant but a differentiable function that behaves as if it is a constant in the infinitesimal world. Such a re-statement of $(4)_a,\ (4)_b$ does not come from the more formal process of "infinitesimalizing." It is a physical infinitesimal light-clock hypothesis. Further, this implies that $L\Pi_m$ is an infinitesimal although Π_m can still be an infinite number and that all other similar finite quantities in (3) are nonzero infinitesimal numbers representing infinitesimal light-clock measures. Writing these infinitesimals in the customary differential form, let

$$dS^2 = (dt^s)^2c^2 - ((dx^s)^2 + (dy^s)^2 + (dz^s)^2), \tag*{$(5)_a$}$$

$$d\tau^2 = (dt^s)^2 - (1/c^2)((dx^s)^2 + (dy^s)^2 + (dz^s)^2), \tag*{$(5)_b$}$$

where $dZ^s, dZ^m,\ Z \in \{t,x,y,z\}$ are infinitesimal light-clock measures. Notice that the quasi-time-like $(5)_a$ and proper-time-like $(5)_b$ are not metrics as these terms are generally understood within mathematics. [The standard approach (Bergmann, 1976, p. 44) is to consider real numbers as represented by variables without the s or m superscripts. But, for any real number $r \neq 0$, there exists an infinite integer Γ_L, [resp. Γ_u] such that $L\Gamma_L \approx r$, [resp. $L\Gamma_u \approx r$]. Hence, $ds \approx dS$. For hyperrational numbers, $ds = dS$ and the two τ are equal. [Also see note 22c]] The basic goal is to determine to what the left-hand sides of $(5)_a$, $(5)_b$ correspond. This is done by examining two NSP-world infinitesimal views that compare infinitesimal physical world behavior with NSPPM altered infinitesimal behavior as both are viewed from the NSP-world.

Equations $(4)_a$, $(4)_b$ use unaltered infinitesimal light-clocks. The L, u, for such clocks are infinitesimalized. For this reason, the right-hand side of equations $(4)_a$, $(4)_b$ can be expressed in terms of infinitesimal concepts. However, the left-hand side can only be considered as near to the right hand side. Does this matter? The differentials that appear in $(5)_a$ and $(5)_b$ represent infinitesimal Einstein time intervals and associated distance measures. As shown in Herrmann (1985, p. 175), classical differential calculus cannot differentiate between types of differentials if either the concept of infinitesimal "indistinguishable affects" or Riemann integration is considered. Under these conditions, this gives an additional freedom in differential selection. Consequently, as shown in Herrmann (1992, Article 2), each of these differentials can be assumed to represent *exactly*, rather than approximately, the infinitesimal light-clock behavior. Expressions $(5)_a$, $(5)_b$ do not refer to the geometry of the universe in which we dwell. They and dS refer totally to the restricted concept of electromagnetic propagation within an infinitesimal light-clock. These expressions do not reveal what natural world relation might be operative unless other considerations are introduced. For this reason, certain basic properties are imposed upon the NSPPM.

As done in Herrmann (1991a p. 170, arxiv p. 162; 1992, 1994a), the concept of substratum *infinitely close of order one* effects (i.e. indistinguishable for dt effects) is the simplest and most successful modeling condition to impose upon the NSPPM. In order to investigate what affect $(5)_a$ produces in the infinitesimal world over dt of NSPPM infinitesimal changing t, this concept says, for dS, dS^m, that for each infinitesimal dt there is an infinitesimal ϵ such that $dS^m = dS + \epsilon\, dt$. This infinitesimal approach allows infinitesimal changes about a point to be extended to a local environment. In this case, the to-and-fro property is observationally subdivided into a finite collection of "to"s followed by a finite collection of "fro"s. If one subdivides a NSPPM t-interval ${}^*[a,b]$ into infinitesimal pieces of "size" dt and considers the $(dS^m)^i$ and dS^i, where the superscript, not exponent, i varies over the number ω of these subdivisions, it is not difficult to show using the notion of indistinguishable effects (Herrmann, 1991a, p. 87, arxiv p. 60) that

$$\sum_{i=1}^{\omega}(dS^m)^i = \sum_{i=1}^{\omega} dS^i + \lambda, \tag{6}$$

where λ is an infinitesimal.

Suppose that the entities t_E, x_E, y_E, z_E, are functions expressed in parameter t. For nonuniform relative velocity, these functions might be but restrictions of differentiable functions that yield an integrable $dS = f(t)dt$ over standard $[a,b]$. Assuming this, the standard part operator yields

$$\mathtt{st}(\sum_{i=1}^{\omega}(dS^m)^i) = \mathtt{st}(\sum_{i=1}^{\omega} dS^i) = \int_a^b f(t)\,dt. \tag{7}$$

Equation (7) can be interpreted in the exact manner as is $(4)_a$ assuming the conditions imposed upon its derivation. [See important note 21.] Expressions such as (6) and (7) and the properties of the standard part operator imply that when standard methods are used to derive an expression, then the expression can be re-expressed in terms of infinitesimal light-clock counts.

2. General Effects

Surdin (1962) states that it was Gerber in 1898 who first attempted to adjoin to Newton's theory of gravity a time-varying potential so as to explain the additional advance of Mercury's perihelion. Is it possible that an infinitesimal effect such as γdt^m or γdt^s is a significant part of a general NSPPM effect for all natural system behavior?

Various investigators (Barnes and Upham, 1976), assume that "clocks" and "rods" are altered in a specific way and select the appropriate γ expression that will transform $(5)_b$ into a proper time-like Schwarzschild line-element. However, from a more general relation derived solely from some simple NSP-world assumptions, the Schwarzschild relation will be obtained. To investigate a possible and simple effect, we improve significantly upon a suggestion of Phillips (1922) and use a simple monadic (i.e. infinitesimal) world behavioral concept. Recall that the collection of NSP-world entities infinitely close to a (standard) natural world position is called *a monad, monadic neighborhood*, or a *monadic cluster* when considered as composed of various types of propertons.

Further, recall that propertons should never be visualized as "particles" (Herrmann, 1986b, p. 50). Indeed, they are often simply called "things." The ultra-propertons, those with all but two coordinates denoted by $\pm 1/10^{\delta}$, δ an infinite number, are combined into intermediate propertons as modeled by a well-defined process that mirrors finite combinations and is expressed by equational system (2) in Herrmann (1986b, p. 50). Various relations between properton coordinates determine the types of matter or fields that such combinations produce. In what follows, we investigate a simple theoretical relation between the electromagnetic and velocity coordinates of the propertons that comprise the NSPPM.

Although for certain behavior an expression that models natural system behavior within the N-world (i.e. natural (physical) world) may be considered as an invariant form, the General Principle of Relativity is not assumed for our basic line-element derivations and its model tensor analysis is not applied. Without some reasonable physical basis, not all smooth curvilinear coordinate transformations need be allowed. However, for applications of these line elements to specific physical problems, certain invariant forms and solution methods will be assumed. Although infinitesimal world alterations are allowed they represent various physical effects and do not correspond to alterations in the geometry of space-time, but only to alterations in the behavior of natural world entities.

Suppose that timing infinitesimal light-clocks are used as an analogue model to investigate how the NSPPM behavior is related to a physical or physical-like process denoted by P. The process P influences various infinitesimal light-clocks as they are specially oriented. In the first case, we consider the "distance" measuring light-clocks as oriented in a radial and rotational direction as compared to a Euclidean (Cartesian) system. The "timing" infinitesimal light clocks have two non-coordinate "increment" orientations, nonnegative or nonpositive.

Suppose that timing infinitesimal light-clocks are used as an analogue model to investigate how the NSPPM behavior is related to an approximately static process denoted by P. The process P influences various infinitesimal light-clocks as they are specially oriented. In the first case, we consider the "distance" measuring light-clocks as oriented in a radial and rotational direction as compared to a Euclidean (Cartesian) system. The "timing" infinitesimal light clocks have two non-coordinate "increment" orientations, nonnegative or nonpositive. Refined meanings for the superscripts or subscripts s and m are discussed in note 12 and the Appendix B page 93.

Using the established methods of infinitesimal modeling as in Herrmann (1994a), suppose that $v+d$ and c behave within a monadic neighborhood as if they are constant with respect to P. [See note 14.] **Moreover, as a physical principle, since behavior in a monadic neighborhood is a proposed simple behavior, the simple Galilean velocity-distance law and $(4)_a$, $(4)_b$ not just for Einstein measures but for other potential velocities hold.** Hence, for photon behavior and a proposed potential velocity

$$((v+d)+c)dt^s = (v+d)dt^s + cdt^s =$$

$$dR^s + dT^s,\ dR^s = (v+d)dt^s,\ dT^s = cdt^s,\ \text{and}\ \frac{dR^s}{dT^s} = \frac{v+d}{c},\ dt^s \neq 0. \tag{8}$$

Suppose that for physical effects, not just for photons, a microeffect (Herrmann, 1989) alters the dR^s and dT^s in (8). This alteration is characterized by a linear transformation (A): $dR^s = (1-\alpha\beta)dR^m - \alpha dT^m$ and (B): $dT^s = \beta dR^m + dT^m$. This is conceived of within a monadic cluster as determining a properton coordinate relation relative to the P-process. The $\alpha,\ \beta$ are to be determined. Since the effects are to be observed in the natural world, $\alpha,\ \beta$ have standard values. [Equations (A) and (B) represent an "infinitesimal" linear transformation of the infinitesimal light-clocks measurements.]

Assuming simple NSP-world behavior with respect to radial motion, transform only the length portion of $(5)_a$ into spherical coordinates. This yields, not in terms of Einstein measures, but infinitesimal light-clock counts at points that is form invariant and infinitely close to dS^2, which by choice, is equated to dS^2.

$$dS^2 = (dT^s)^2 - (dR^s)^2 - (R^s)^2(\sin^2\theta^s(d\phi^s)^2 + (d\theta^s)^2). \tag{9}$$

In (9), the infinitesimals $d\phi^s,\ d\theta^s$ are assumed to be infinitesimal light-clocks for the two rotational aspects. Such "clock" behavior can be viewed as spherical transformed values for Cartesian coordinate infinitesimal light-clock values.

Consider the radial portion of (9) and let $k = (dT^s)^2 - (dR^s)^2$. Substituting (A) and (B) into k yields

$$k = (1-\alpha^2)(dT^m)^2 + 2(\alpha + \beta(1-\alpha^2))dR^m dT^m +$$
$$(\beta^2 - (1-\alpha\beta)^2)(dR^m)^2. \tag{10}$$

For real world time interval measurements, it is assumes that timing counts can be added or subtracted. This is transferred to a monadic neighborhood and requires dT^m to take on two increment orientations represented by nonpositive or nonnegative infinitesimal values. As with space-time, assume that the P-process is symmetric with respect to the past and future sense of a time variable. This implies that dS^2 is unaltered when dt^m is replaced by $-dt^m$ (Lawden, 1986, p. 143). Hence, k, is not altered in infinitesimal value when $dT^m = cdt^m$ is positive or negative. This implies a transformation restriction that $2(\alpha+\beta(1-\alpha^2)) = 0$. For simplicity of calculation, let $\alpha = -\sqrt{1-\eta}$. Hence, $\beta = \sqrt{1-\eta}/\eta$. Substituting these expressions into (A) and (B) yields

$$dR^s = \frac{1}{\eta}dR^m + \sqrt{1-\eta}\,dT^m$$
$$dT^s = \frac{\sqrt{1-\eta}}{\eta}dR^m + dT^m. \tag{11}$$

Combining both equations in (11) produces

$$\frac{dR^s}{dT^s} = \left(\frac{1}{\eta}\frac{dR^m}{dT^m} + \sqrt{1-\eta}\right) \div \left(\frac{\sqrt{1-\eta}}{\eta}\frac{dR^m}{dT^m} + 1\right). \tag{12}$$

For this derivation, a static condition is assumed. This is modeled by letting $dR^m/dT^m = 0$ over some time interval. [This time interval can be finite or potentially infinite or infinite.] Hence, (12) yields $dR^s/dT^s = (v+d)/c = \sqrt{1-\eta}$ or $\eta = 1-(v+d)^2/c^2 = \lambda \neq 0$ for a standard neighborhood. We note that using $\alpha = \sqrt{1-\eta}$ yields the contradiction $(v+d)/c < 0$ for the only case considered in this article that $0 \leq v+d$. [See note 1.] By substituting η into (11) and then (11) into (9), we have, where $dT^m = cdt^m$,

$$dS^2 = \lambda(cdt^m)^2 - (1/\lambda)(dR^m)^2 - \\ (R^s)^2(\sin^2\theta^s(d\phi^s)^2 + (d\theta^s)^2), \text{ or} \tag{13$_a$}$$

$$d\tau^2 = \lambda(dt^m)^2 - (1/(c^2\lambda))(dR^m)^2 - \\ (R^s/c)^2(\sin^2\theta^s(d\phi^s)^2 + (d\theta^s)^2). \tag{13$_b$}$$

Under our assumption that instantaneous radial behavior is being investigated, then $\theta^s,\ \phi^s$ are not affected directly by the radial properties of P and the superscript (s) in the parts of $(13)_a$, and $(13)_b$ containing these angles can be replaced by a superscript (m). Further, since the monadic neighborhood is only relative to radial behavior, then an infinitesimal rotation of the monadic neighborhood by $d\theta^s$ should have no effect upon the standard radial measure. Hence, considering all other infinitesimal light-clock counts to be zero, this implies that $R^s d\theta^s = R^m d\theta^m = R^m d\theta^s$. Hence, $R^s = R^m$ and this substitution is considered throughout all that follows in this article. [Also see note 12.] [However, if R is not considered as an independent spacetime parameter, then, as will be discussed if it is assumed to vary in "time," it will be considered as a "universal" function.] I again mention that $(13)_a,\ (13)_b$ do not determine metrics under the general mathematical meaning for this term. What they do represent is restricted to an instantaneous effect relating radial effects of P to electromagnetic propagation where a properton coordinate relation that yields this is partially identified. [See note 2 and for the important case where we consider pure complex $(v+d)i$. Also see note 15.]

There are, of course, many conceivable P-processes. Suppose that there exists such a process that is only related, in general, to an objects relative velocity with respect to an observer and possibly an objects distance from such an observer. Not transforming to spherical coordinates, but using the same argument used to obtain $(13)_a$ and $(13)_b$ yields the *linear effect* line-element

$$dS^2 = \lambda(cdt^m)^2 - (1/\lambda)(dr^m)^2, \tag{14$_a$}$$

$$d\tau^2 = \lambda(dt^m)^2 - (1/(c^2\lambda))(dr^m)^2, \tag{14$_b$}$$

where $(dr^m)^2 = (dx^m)^2 + (dy^m)^2 + (dz^m)^2$, where $x^m,\ y^m,\ z^m$ are not functions in t^m (Herrmann, 1995). This linear effect line element can be used, among other applications, to determine linear effects solely attributable to the Special Theory. For that use, one usually considers $v = v_E,\ d = 0$ and Einstein measures are used. The introduction of two aspects for Special Theory behavior will lead to a simplification of $(14)_a,\ (14)_b$. [See note 4,5,6.]

3. Relativistic Alterations

There are many possible coordinate effects produced by the Lorentz transformation. In Herrmann (1992)(i.e. Article 2), it is shown that since a NSPPM is used for this new derivation that there is no contradictory Einstein Special Theory reciprocal effects. For example, consider the so-called time dilation effect. This effect is a "light-clock" (electromagnetic) effect and has no relation to the concept of natural world time dilation. An infinitesimal light-clock is used as a measure of the concept of time. This implies that such time is measured by $u\Pi$ with a possible alteration in L and Π is an infinite Robinson number.

Within the NSPPM, relative motion is measured with respect to two entities F_1 and F_2. With respect to relativistic effects, it is always the case that F_1 is selected as denoting the entity that has NSPPM scalar velocity ω_1 less than or equal to ω_2 for F_2, and $\omega_1, \omega_2 \geq 0$. NSPPM scalar velocities are not modeled by directed numbers and, hence, do not follow the same arithmetic as natural world scalar velocities. Such velocities are additive but not subtractive. Subtraction is replace by the (true) metric $d(\omega_1, \omega_2) = |\omega_1 - \omega_2|$, which represents NSPPM relative velocity. Such effects are instantaneous "snapshot" effects.

For the non-infinitesimal change point of view, a timing infinitesimal light-clock corresponding to F_1 is denoted by $u\Pi^s$. The timing infinitesimal light-clock that corresponds to motion is relative to F_2 and is denoted by $u\Pi^m$. If only the Einstein time coordinate is affected by some NSPPM process, then there are two possible alterations in these infinitesimal light-clock counts due to motion as it can be viewed from the NSPPM. Either, (I) $\gamma u\Pi^s = (\gamma u)\Pi^s \approx u\Pi^m$ or (II) $\gamma u\Pi_1^m = (\gamma u)\Pi_1^m) \approx u\Pi_1^s$, but both cannot hold unless $v_E = 0$. Since (I) has lead to $(5)_a$ and $(5)_b$ and relativity notions must be maintained, it is conjectured that when m-points are considered that derivations will lead to line elements related to (9.1) and (9.2).

Once a derivation is obtained, it requires interpretation, although the basic electromagnetic properties that lead to a consequence are fixed. In all cases, the nature of the NSPPM and its associated effects are characterized by the "time" measuring infinitesimal light-clocks, while the "length" measuring infinitesimal light-clocks characterize the to-and-fro path traversed concept within the NSPPM and its associated effects. As this investigation progresses, it will become more evident that Builder (1960) may be correct in that all physical phenomena are associated with properties of an electromagnetic field; in this case, the NSPPM.

Laboratory determined selection of one or more of these possibilities is the major modeling technique used by numerous investigators, including Barnes and Upham, Builder, Lorentz, Dingle, but, especially, Herbert Ives, in their attempts to understand relativistic properties, where the velocities considered are the Einstein relative velocities v_E. This same accepted method is used in Herrmann (1992) to explain the Michelson-Morley and Kennedy-Thorndike type experiments. However, for the Ives-Stillwell type experiment (Ives and Stillwell, 1938), it is argued from empirical evidence that an alteration of the unit of "time" is not the correct interpretation, but, rather, that such experiments display an alteration of the frequency of radiation associated with an atomic system, as it corresponds to the timing infinitesimal light-clock, due to an *electromagnetic interaction with the NSPPM* (emis). For special relativity, (emis) refers to hyperbolic velocity behavior within the NSPPM (p. 50, (A3)), and it implies that this intimate relation exists. Thus certain details as to how the NSPPM's behavior influences these and similar types of experimental scenarios is indirectly known. However, rather than simply postulating the correct infinitesimal relation, the correct relation will be predicted from well-established atomic system behavior.

Suppose that certain aspects of a natural system's behavior are governed by a function $T(x_1, x_2, \dots, x_n, t)$ that satisfies an expression $D(T) = k(\partial T/\partial t)$, where D is a (functional) t-separating operator and k is a universal constant. Such an expression is actually saying something about the infinitesimal world. With respect to electromagnetic effects, the stated variables are replaced by variables with superscripts s if referred to F_1 behavior where s now indicates that no (emis) modifications occur. In what follows, all measures are Einstein measures.

In solving such expressions, the function T is often considered as separable and D is not related to the coordinate t. In this case, let $T(x_1, x_2, \ldots, x_n, t) = h(x_1, x_2, \ldots, x_n)f(t)$. Then $D(T(x_1, x_2, \ldots, x_n, t)) = D(h(x_1, x_2, \ldots, x_n))f(t) = (kh(x_1, x_2, \ldots, x_n))(df/dt)$ and is an invariant separated form.

Let $(x_1^s, x_2^s, \ldots, x_n^s, t^s)$ correspond to measurements taken of the behavior of a natural system that is influenced by (9) [resp. $(5)_a$] and using identical modes of measurement let $(x_1^m, x_2^m, \ldots, x_n^m, t^m)$ correspond to measurements taken of the behavior of a natural system that is influenced by $(13)_a$ [resp. $(14)_a$]. [Notice that this uses the language of "measurements" and not that of transformation. The term "modes" means that identically constructed devices are used.] Now suppose that $T(x_1^s, x_2^s, \ldots, x_n^s, t^s) = h(x_1^s, x_2^s, \ldots, x_n^s)f(t^s)$. We assume that T is a universal function and that separation is an invariant procedure. What this means is that the same solution method holds throughout the universe and any alterations in the measured quantities preserves the functional form; in this case, preserves the separated functions. [See note 14.] Let the values $h(x_1^s, x_2^s, \ldots, x_n^s) = H(x_1^m, x_2^m, \ldots, x_n^m)$ and the values $f(t^s) = F(t^m)$ and $T(x_1^m, x_2^m, \ldots, x_n^m, t^m) = H(x_1^m, x_2^m, \ldots, x_n^m)F(t^m)$. One differentiates with respect to t^s and obtains by use of the chain rule

$$\delta^s = \left(\frac{D_s(h(x_1^s, x_2^s, \ldots, x_n^s))}{h(x_1^s, x_2^s, \ldots, x_n^s)}\right) = k\frac{1}{f(t^s)}\frac{df}{dt^s} = k\frac{1}{F(t^m)}\frac{dF}{dt^m}\frac{dt^m}{dt^s}. \tag{15}$$

With respect to m,

$$\left(\frac{D_m(H(x_1^m, x_2^m, \ldots, x_n^m))}{H(x_1^m, x_2^m, \ldots, x_n^m)}\right) = k\frac{1}{F(t^m)}\frac{dF}{dt^m} = \delta^m. \tag{16}$$

First, consider physical structure. With respect to the NSPPM, consider the (emis) effects of this P-process caused by the NSPPM velocity ω. This is associated with a physical effect, the nonsigned relative velocity. Further, this (emis) effect is considered as occurring within the physical structure itself and, due to the use of infinitesimals, it is the general practice to assume the modeling concept that when such physical alterations occur the structure is momentarily at rest with respect to both the observer and its immediate environment. This is modeled with respect to the linear effect line-element by letting $dr^m = 0$ in $(14)_a$, $v = v_E$, $d = 0$, and $dr^s = 0$, in $(5)_a$. Comparing the resulting dS^2 yields for this case, that this Special Theory P-process requires via application of (15) and (16) that

$$\sqrt{\lambda}\, dt^m = \gamma\, dt^m = dt^s, \tag{$**$}$$

which is all that is needed for such relativistic effects. [See note 22c.] The assumption that $d = 0$ is taken to mean that we are either interested only in local effects where the d effect would be removed from the problem or effects where the d is exceeding small in character. [Also see note 3.] Notice that this is one of the many possible Special Theory coordinate alterations and establishes that the eigenvalues are related to physical NSPPM properties as they are measured by infinitesimal light-clocks. Also notice that from the infinitesimal viewpoint (**) is similar to (9.2) [Note: 21b]. Finally, assume that for a physical structure that a P-process is modeled by the above D operator equation. Then

$$\delta^s = \delta^m/\gamma. \tag{17}$$

Consequently, $\gamma\,\delta^s = \delta^m$.

Suppose that $T = \Psi$ is the total wave function, D for (17) is the operator $\nabla^2 - p$, where $n = 3$ and the constant k, function p are those associated with the classical time-dependent Schrödinger equation for an atomic system. It is not assumed, as yet, that such a Schrödinger type equation predicts any other behavior except that it reasonably approximates the energy associated with electromagnetic radiation and that the frequency of such radiation may be obtained, at least approximately, from this predicted energy variation. The eigenvalues (Pohl, 1967, p. 31) for this separable solution are correlate to energies E^s and E^m for such a radiating atomic system. Hence,

$$\gamma\Delta E^s = \Delta E^m. \tag{18}$$

Since comparisons as viewed from one location are used, divide (18) by Planck's constant and the comparative relativistic redshift (transverse Doppler, where $\alpha = \pi/2$) result $\gamma\nu^s = \nu^m, d = 0$, is predicted. [Note that, as mentioned, pure Special relativistic effects would, usually, have the effects of any d removed from consideration. However, this may not be the case, in general, for all such effects.] This is the same expression, where ν^s means a stationary (laboratory determined value), first verified by Ives and Stillwell and which is attributed to observer time dilation. But it has been established that it can be interpreted as an (emis) effect and not an effect produced by absolute time dilation. Observer time is dilated via alterations in the machines that "measure" time.

The above Schrödinger equation approach does not just apply to atomic and molecular physical processes that exhibit uniform frequencies associated with such energy changes. Indeed, for consistency, all time related behavior must undergo similar alterations. This implies that the Schrödinger equation approach is universal. The same alterations are produced by gravitational fields. If needed to verify this conjecture, as demonstrated shortly, the (15), (16) method may need to be modified. Again these would be an electromagnetic or (emis) effects. [See note 22.]

We next apply the linear effect line-element to the problem of radioactive and similar decay rates. The usual arguments for the alteration of such rates are in logical error. Let $N(t^s)$ denote a measure for the number of active entities at the light-clock count time t^s and τ_s be the (mean) lifetime. These measures are taken within a laboratory and are used as the standard measures. This is equivalent to saying that they are, from the laboratory viewpoint, not affected by relativistic alterations. The basic statement is that there exists some $\tau \in (0, B]$ such that (*) $(-\tau)dN/dt = N$. Even though the number of active entities is a natural number, this expression can only have meaning if N is differentiable on some time interval. But, since the τ are averages and the number of entities is usually vary large, then such a differential function is a satisfactory approximation. Recall that the required operator expression is

$$D(T) = k(\partial/\partial t)(T). \tag{19}$$

Let $k = 1$ and $h(r) = 0 \cdot r^2 + 1 = 1$. Then define $T(r, t) = h(r)N(t) = (0 \cdot r^2 + 1)N(t)$, where $r^2 = x^2 + y^2 + z^2$, and let D be the identity map I on $T(r, t)$. Then $D(T(r, t)) = D(h(r))N(t) = D(0 \cdot r^2 + 1)N(t) = 1 \cdot N(t)$ and, in this form, D is considered as only applying to h and it has no effect on $N(t)$. In this required form, first let $r = r^s$ and $t = t^s$. Then, consider $T(r^m, t^m) = H(r^m)\overline{N}(t^m),\ H(r^m) = 0 \cdot (r^m)^2 + 1 = 1$. (Notice that it is not necessary to explicitly define h and H when one assumes the such a T is a universal function, since the h and H are factored from the final result. One simply assumes that there are functions h and H such that $h(r^s) = H(r^m)$.) In order to determine whether there is a change in the τ_s, one considers the value $N(t^s) = \overline{N}(t^m)$. This yields the final requirement for T. Notice that t^m is Einstein time as measured from the s-point. This is necessary in that the $v = v_E$, which is a necessary requirement in order to maintain the hyperbolic-velocity space behavior of v.

Applying (19) to T and considering a corresponding differentiable equation (*) and the chain rule, one obtains that there exist a real number τ_s such that

$$N(t^s) = (-\tau_s)(d/dt^s)N(t^s) =$$
$$(-\tau_s)(d/dt^m)\overline{N}(t^m)(d/dt^s)(t^m) =$$
$$(-\tau_s/\gamma)(d/dt^m)\overline{N}(t^m). \tag{20}$$

And, with respect to m, and for τ_m

$$\overline{N}(t^m) = (-\tau_m)(d/dt^m)\overline{N}(t^m). \qquad 21)$$

Using (20) and (21) one obtains that $\tau_m = \tau_s/\gamma$. (In the linear effect line element $d = 0$.) This is one of the well-known expressions for the prediction for the alteration of the decay rates due to relative velocity (that is v_E). The τ_s can always be taken as measured at rest in the laboratory since the relative velocity of the active entities is determined by experimental equipment that is at rest in the laboratory.

As another example of the previous procedures, we consider the so-called Special Theory mass alteration expression. Consider two perfectly elastic objects of mass M and moving in opposite directions with the same velocity and colliding. Let this occur at both the s-position and m-positions. Then at the moment they collide they are momentary at rest. Thus, at that moment, $dr^s = 0 = dr^m$ expression (**) holds. Consider one of these colliding objects. For a Hamilton characteristic function S', the classical Hamilton-Jacobi equation becomes $(\partial S'/\partial r)^2 = -2M(\partial S'/\partial t)$. Suppose that $S'(r,t) = h(r)f(t)$. Again consider a P-process that yields this isotropic behavior and that S' is universal in character and the solution method holds throughout our universe. This yields that $h(r^s) = H(r^m),\ f(t^s) = F(t^m),\ S'(r^s,t^s) = S'(r^m,t^m)$. Let $D = (\partial(\cdot)/\partial r)^2$. The same procedure used previously yields

$$\left(\frac{\partial h(r^s)}{\partial r^s}\right)^2\left(\frac{1}{h(r^s)}\right) = -2\frac{M^s}{f^2(t^s)}\frac{df}{dt^s} =$$
$$-2\frac{M^s}{F^2(t^m)}\frac{dF}{dt^m}\frac{dt^m}{dt^s} = M^s\lambda^m/\gamma. \tag{22}$$

With respect to m,

$$\left(\frac{\partial H(r^m)}{\partial r^m}\right)^2\left(\frac{1}{H(r^m)}\right) = -2\frac{M^m}{F^2(t^m)}\frac{dF}{dt^m} = M^m\lambda^m. \tag{23}$$

In (22) and (23), the quantities M^s and M^m are obtained by means of identical modes of measurement that characterizes "mass." Assuming that the two separated forms on the left of (22) and (23) are invariant, leads to the Special Theory mass expression $M^m = (1/\gamma)M^s$. This result is postulated to hold, in general, for identical objects stationary at the s-point and m-point. This result indirectly demonstrates an actual cause for the so-called rest mass alteration. It indicates the possible existence of a P-process that is produced by the NSPPM and yields an alteration in the mass effect which is either electromagnetic in nature or, at the least, an (emis) effect.

4. Gravitational Alterations

The results derived in the previous section are all relative to Special Theory alterations produced by (emis) effects and these are not associated with a Newtonian gravitational potential. Suppose, however, that a varying Newtonian gravitational potential additionally influences electromagnetic behavior and that this potential is determined by a P-process. An entity of mass M, as analogue modeled by a homogeneous spherical object of radius $R_0 \leq R^m$, has an instantaneous Newtonian potential at a distance $R \geq R^m$, where we are not concerned with the question of whether this is an action-at-a-distance or a field propagation effect. Let the general potential difference expression for a distance R and a mass m_0 be

$$U(R) = \frac{GMm_0}{R^m} - \frac{GMm_0}{R}, \tag{24}$$

where the minute potential due to all other matter in the universe is omitted.

By the usual techniques of nonstandard analysis, (24) has meaning in the NSP-world at points where $R = \Lambda$ is an infinite number. In this case,

$$U(\Lambda) \approx \frac{GMm_0}{R^m}. \tag{25}$$

Of course, depending upon the observer's viewpoint, you can consider $U(\Lambda) \approx 0$ and $U(R^m) = -GMm_0/R^m$.

Viewed as escape velocity, $\mathtt{st}(U(\Lambda)) = GMm_0/R^m$ indicates the potential energy associated with escaping totally from the natural world to specific points within the NSP-world. Since the NSP-world "size" of the our universe at the present epoch, whether finite or not, is not known, such a radius Λ from the massive body is necessary in order to characterize a total escape. On the other hand, $\mathtt{st}(U(\Lambda)) = GMm_0/R^m$ can be viewed as the potential energy associated with a "potential velocity" that is attained at R^m when finite mass m_0 is "moved" from such a specific point within the NSP-world. Suppose that this potential energy is characterized as kinetic energy. Then the potential velocity is $v_p = \sqrt{2GM/R^m}$. In order to incorporate an additional gravitational (emis) effect, substitute $v_p = v_E$ into $(13)_a$ rather than the possibility that $v_p = \omega$, where ω is the NSPPM velocity. This expression holds even if we assume infinitesimal masses. The use of infinitesimal light-clocks allows us to apply the calculus. Further, although it need only be considered as a modeling technique, the concept of viewing the behavior of our cosmos from a single external position within the NSP-world appears relevant to various cosmologies.

As is customary, for this single object derivation, (9) applies at an "infinite" distance from the homogeneous object. But when astronomical and atomic distances are compared, then (9) can be assumed to apply approximately to many observers within the universe. This is especially the case if an observer is affected by a second much weaker Newtonian potential, in which case (9) is used as a local line-element relating measures of laboratory standards.

Following the usual practice for radiation purposes, the representative atomic system, as well as other physical systems, is considered as momentarily at rest with respect to the spherical object and the observer. Hence $dR^m = d\phi^m = d\theta^m = dR^s = d\phi^s = d\theta^s = 0$. Equation $(13)_a$ yields that $dS^2 = \lambda(cdt^m)^2$ and (9) yields $dS^2 = (cdt^s)^2$. Thus, for this atomic system case, the differentials dt^m and dt^s are again related by the expression $\gamma dt^m = dt^s$, where $\gamma = \sqrt{\lambda}$.

Using the same operator as in the relativistic redshift case, yields the basic gravitational redshift expression $\gamma\nu^s = \nu^m$ (Bergmann, 1976, p. 222, where $d = 0$). Using the General Theory of Relativity, this same expression is obtained for what is termed a "weak" gravitational field that can be approximated by a Newtonian potential although it is often applied to strong fields and is derived using time dilation. The Schrödinger type equation derivation is a different approach and holds for Newtonian potentials in general. Indeed, even if radiation is not the immediate product of atomic emission, it may be assumed to be controlled by the Schrödinger equation if there is any energy alteration. Hence, this approach may be applied anywhere within a gravitational field.

Also repeating the derivations in the previous section, we have the predicted gravitational alterations in the radioactive decay rates, and atomic clocks, etc. This will yield laboratory verified variations that are attributed to time dilation, but in this theory they are all attributed to electromagnetic or (emis) effects.

For the case where $2GM/c^2 < R^m$, when one substitutes $v = v_p = \sqrt{2GM/R^m}$ into $(13)_b$ [resp. $(13)_a$], one obtains, for $d = 0$, the so-called proper-time-like Schwarzschild line-element $(13)_{bp}$ [resp. $(13)_{ap}$]. Using the Schwarzschild relation $(13)_{bp}$, many physical predictions have been made. These include the advance of the perihelion of Mercury and the deflection of a light ray by a massive body are predicted (Lawden, 1982, pp. 147–152), where the language of geodesics does not refer to space-time curvature but rather to a P effect. That is Riemannian geometry is but an analogue model for the behavior of infinitesimal light-clocks. A relation such as $(13)_{bp}$ should only be applied to a Newtonian potential for which other such potentials can be neglected. Thus such predictions would be restricted to special physical scenarios. To see that this identified (emis) is an intimate properton coordinate relation and not a cause and effect concept, in one scenario the Newtonian potential appears to alter NSPPM behavior, but for another scenario properties of the NSPPM appear to alter the Newtonian potential. **It is important to note that other (gravitational) line-elements can be obtained for non-homogeneous bodies if one is able to find an appropriate "potential" velocity v_p for such bodies.** For nonzero values of d, one obtains what I term the *quasi-Schwarzschild* line-element.

In general when the Newtonian potential velocity is used and d is constant, this is not exactly the same as the modified Schwarzschild line-element that contains the Einstein cosmological constant Λ (Rindler, 1977, p. 184). There is one additional term in the radial coefficients of the quasi-Schwarzschild line element. Also, $d = 0$ if and only if $\Lambda = 0$ and, more generally, $d \geq 0$ if and only if $\Lambda \geq 0$. However, there is a $d = f(R^m)$ that will yield the *modified Schwarzschild* line-element $(13)_a$ where $\lambda = 1 - 2GM/(R^m c^2) - (1/3)\Lambda(R^m)^2/c^2$ (Rindler, 1977, p. 184, Eq. 8.151), (the Λ unit is $(\text{time})^{-2}$). Further note that when one puts $M = 0$ and uses this modified Schwarzschild, the de Sitter line-element is obtained (Rindler, 1977, p. 184, eq. 8.155). Thus, major line-elements are obtained by this approach.

One of approximations discovered for the Einstein gravitational field equations is when gravitational potentials are used and $v_p^2 \ll c^2$. The coefficients g_{ij} are determined by considering the system of bodies that produce the field to be at a great distance from the point being considered. From the viewpoint of the Newtonian potential, this would yield an approximating parallel force field relative to the center of mass for the system. Hence, consider substituting into the linear effect line-element $(14)_a$, $v^2 = 2GM/r^m,\ d = 0$. From this, one obtains

$$dS^2 = (1 - 2GM/(r^m c^2))(cdt^m)^2 - \left[\frac{1}{(1 - 2GM/(r^m c^2))}\right](dr^m)^2. \tag{26}$$

But, letting $(dr^m)^2 = dx_m^2 + dy_m^2 + dz_m^2$, then (26) would be the proper line-element for this approximation.

What happens when the coefficient $[1/((1 - 2GM/(r^m c^2))]$ is approximated? Expanding, we have that $1/((1 - 2GM/(r^m c^2)) = 1 + 2GM/(r^m c^2) + \cdots$. Substituting this approximation into (26) yields

$$dS^2 \approx (1 - 2GM/(r^m c^2))(cdt^m)^2 - (1 + 2GM/(r^m c^2))(dr^m)^2. \tag{27}$$

Equation (27) is the customary and well-known Newtonian first approximation associated with the Einstein law of gravity. It is used by many authors for various purposes.

Notwithstanding the methods used to model Einstein's General Principle of Relativity that allow for numerous coordinate transformation to be incorporated into the theory and for certain so-called "singularities" to be considered as but coordinate system anomalies, there would be a natural world Newtonian bound $0 \leq (2GM)/c^2 \leq R^m$ when the operator expression $D(T) = k(\partial T/\partial t)$ is used to investigate such things as the frequency change $\gamma\nu^s = \nu^m$, and the gravitational alteration in timing devices. The bound would be retained, at this epoch, for entities to which the Schrödinger equation applies. On the other hand, unless for other reasons such a bound is shown to be necessary, then an alteration in atomic system behavior can certainly be incorporated into theorized mechanisms if one assumes that it is possible in the natural world for $(2GM)/c^2 > R^m$.

It is also interesting to note that D can be replaced by the Laplacian. The same analysis would yield that if only NSPPM behavior is considered, then gravitational effects would alter the nature of internal heat transfer. General Relativity also predicts certain temperature shifts (Misner, 1973, p. 568).

In this section, the use of ad hoc coordinate transformation is not allowed. Thus it is necessary that $\lambda \neq 0$ in $(13)_a$ and $(13)_b$. From continuity considerations this, at present, forces upon us for Newtonian potentials the slightly move restrictive bound $0 \leq 2GM/c^2 < R^m$. Using the proper initial condition $U(\Lambda) \approx 0$ and the light-clock interpretation does not lead to a theoretical impasse as suggested by Lawden (1982, p. 156). Relative to action-at-a-distance, where natural world alterations of Newtonian potentials are to take place instantaneously with respect to a natural world time frame, there may be NSP-world informational entities, the hyperfast propertons, that mediate these instantaneous changes (Herrmann, 1986b, p. 51). Today, the concept of action-at-a-distance is still accepted, partially or wholly, as the only known description that accurately predicts certain natural system behavior (Graneau, 1990. Herrmann, 1999). On the other hand, since Maxwell's field equations are stated in the language of infinitesimals and reveal basic behavior within a monadic cluster, then it is not ad hoc to speculate that gravitational alterations, that in the gravostatic case yield the Newtonian potential, are controlled by a similar set of field expressions and that gravitational effects are propagated with a finite velocity. This speculation has been advanced by various researchers as far back as 1893 (Heaviside, 1922). There are, as well, more recent advocates of this approach (Barnes and Upham, 1976; Barnes, 1983; Jefferson, 1986; Brietner, 1986).

5. NSPPM Analysis

It may be assumed that numerous distinct processes contribute to the present epoch behavior of the cosmos. One possibility is the metamorphic (i.e. sudden) structured appearance of our universe or a natural system contained within it at various levels of complexity. (Schneider, 1984; Herrmann, 1990, p. 13.) The rational existence of ultimate ultrawords and a specific NSP-world process, an ultralogic, that combines these processes together rationally and yields the present epoch behavior has been established (Herrmann, 1991b, p. 103). [See (Herrmann, 1986a, p. 194) where such entities are described using older terminology.] It might be argued that one aspect of present day cosmological behavior superimposed upon all of the other aspects is a smoothed out galactic gas aspect. A cosmological redshift verification for an "expanding" universe model might not actually be attainable by means of a redshift measurement (Ettari 1988, 1989). However, the superimposition of a NSPPM physical effect can model such an expansion as it occurs throughout the development of our universe. Of course, this need not be extrapolated backwards to the beginning of, say, the

"Big Bang."

We solve this problem by the exact same method used in section 3 to obtain all of the previous line-elements. *The assumption is that there is a type of expansion of the properton (classical) field taking place that directly influences the general behavior of our universe and this affect is superimposed upon all other behavior.* For the derivation of this new line-element, consider $v + d = (R^s/a),\ v = 0,\ \ a \neq 0,\ dR^s = (R^s/a)dt^s$. The exact same derivation yields the line-element

$$dS_e^2 = (1 - (R^m)^2/c^2a^2)(cdt^m)^2 - \frac{(dR^m)^2}{1-(R^m)^2/(ca)^2} -$$

$$(R^m)^2(\sin^2\theta^m(d\phi^m)^2 + (d\theta^m)^2). \tag{28}$$

What is needed is to relate measures within the NSPPM to physical alterations within the natural world. From all of our previous derivations for the natural world alterations in physical behavior produced by the NSPPM, it was argued in each case that $(dt^s)^2 = \lambda(dt^m)^2$. Thus consider substituting into the line-element that relation and obtaining

$$dS_e^2 = (cdt^s)^2 - \frac{(dR^m)^2}{1-(R^m)^2/(ca)^2} -$$

$$(R^m)^2(\sin^2\theta^m(d\phi^m)^2 + (d\theta^m)^2) = (cdt^s)^2 - d\ell_e^2. \tag{29}$$

Equation (29) is one form of the famous Robertson-Walker line-element, when it is assumed that R^m is only "time" dependent so that it can be used for the concept of an isotropic and homogeneous universe (Ohanian, 1976, p. 392). It can also be used to satisfy the Copernican principle (i.e. the Cosmological principle), in this case, if one wishes to apply it at any position. Of course, this general application is not necessary. For that reason, it is not assumed, in general, that such NSPPM behavior as it affects the natural world only depends upon t^s. Functions such as R^m are considered as possibly dependent upon a fixed frame of reference within the NSPPM as it is reflected in the non-gravitational and non-expanding natural world by the coordinates t^s, x^s, y^s, z^s. To correlate to Ohanian, the units are changed to to light units (i.e. c = 1). In comparing (29) to the Einsteinian approach, it is the line-element for the positive curvature Friedmann model with the Riemannian curvature $K = 1/a^2$ (Ohanian, 1976, p. 391-2),where a behaves like the "radius" of a four-dimensional hypersphere. In the analysis as it appears in Lawden (1982), not using light units, $a = S/c$. The definition of d clearly indicates that the expanding properton field "velocity" forces this hypersphere behavior upon our universe. (I mention that Fock (1959, p. 173, 371) and others who require $\Lambda = 0$, consider only the Friedmann models as viable scenarios.)

The selection of the above d is not ad hoc but is consistent with astronomical observation. The observation is the apparent expansion redshift as modeled by the Hubble Law. This law states that the velocity of the expansion (or contraction) is $v(t^s) = H(t^s)\ell_e(t^s)$, where $\ell_e(t^s)$ is a distance to the center of a spherical mass. The influence this expansion has within the natural world is a direct reduction (or addition) to the Newtonian gravitational potential. Assuming Newtonian potentials and Second Law of motion, Ohanian (1976, pp. 370-373) derives easily the usual relation between the *deceleration parameter* $q = -(1 + (1/H^2)dH/dt^s)$ and its relation to a uniform, but changing in t^s, density ρ. This relation is $-qH^2 = -(4\pi G\rho(t^s))/3$. Moreover, by letting $dt^s = ad\eta$, one obtains the usual differential equation for the Friedmann closed universe model, $3((da/d\eta)^2 + a^2) = (4GM/\pi)a$, where the mass of the universe $M = 2\pi^2a^3\rho(t^s)$. If we let $d = (R^s/a)i$, then the Friedmann open universe model is obtained. These Friedmann models are, therefore, based entirely upon the Newtonian potential concept and not upon Einstein's theory. Further, the Hubble function $H(t^s) = (1/a)(da/dt^s)$. These results are all consistent with the d selected. [See note 7.] The concept of an expanding properton field will be utilized explicitly for other purposes in the last section of this article.

Relative to gravitational collapse, **unless specific physical processes are first introduced**, the methods discussed in this section preclude collapse through the Schwarzschild surface (i.e. radius). This yields but a restricted collapse. However, if such a restricted collapse occurs, then the optical appearance to an exterior observer would be as it is usually described (Misner 1973, p. 847), but no actual black hole would be formed. Any observational black hole effects, would mostly come from the gravitational effects such an object might have upon neighboring objects. Black hole internal effects, such as the retention of photons and material particles generated within the body as well as those that pass over the Schwarzschild surface, depend upon a strong gravitational field. In this research, this would depend upon *physical concepts* that lead to a coordinate transformation, not, in general, conversely. For this reason, there would not exist, as yet, the concept of the Einstein–Rosen bridge (wormholes) (Misner 1973, p. 837) and the like which tend to be associated with regular coordinate transformation (Rindler, 1977, p. 320.)

In the next section, a method will be investigated that will allow certain physical transformation to occur in such a way that the so-called Schwarzschild radius or singularity $(2GM)/c^2 = R^m$ can essentially be bypassed.

6. Minimizing Singularities

In section 2, the quasi-Schwarzschild line-element dS^2 is derived by considering Newtonian gravity as being a P-process considered as emanating from the center of a homogeneous spherical configuration and its interaction with the NSPPM. Adjoined to this gravitational effect was a possible properton field expansion (contraction) effect. The (emis) interaction is modeled by taking the Special Theory chronotopic interval and modifying its spherical coordinate transformation by a type of damping of the basic infinitesimal light-clocks. This damping is characterized by an infinitesimal nonsingular linear transformation of the infinitesimal light-clock mechanism. [Note that the length determining infinitesimal light-clock is the same as the "time" determining light-clock with the exception of a different unit of measure. Thus, in all of our cases, there is a close relationship between these measuring devices.]

In General Relativity, appropriate differentiable coordinate transformation with nonvanishing Jocabians may be applied to a solution of the Einstein law of gravity and, with respect to the same physical constraints, this would yield, at least, a different view of the gravitational field. In this and the next section, this notion is assumed.

The Eddington-Finkelstein transformation was one of the first of the many purposed transformation. But, in (Lawden, 1982), the derivation and argument for using the this simple transformation (**) $dU^m = dt^m + f_M(R^m)dR^m$ to obtain a black hole line-element appears to be flawed. The apparent flaw is caused by the usual ad hoc logical errors in "removing infinities." Equation 57.11 in (Lawden (1982), p. 157), specifically requires that $R^m > 2GM/c^2$. However, in arguing for the use of the transformed Schwarzschild line-element, Lawden assumes that it is possible for $R^m \leq 2GM/c^2$. But the assumed real valued function defined by equation 57.11 is not defined for R^m such that $R^m \leq 2GM/c^2$. Hence, a new and rigorously correct procedure for such transformation might be useful. Such a procedure is accomplished by showing that (**) can be considered as a hypercontinuous and hypersmooth transformation associated with a new P-process that yields an alteration to the gravitational field in the vicinity of the Schwarzschild surface during the process of gravitational collapse.

This *speculation* is modeled by the expression (**) which is conceived of as an alteration in the time measuring light-clock. [See note 13.] Further, this alteration is conceptually the same as the ultrasmooth microeffects model for fractal behavior (Herrmann, 1989) and thus has a similar physical bases. This transformation takes the Schwarzschild line-element, which applies only to the case where $R^m > 2GM/c^2$, and yields an NSP-world black hole line-element that only applies for the case where $R^m \leq 2GM/c^2$. Like ultrasmooth microeffects, the nonstandard transformation process is considered as an ideal model of behavior that approximates the actual natural world process. Thus we have two district line-elements connected by such a transformation and each applies to a specific R^m domain.

To establish that an internal function $f_M(R^m)$ exists with the appropriate properties proceed as follows: let $\mathcal{I}$ be the set of all nonsingleton intervals in $\mathcal{P}(\mathbb{R})$, where $\mathbb{R}$ denotes the real numbers. Let $\mathcal{F} \subset \mathcal{P}(\mathbb{R} \times \mathbb{R})$ be the set of all nonempty functional sets of ordered pairs. For each $I \in \mathcal{I}$, let $C(I, \mathbb{R}) \subset \mathcal{F}$ be the set of all real valued continuous functions (end points included as necessary) defined on I. For each $k > 0$, $\exists f_k \in C((-\infty, 0], \mathbb{R}),\ (-\infty, 0] \in \mathcal{I}$, such that $\forall x \in (-\infty, 0],\ f_k(x) = 1/(x-k)$. Further, $\exists g_k \in C((0, 2k], \mathbb{R}),\ (0, 2k] \in \mathcal{I}$, such that $\forall x \in (0, 2k],\ g_k(x) = -x^3/(2k^4) + 7x^2/(4k^3) - x/k^2 - 1/k$. Then $\exists h_k \in C((2k, +\infty), \mathbb{R}),\ (2k, +\infty) \in \mathcal{I}$, such that $\forall x \in (2k, +\infty),\ h_k(x) = 0$. Finally, it follows that $\lim_{x\to 0^-} f_k(x) = \lim_{x\to 0^+} g_k(x),\ \lim_{x\to 2k^-} g_k(x) = \lim_{x\to 2k^+} h_k(x)$. Hence

$$H_k(x) = \begin{cases} f_k(x); & x \in (-\infty, 0] \\ g_k(x); & x \in (0, 2k] \\ h_k(x); & x \in (2k, +\infty) \end{cases}$$

is continuous for each $x \in \mathbb{R}$ and has the indicated properties.

Now $H'_k(x)$ exists and is continuous for all $x \in \mathbb{R}$ and

$$H'_k(x) = \begin{cases} f'_k(x); & x \in (-\infty, 0] \\ g'_k(x); & x \in (0, 2k] \\ h'_k(x); & x \in (2k, +\infty) \end{cases}$$

All of the above can be easily expressed in a first-order language and all the statements hold in our superstructure enlargement (Herrmann, 1991b). Let $0 < \epsilon \in \mu(0)$. Then there exists an internal hypercontinuous hypersmooth $H_\epsilon\colon {}^*\mathbb{R} \to {}^*\mathbb{R}$ such that $\forall x \in {}^*(-\infty, 0],\ H_\epsilon(x) = 1/(x - \epsilon)$ and $\forall x \in {}^*(-\infty, 0) \cap \mathbb{R},\ \mathtt{st}(H_\epsilon(x)) = \mathtt{st}(1/(x - \epsilon)) = 1/x$; and for $x = 0,\ H_\epsilon(0)$ exists, although $\mathtt{st}(H_\epsilon(0))$ does not exist as a real number. Further, $\forall x \in (2\epsilon, +\infty) \cap \mathbb{R} = (0, +\infty),\ \mathtt{st}(H_\epsilon(x)) = 0$. To obtain the hypercontinuous hypersmooth f_M, simply let $cf_M = H_\epsilon,\ x = \lambda,\ R^m \in {}^*\mathbb{R}$.

In order to motivate the selection of these functions, first recall that a function f defined on interval I is standardizable (to F) on I if $\forall x \in I \cap \mathbb{R},\ F(x) = \mathtt{st}(f(x)) \in \mathbb{R}$. Now, consider the transformation (**) in the nonstandard form $dU^m = dt^m + f_M(R^m)dR^m$ where internal $f_M(R^m)$ is a function defined on $A \subset {}^*\mathbb{R}$, and $\lambda = \lambda(R^m)$. There are infinitely many nonstandard functions that can be standardized to produce the line element dS^2. In this line-element, consider substituting for the function $\lambda = \lambda(R^m,)$ the function ${}^*\lambda - \epsilon$. The transformed line-element then becomes, prior to standardizing the coefficient functions (i.e. restricting them the natural world),

$$
\begin{gathered}
T = ({}^*\lambda - \epsilon)c^2((dU^m)^2 - 2f_M dU^m dR^m + f_M^2 (dR^m)^2) - \\
(1/({}^*\lambda - \epsilon))(dR^m)^2 - \\
(R^m)^2(\sin^2\theta^m (d\phi^m)^2 + (d\theta^m)^2) = \\
({}^*\lambda - \epsilon)c^2(dU^m)^2 - 2({}^*\lambda - \epsilon)c^2 f_M dU^m dR^m + \\
\overbrace{(({}^*\lambda - \epsilon)c^2 f_M^2 - (1/({}^*\lambda - \epsilon)))dR^m}^{b}\, dR^m - \\
(R^m)^2(\sin^2\theta^m (d\phi^m)^2 + (d\theta^m)^2). \qquad (30)
\end{gathered}
$$

Following the procedure outlined in Herrmann (1989), first consider the partition $\mathbb{R} = (-\infty, 0] \cup (0, 2\epsilon] \cup (2\epsilon, +\infty)$, where ϵ is a positive infinitesimal. Consider the required constraints. (2) As required, for specific real intervals, all coefficients of the terms of the transformed line-element are to be standardized and, hence, the simplest are extended standard functions. (3) Since any line-element transformation, prior to standardization, should retain its infinitesimal character with respect to an appropriate interval I, then for any infinitesimal dR^m and for each value $R^m \in I$ terms such as $G(R^m)dR^m$, where $G(R^m)$ is a coefficient function, must be of infinitesimal value.

For the important constraint (3), Definition 4.1.1, and theorems 4.1.1, 4.1.2 in Herrmann (1991a) imply that for a fixed infinitesimal dR^m in order to have expression b infinitesimal as R^m varies, the coefficient $h(R^m) = ({}^*\lambda - \epsilon)c^2 f_M^2 - 1/({}^*\lambda - \epsilon)$ must be infinitesimal on a subset A of an appropriate interval I such that $0 \in A$. The simplest case would be to assume that $A = {}^*(-\infty, 0]$. Let standard $r \in A \cap \mathbb{R}$. Then it follows that $h(r) \subset \mu(0)$. Thus $\mathtt{st}(h(r)) = 0$. Indeed, let $x \in (\cup\{\mu(r) \mid r < 0,\ r \in \mathbb{R}\}) \cup (\mu(0) \cap A)$. Then $\mathtt{st}(h(x)) = 0$. Since we are seeking a transformation process that is hypercontinuous, at least on ${}^*(-\infty, 0]$, this last statement suggests the simplest to consider would be that on ${}^*(-\infty, 0]$, $h = 0$. Thus the basic constraint yields the basic requirement that on ${}^*(-\infty, 0]$ the simplest function to choose is $cf_M(x) = 1/(x - \epsilon)$. Since standardizing is required on ${}^*(-\infty, 0) \cap \mathbb{R}$, we have for each $x \in {}^*(-\infty, 0) \cap \mathbb{R}$, that $\mathtt{st}(cf_M(x)) = c\mathtt{st}(f_M(x)) = \mathtt{st}(1/(x - \epsilon)) = 1/x$. This leads to the assumption that on $(-\infty, 0]$ the function $f_k(x) = 1/(x - k),\ k > 0$, should be considered. After *-transferring and prior to standardizing, this selection would satisfy (3) for both of the coefficients in which f_M appears and for the interval $I = {}^*(-\infty, 0]$. The function g_k is arbitrarily selected to satisfy the hypercontinuous and hypersmooth property and, obviously, h_k is selected to preserve the original line-element for the interval $(2\epsilon, +\infty)$. Finally, it is necessary that the resulting new coefficient functions, prior to standardizing, all satisfy (3) at least for a fixed dR^m and a varying $R^m \in {}^*(-\infty, 0]$ for the expression (**). It is not difficult to show that $|H_\epsilon(x)| \leq 2/\epsilon$ for all $x \in {}^*\mathbb{R}$. Consequently, for $\epsilon = (dR^m)^{1/3}$ expression (**) is an infinitesimal for all $R^m \in {}^*\mathbb{R}$.

Let $1 - v^2/c^2 = \lambda$. For the collapse, scenario $R^m = 2GM/c^2$. If $2GM/(R^m c^2) < 1$, substituting $2GM/R^m = v^2$, into $(13)_k$, yields the so-called Schwarzschild line-element. With respect to the transformation, (A) if $R^m < 2GM/c^2$, then for $\mathtt{st}(f_M(R^m)) = 1/(c\lambda),\ \lambda = 1 - 2GM/(R^m c^2)$; for (B) $R^m > 2GM/c^2$; $\mathtt{st}(f_M(R^m)) = 0$, and for the case that (C) $R^m = 2GM/c^2$, the function f_M is defined and equal to a NSP-world value $f_M(R^m)$. [It is a Robinson infinite number. Such numbers have very interesting algebraic properties and are not equivalent to the behavior of the concept being considered when one states that something or other "approaches infinity." (Also see Article 2.)] Now, for case (C), $\mathtt{st}(f_M(R^m))$ does not exist as a real number. Hence, (C) has no direct effect within the natural world when $R^m = 2GM/c^2$, although the fact that $f_M(R^m)dR^m$ is an infinitesimal implies that $\mathtt{st}(f_M(R^m)dR^m) = 0$. Using these NSP-world functions and (30), cases (A) and (C) yield

$$dS_1^2 = \lambda(cdU^m)^2 - 2cdU^m\, dR^m - (R^m)^2(\sin^2\theta^m(d\phi^m)^2 + (d\theta^m)^2). \tag{31}$$

But case (B), leads to the Schwarzschild line-element. The two constraints are met by $f_M(R^m)$, and indeed the standardized (A) form for $f_M(R^m)$ is unique if (3) is to be satisfied for a specific interval.

Since this is an ideal approximating model, in order to apply this ideal model to the natural world, one must select an appropriate real k for the real valued function H_k. Finally, it is not assumed that the function g_k is unique. For solutions using line-element (31), the dU^m [resp. dR^m] refers to the timing [resp. length] infinitesimal light-clocks.

If one is concerned with how this theory of gravity compares with the Einsteinian theory, then for a given positive non-infinitesimal k the transformations in terms of such an k do not satisfy the (restricted) Einstein gravitational law. The new transformation required in the transitional zone is not a proper transformation at but the one point $k/3$ where it does not have a local inverse. Continuity considerations can be applied on either side of this point. Since within this zone the R^m is assumed to change very little, then to analyze effects in this zone it seems reasonable to assume that a behaves as a constant.

The above method for transforming one line-element into another to minimize singularities, so to speak, can be done for other transformations. Our use of the Eddington-Finkelstein transformation is but an illustration, although in the next section, based upon the concept of simplicity, it will be used in a brief investigation of the non-rotating black hole concept. It will be shown how a black hole can exhibit interesting white hole characteristics when properton field expansion is included.

7. Applications

How should distance be measured when such line-elements as the Schwarzschild, (26), (27) or (31) are investigated? For measurements relative to a Special Theory scenario Einstein distances, velocities or times are appropriate for the measurements. **The infinitesimal light-clocks yield how the physical universe is being altered by the (emis) effects.** This is all that this entire theory represents. As pointed out by Fock (1959, p. 177, 351), such concepts only have meaning when they are compared to similar concepts more closely related with human intuition. Basic intuition at the most local level is obtained through our use of a Euclidean system. But we also live in an approximate exterior (gravitational) Schwarzschild field. To investigate how new gravitational effects alter behavior, these new effects should be compared with behavior essentially not affected by the specific gravitational field effect being considered. Such comparisons are made with respect to the measurements made by local infinitesimal light-clocks used as a standard. Depending upon the problem, these may be taken as the "s." For comparison purposes, the measurement of distance between two fixed points, where the distance measure is considered as being physically altered by (emis) effects, the "radar" or "reflected light pulse" method would be appropriate. The same would hold for the linear effect line-element. Of course, this is actually the behavior of an electromagnetic pulse (a photon) as it is being affected by (emis). Thus to obtain such measurements, let dS^2 or $dS_1^2 = 0$ and consider only the radial part for the Schwarzschild and (31), or the entire line-element for the linear effect (26) and (27). For $(13)_a$, this gives $(dR^m)^2 = (\lambda)^2(cdt^m)^2$. Taking, say $(1/\lambda)dR^m = cdt^m$. Let $R_1^m,\ R_2^m$ be light clock measured distances from the center, assuming both are exterior to the Schwarzschild radius, taken at light-clock times $t_1^m,\ t_2^m$. These light-clocks have been altered by the exterior Schwarzschild field. For the Schwarzschild field, this gives

$$c(t_2^m - t_1^m) = R_2^m - R_1^m + r_0 \ln\left[\frac{R_2^m - r_0}{R_1^m - r_0}\right], \tag{32}$$

where $r_0 = 2GM/c^2$. Of course, for the quasi-Schwarzschild case, (32) has a slightly more complex form. The reason we have such an expression is that, compared to the to no gravitational field, the path of motion of such a pulse is not linear.

One of the more interesting coordinate transformations used in the Einsteinian theory is the Kerr transformation for a rotating body. Analysis of the pure vacuum Kerr solution yields some physical science-fiction type conclusions (Ohanian, 1976, p. 334). Ohanian states that these conclusions are physically meaningless unless ". . . a white hole was – somehow – created when the universe began" (1976, p. 341). He also mentions that such objects would probably not survive for a long "time" due to the instability of white holes, and the like, within the pure Kerr geometry. The possibility that a non-rotating black hole can be altered into a pseudo-white hole will be investigated using the notions from the previous section. This will not be done using another science-fiction type transformation, the Kruskal space. As pointed out by Rindler (1977, p. 164), this space also suffers from numerous "insurmountable difficulties" and the full Kruskal space probable does not exist in nature.

Referring back to the previous section, consider a *transition zone* for a given k. This zone is for all $\lambda = 1 - (v_p + d)^2/c^2 \in (0, 2k]$. The transition zone motion of photons and material "particles" can be investigated. As in the case of expressions such as (32), the mathematical analysis must be properly interpreted. To do this, physical entities must be characterized as behaving like a "photon" or like a "material particle." You will almost never find a definition of the notion of the "material particle" within the literature. Since this is the infinitesimal calculus, then, as has been shown (Herrmann, 1991a), the "material" particle is an (not unique) infinitesimal entity that carries hyperreal material characteristics. However, such a particle does not affect the standard field (i.e. the field exterior to the Schwarzschild surface still behaves like a gravitational vacuum). When one investigates the paths of motion or other physical concepts for such material particles as they are measured by infinitesimal light-clocks, the proper interpretation is to state that the physical property is affected by the (emis) as it is altered by the NSPPM <u>and</u> as it is compared with the non-altered (emis) effects.

To analyze properly particle behavior, we have three partial line-elements, that represent radial behavior. These partial line-elements are

$$d\ell^2 = (\lambda - k)(cdt^m)^2 - (1/(\lambda - k))(dR^m)^2,$$

$$d\ell_1^2 = (\lambda - k)(cdU^m)^2 - 2cdU^m dR^m,$$

$$d\ell_t = (\lambda - k)c^2(dU^m - (1/c)g_k dR^m)^2 - (1/(\lambda - k))(dR^m)^2, \tag{33}$$

where $d\ell_1$ is applied when $\lambda < 0$, $d\ell_t$ is applied when $0 < \lambda < 2k$, and $d\ell$ is applied when $\lambda > 2k$. For most analysis, the conclusions are extended to $\lambda = 0, 2k$ by continuity considerations.

Rather than give a complete analysis of the above line-elements in this article, we illustrate how it would be done by considering the general behavioral properties for electromagnetic radiation and material particles. If there was no altering gravitational field present, then we have that, for radiation, $dS^2 = 0 = c^2(dt^m) - d(R^m), s = m$. Hence, we have that $dR^m/dt^m = \pm c$. The selection is made that $dR^m/dt^m = c > 0$ represents "outgoing" radiation and that $dR^m/dt^m =$

$-c < 0$ represents "incoming" radiation. For material particles, we have the concept of incoming and outgoing particles as they are modeled by the general statement that $\pm dR^m/dt^m < c$. Lawden (1982, pp. 155–157) correctly analyzes the cases for $d\ell$ and $d\ell_1$. His analysis holds for the case of the quasi-Schwarzschild field as well. Both incoming radiation and particles can pass from the exterior quasi-Schwarzschild field into the transition zone and if they can leave the transition zone, they be forced to continue towards the center of attraction, where, for this analysis, one may assume that the mass is concentrated. Further, no material particle or radiation pulse can leave the region controlled by $d\ell_1$. What happens in the transition zone?

If one analyzes what effects occur in the transition zone in terms of t^m and R^m, one finds that there is a general photon turbulence depending upon the different photon "families" predicted by the statement that $dR^m/dt^m = \pm c(\lambda - k)$, where $0 < \lambda < 2k$. A Lawden type analysis for material particle behavior also leads to a particle turbulence within the transition zone.

Now as suggested by Ohanian, what happens if the universe is formed and a homogeneous sphere appears such that its physical radius R implies $\lambda \leq 2k$? For simplicity, it is assumed that for the following speculative scenario that, with respect to these pure gravitational line-elements, $d = 0$

(1) Since the entity being considered, under a special process, could appear when the universe is formed, then the actual material need not be the same as a neutron star and the like. Of course, this does not necessarily assume the Big Bang cosmology but does assume that the Laws of Nature also appear at the moment of formation. [This possibility comes from the MA-model scenario (Herrmann, 1994b).] Suppose that the material is malleable with respect to the gravitational force. If there is any "space" outside of the radius R^m, then the Schwarzschild field would apply in this vacuum. [Recently using a different argument and assuming the entire Einsteinian theory, Humphreys (1994) has speculated that the material could be ordinary water!]

(2) During the transitional phase, the apparent turbulent physical behavior for the material particles would tend to keep a certain amount of material within this zone as the gravitational collapse occurs with respect to the remaining material. This has the effect of producing a "halo" or a spherical shell that might or might not collapse along with the material that has been separated from the material that has remained within the transition zone. Collapse of this shell would tend to depend on its density, the actual continuation of the collapse and numerous other factors.

Unless something were to intervene after collapse began, then the usual black hole scenario would occur. In the next and last section of this article, we speculate upon such an intervention.

8. Prior to Expansion, Expansion and Pseudo-White Hole Effects.

The concept of the white hole is almost always developed by considering "time reversal." Although the timing infinitesimal light-clock can be oriented with a non-positive orientation, this process may not be necessary for certain cosmological events to occur. If one assumes that the investigated black hole is formed, then there is a vast number of diverse black hole scenarios highly dependent upon many parameters that have been held fixed for our previous investigations. The notions of spherical symmetry, uniform density, uniform expansion, gravitational vacuum states, and the like, will in reality be violated. In this theory, as well as the Einstein theory, the assumptions made as to the simplicity of the Newtonian potentials will certainly be violated in a real expanding universe. Although it might be possible to substitute a new potential velocity v_p for the simple one presented here, say in the case of a bounded universe, in reality other competing potentials will preclude such a simplistic approach. Thus any speculative description for how a black hole could actually change in such a manner to produce white hole effects, and even produce some effects associated with a Big Bang cosmology, must be very general in character. Further, these speculations probably cannot be arrived at by strict mathematical analysis. This leaves these speculations to descriptions generalized by means of human intuition. This further weakens their application since it assumes that the human mind is capable of comprehending, even on the most general level, the actual processes that yield the development of the universe in which we dwell. I caution the reader to consider these facts while examining the next speculative descriptions.

First, the real values for the basic expansion function a (i.e. $\mathtt{st}({}^*a) = a$) are controlled from the NSP-world. Indeed, it is a connection between the properton field and the natural world. Since observation from the NSPPM is the preferred observation, then, as mentioned, one might assume that there is a preferred coordinate system within the properton field and that the values of d can depend upon specific locations within the natural world. This, of course, includes the special case where d depends only upon the t^s and the Copernican principle is applied, as well as the restrictive case that the universe actually has a center and expansion is with respect to that center. Even if one assumes the Copernican principle, it need not be assumed that the radial expansion follows this simplistic pattern *when viewed from every position.*

In what follows, certain simplistic assumptions are made relative to the behavior of the properton field and such assumptions are only assumed to hold in a neighborhood of the black hole. Five possible scenarios are presented. It might not be possible to differentiate scientifically these scenarios one from another by any observational means from our present epoch. For this reason, an individual's selection of one of the numerously many scenarios will probably involve philosophical considerations rather than scientific data.

(1) Suppose that at formation scenario (2) of section 7 occurs and the halo is separated from the remaining material and the malleable material undergoes gravitational collapse. No superimposed expansion occurs. That is ${}^*a$ is an infinite hyperreal number. Suppose that at a particular moment based upon collapse factors, an extreme rate of spatial expansion occurs. This would radically alter the density of the collapsed malleable material. The material captured in the transition zone, since the zones size is fixed and the gravitational effects in this zone are based upon the gravitational field produced by the collapsing material, would expand beyond that zone and continue to "move outward" with respect to the center of the collapsing material (i.e. the center of attraction). Under exceptional critical values for the parameters involved, it is possible that the expansion rate is so great and the density is reduced to such an extent that the assumed symmetric collapsing material actual increases its radius to a point that would rapidly go beyond the original Schwarzschild radius, and beyond the transition zone. This reduces the original Schwarzschild radius due to the loss of mass and would alter greatly the predicted behavior since the simple potential velocity and spherical symmetry would certainly be altered.

As previously derived, the alterations in many physical processes due to the gravitation field would probably still occur "near" to the new Schwarzschild radius. These alterations would tend to "slow" down certain processes when compared to a standard. On the other hand, if the standard is considered as having values near to the new Schwarzschild surface, then the processes would seem to "increase" within the material that expanded to great distances beyond the new Schwarzschild surface. Depending upon critical values associated with the expansion, the composition of the material, and the "explosive" effects, the new Schwarzschild surface could slowly continue to shrink.

The composition of the material that has expanded beyond the original Schwarzschild surface depends upon whether or not the collapsing material follows the known laws of quantum mechanics. These laws need not apply since we have no laboratory verified knowledge of exactly how extreme gravitational potentials affect quantum behavior. What can be assumed is that a great deal of "cooling" might take place along with the great increase in expansion. I mention the theoretically derived result that a properton composed field is capable of drawing off energy, even in vast amounts. Depending upon many factors, there could be a great deal of collapsed material forced beyond the previously located Schwarzschild surface. This process might, of course, stop the gravitational collapse. To an outside observer there might appear to be a spherical material shell expanding from the previous black hole with a great deal of additional material between this shell and the remnants. This "explosion" of material from a specific position in space corresponds to one white hole aspect. This is a pseudo-white hole effect. The effect would also be similar to the appearance of a supernova. I point out that extreme and varying expansion rates have been postulated previously (Guth, 1981).

(2) Consider the scenario described in (1) with the exception that the transition zone is empty and collapse begins at the edge of the transition zone at formation.

(3) Consider the scenario described in (1) with material in the transition zone, but at formation there is a separation between the transition zone and the collapsing material at the moment of formation.

(4) Consider the scenario described in (1) with the exception that there is no material in the transition zone and there is a separation between the transition zone and collapsing material at the moment of formation.

(5) Modify the previous scenarios by considering the infinitely many variations brought about by diversions from the ideal uniform and homogeneous behavior.

Of course, if there was no black hole formed, then the above speculations are vacuous. Further, I am convinced that this corrected theory is capable of predicting all of the actual verified effects that are associated with the Einstein theory. It specifically shows that all such effects are caused by an (emis). Also, this corrected theory shows, once again, that there is not one theory that predicts such behavior. Hence, this article establishes that the selection of any theory for the development of our universe must be based upon considerations exterior to theoretical science.

As previously mention, recently Humphreys (1994) has proposed a theory for the formation of the entire universe by assuming that the entire universe was produced by such a black hole. His theory uses concepts from Einstein's theory, which I reject, and assumes that the rapid expansion is caused by a sudden change in the cosmological "constant." His scenario is very similar to (4) above. He assumes that the cosmos is bounded and that formation occurs at a specific point, say at the center of the black hole, which, at the moment of formation, is composed of ordinary water. The above corrected theory also applies to a bounded cosmos with its gravitational center of mass. Humphreys includes various descriptions for physical changes that might occur within the black hole while undergoing gravitational collapse. His selection of one of the above general scenarios is based entire upon a philosophical stance. Indeed, it appears that scenario (3) might have been a slightly better choice.

[Note added 1 June 1998, corrected 28 March 1999. It appears that Humphreys' model as stated may fail to achieve the goals claimed in a few instances. First, the present day cosmological constant Λ is estimated to be no larger than 10^{-56}cm^{-2}. Humphreys uses the Schwarzschild configuration, the vacuum solution and the classical Schwarzschild surface (i.e. event horizon) throughout his discussions, especially relative to the geometry <u>exterior</u> to such a surface. Due to the dust-like properties of matter interior to this surface and due to a comparatively large cosmological constant, the collapse scenario for the dust-like material would be overcome and the material would escape through the event horizon and give a white hole effect. (However, this scenario does not appear to have all of the actual white hole properties.) He states, "I suggest that the event horizon reached earth early in the morning of the fourth day." (Humphreys, 1994, p. 126) The earth here is a type of "water-world" that has stayed "coherently together." (Humphreys, 1994, p. 124) The event horizon also remaines approximately in that position the entire "fourth day." Humphreys discusses the Klein line-element and the Schwarzschild line-element without the cosmological constant. However, it is necessary that the cosmological constant be considered and other line-elements that include the cosmological constant should be investigated prior to acceptance of this model. For example, consider the modified Schwarzschild solution where the significant expression is $1-2GM/(c^2r)-(1/3)\Lambda r^2 = 0$. A simple calculation, using 6.67×10^8cm as the radius of earth and .889cm as the value for $2GM/c^2$ yields $\Lambda = 7.39 \times 10^{-18}/\text{cm}^2$. Humphreys states that the cosmological constant is to be set at a large value on day two of his creation model in order to produce a "rapid, inflationary expansion of space." (Humphreys, 1994, p. 124) This does not appear to be the large value of the cosmological constant that Humphreys is considering in order to obtain the necessary rapid inflationary expansion as shown in the Moles paper cited by Humphreys. More importantly, if this value is inserted into this modified Schwarzschild expression with the mass of the universe, then the event horizon that was at 450×10^6 lyr suddenly vanishes, indeed, no event horizon exist. This yields a direct contradiction. (Including a term for "charge," in the above, will not significantly affect these results.)]

I would like to thank T. G. Barnes and R. J. Upham who supplied certain important references that led to many improvements in this paper. [See note 8, parts 1, 2, 3, 5.]

NOTES

[1] I have been asked to more fully justify my statement in Article 3 of the "Foundations . . . ." paper, just below equation (12). The basic characterizing equation in line 14 is $\alpha+\beta(1-\alpha^2) = 0$. The notation used assumes that we are working in real and not complex numbers. The expression $\alpha = \pm\sqrt{1-\eta}$ characterizes η such that $\sqrt{1-n} \geq 0$. The combined velocity $v+d$ has the property that $0 \leq v+d$. Consider the case that $0 < v+d$ and suppose that $\alpha = \sqrt{1-\eta}$. Then from the line 14 expression we have that $\eta\beta = -\sqrt{1-\eta}$. This also tells us that $\eta \neq 0$. Hence we may write $\beta = -\sqrt{1-\eta}/\eta$. Now substituting into (B) ($dT^s = \beta dR^m + dT^m$) yields (i) $dT^s = -(\sqrt{1-\eta}/\eta)dR^m + dT^m$ and into (C) ($dR^s = (1-\alpha\beta)dR^m - \alpha dT^m$) yields (ii) $dR^s = dR^m/\eta - \sqrt{1-\eta}dT^m$. Combining the two differentials yields the requirement that

$$\frac{dR^s}{dT^s} = \left[\frac{1}{\eta}\frac{dR^m}{dT^m} - \sqrt{1-\eta}\right] \div \left[-\frac{\sqrt{1-\eta}}{\eta}\frac{dR^m}{dT^m} + 1\right]. \tag{1}$$

Now consider $dR^m = 0$ in (i) and (ii). Then we have that for $v+d \neq 0$, $(v+d)/c = -\sqrt{1-\eta} < 0$. This contradicts the original requirement for this case that $0 < v+d$.

Note that in modern infinitesimal analysis the actual combining process to obtain (1) is not division, although the result is the same but the function interpretation is important. (i) states that $dT^s/dT^m = -(\sqrt{1-\eta}/\eta)(dR^m/dT^m) + 1$, (and nonzero since t^m is dependent upon v) $\Rightarrow$ $dT^m/dT^s = (-(\sqrt{1-\eta}/\eta)(dR^m/dT^m)+1)^{-1}$ and from (ii) $dR^s/dT^m = (1/\eta)dR^m/dT^m - \sqrt{1-\eta}$. Application of the chain rule leads to (1).

[2] One of the more difficult aspects of this research is to disregard the classical interpretations of Einstein's theories and to interpret the mathematical statements in a simple and consistent manner. Notice that the chronotopic interval expressions $(4)_a$, $(4)_b$, $(5)_a$, $(5)_b$ are stated in terms of subscripts and superscripts. The infinitesimal light-clocks being modeled by these expressions have two distinct interpretations. One is that they represent the "actual" u or L associated with an infinitesimal light-clock, the other is that they are but analogue models for the (emis) effects.

Usually, the left-hand sides represent "actual" infinitesimal light-clock and how the light-clock is altered with respect to motion by the NSPPM. For these four expressions, the right hand side represents unaffected infinitesimal light-clocks located in the proper coordinate positions and how they would "measure," the "actual" changes that take place within the the two "actual" NSP-world measuring infinitesimal light-clocks.

The expressions $(4)_a$, $(4)_b$, $(5)_a$, $(5)_b$ are what is gleaned from the most basic laboratory observations within the N-world relative to electromagnetic propagation and are not, as yet, related to possible (NSP-world) NSPPM physical-like properties that produce these effects. Possible NSPPM physical properties are investigated by using expressions such as (8) and (A), (B). Coordinate transformations, if made, are relative to possible NSPPM physical properties. Suppose that these measuring infinitesimal light-clocks are affected by this P-process. We seek a relationship $\phi(dR^m, d\theta^m, d\phi^m, dt^m)$ between altered behavior of these infinitesimal light-clocks as they would appear for the measuring infinitesimal light-clocks so that $L\Pi_m = \phi(dR^m, d\theta^m, d\phi^m, dt^m)$.

The results of this approach indicate that the quantities now denoted by the superscript m represent N-world measurements with respect to coordinate infinitesimal light-clocks that incorporate the (emis) effects. These measurements are taken relative to the coordinate transformation. It is clear from our letting $R^m = R^s$, $\theta^s = \theta^m$, $\phi^s = \phi^m$ and other considerations that the measuring devices used to measure these qualities are not, at the moment, being considered themselves as being altered by the P-process. However, the reason for now using such a variable in the form R^m is that relative to the hyperfinite approach to integrals, in general, the values of R^m or any function in R^m are not constant, in general, but depend upon each subdivision. Thus, such variables as R^m represent a type of cumulative alteration from the standard R^s. The method used to find the value of η after equation (12), where dR^m/dT^m has been set to zero, should be considered as an initial condition for the static behavior of P or other behavior that yields $dR^m/dT^m = 0$.

After the line-element is obtained, the next step is to interpret the element relative to its effects upon other entities. There are arguments that show that such a *re-interpretation* is viable by means of the test particle concept which itself does not essentially alter the field. The behavior to be calculated is N-world behavior. Thus, a test particle can be conceived of as a physical infinitesimal light-clock.

When this derivation of the Schwarzschild line-element is used to investigate planetary motion, $\theta^m =$ constant. Then the dt^m and dS are eliminated to obtain an expression in terms of R^m and ϕ^m. Rather than use the concept of geometric geodesics, Fermat's general principle of least "time" or "action" can be applied. This leads to the same partial differential equations as would the geodesic approach. The resulting variables ϕ and R can be measured with respect to any standard by the observer. Exactly the same variables are used for the measurement of the possible deflection of electromagnetic radiation by massive bodies.

[3] There is a slight confusion as to my use of the term "invariant" with respect to dS^2. The term "invariant" only refers to its "value." How does one relate this inf. light-clock approach to the classical one? For clocks, the classical approach claims to present expressions for time measurements for all clocks. But, for many circumstances, time needs to vary continuously. There is no such clock that has this property. So, the classical approach is but an approximation. But, it uses the notion of infinitesimalizing. The only physical behavior that most closely approximates infinitesimal behavior is subatomic photon behavior. Hence, I chose the light-clock for both time and distance measures. The inf. light-clock is, of course, a conceptual model. It also allows us to show how photons locally behavior for various v_p .

Of course, one can immediately return to the classical approach by symbol substitution but must explain them. For example, for a gravitational field if the m and s superscripts are dropped in $(13)_a$, let $dS = ds$, and, state the variables that now appear represent measures where there is no gravitational field, you can derive the classically expressed Schwarzschild line element.

These articles are intended as a mere beginning and as an indication of an appropriate method. Not all reasonable and superimposed physical processes have been considered. Further research, by individuals other then myself, relative to other reasonable physical NSPPM processes should provide additional confirmation that this approach is viable.

[4] The concept of the linear effect line-element is significant in that it yields a NSPPM physical reason for Special Theory effects. Notice that so as not to confuse this with the spherically transformed line-element, dr^s replaces dR^s and dr^m replaces dR^m. Further, the method used to obtain the transverse Doppler and the mass variation predictions replaces the r^m and the t^m (emis) effect quantities with measurable N-world quantities. (See note [19]).

[5] If for various investigations variables such as τ and t^m cannot be replaced by other measurable quantities, then the concept of the proper time is replaced by an "actual" NSP-world measure of the infinitesimal light-clock time as registered by the test particle itself. The "coordinate" time t^m is conceived as related to an N-world light-clock that is affected by the NSPPM and that can only approximate an infinitesimal light-clock. Further, the infinitesimal light-clock used to measure this "coordinate time" is measuring just one aspect of the (emis) effect. Under certain circumstances, such as investigating the Schwarzschild line-element for test particles approaching the Schwarzschild surface, the NSP-world time measure $u\Pi$ has different properties than the N-world time measure. Thus these two differences in "time" measurements does not lead to a contradictory. This is similar to the Special Theory statement that the relative velocity w is an unbounded NSP-world measure while the N-world Einstein measure v_E is bounded.

[6] For the case of electromagnetic radiation, the linear effect line-element refers only to the Ives' interferometer case of two fixed positions F_1 and F_2 having $v_E = 0$ (i.e. a to-and-fro "linear" light path scenario). In which case, the Fermat's principle (or "geodesic") approach leads to the two differential equations $dt^m/d\tau = K$ and $K^2(dr^m/dt^m)^2 - c^2K^2 = 0$. Since, in general, $K \neq 0$, this yields that $(dr^m/dt^m) = c$. This corresponds to the laboratory measurement of the to-and-fro velocity of light. $(14)_{\rm a}$, $(14)_{\rm b}$ must be carefully applied within the physical world. (See note [19].) Usually, they applied only to infinitesimal light-clocks where there is an alteration in counts since c is probably altered. This eliminates the need to interpret (8.2), (9.2) as "unit" alterations.

[7] The actual derivation uses the ballistic property within a monadic cluster. This is modeled by a moving point. In the case where the point's velocity is the velocity of the properton field itself, then using the point velocity R^s/a result (29) is obtained. However, it is just as possible that the point is not moving and the P-process is affecting the velocity of c in the manner indicated. This can be produced by various motions of the NSPPM material. Unless there is some other confirmation that d is motion of a point, then this cannot be assumed. Thus this need only be an <u>apparent</u> general textual expansion due to this special effect associated with electromagnetic radiation. What this means that such general expansion need not occur in reality, but rather it would indicate a superimposed property produced by an interaction with the underlying properton field. If this were the case, it would invalidate some of these speculations.

[8] It should be obvious that in these articles I have not attempted to duplicate the approximately 80 years of General and Special Theory work. What has been done is to point out the absolute logical

errors in these theories. Then:

(1) a method is given that retains the concepts associated with photon propagation.

(2) Based upon laboratory observations within our local environment and a privileged observer within the NSPPM, certain conclusions are developed by a strict interpretation of a mathematical structure.

(3) Specific physical descriptions for behavior within the NSPPM (i.e. the P-process) that alter natural world behavior are introduced. These physical processes are then modeled by means of a line-elements that predict the behavior of physical entities as this behavior is measured by infinitesimal light-clocks. This yields intimate relations between such behavior and the properties of electromagnetic propagation. These physical processes and the paths along which they operate have taken the place of the ad hoc coordinate transformations of the Einstein theory.

(4) It is very important to realize that all of our analysis relative to the Special Theory (ST) is local. Indeed, it is relative only to effects within an empty universe. The effects can only be properly measured over local regions where the gravitational potential is considered to be constant and can, thus, be "factored," so to speak, from the measurements. Measurements that might be taken by what could be considered as "large light-clocks" are not analyzed and could give different results. Predictions associated with ST for all of the alterations are based entirely upon very local measurements and uniform relative velocity. These predictions become less accurate when these conditions are altered. Further, as I have shown previously (Herrmann, 1989), so-called constant quantities can actually be considered as but piecewise constant. This piecewise constancy may be considered as a natural world restriction of hypercontinuous and hypersmooth NSP-world processes. We infinitesimalize according to our views of natural world behavior. But as shown by our ST derivation, physical processes within the natural world and the NSP-world might be considered as contradictory if they occurred solely within one of these worlds. Consequently, physical observation and theoretical constructs are needed prior to infinitesimalizing for physical theories. It is very possible that the ST results cannot themselves be infinitesimalized in the mathematical sense that a continuous curve is the standard part of an infinitesimal polygonal path. Only experimental evidence would imply such a process. This means that there can be a considerable difference in (emis) effects for rotation. These effects need not be predictable by application of locally linear ST effects.

(5) I have not combined together the pure ST relative velocity as a d and the gravitational potential velocity v_p due to what I feel is a logical difficulty with the intuitive difference between a "directed" and "non-directed" effect. The d expression used to obtain our Robertson-Walker type line-element assumes, in order for it to have any meaning, that the universe is not empty. Further, always remember that the predictions derived for the Newtonian potentials would not be correct if the potentials took on a more complex character. Considering the alterations in the Newtonian potentials associated with a rotating body could certainly be considered and would lead to another line-element that might compare favorably with the Einsteinian theory. [These effects need not be gravitational but may be centrifugal or the like. It is possible that there are no actual local (emis) gravitational field rotational effects except those countering effects produced by pure rotation itself.] However, in general, their character would be so complex that only very general conclusions could be predicted. The analysis in this article can be extended to include the effects of a Newtonian potential propagated with some specific velocity such as c. This could lead to a Newtonian theory of gravitational propagation. For example, see equation (1) in Surdin (1962, p. 551).

Finally, the idea of potentials and trajectories as modeled by the complex plane has been well established. Hence, it may be profitable to consider, within various line-elements, complex valued v,

d or $v + d$ when they model potentials or tensions. Indeed, for pure complex d and $v = 0$ this would lead, in many cases, to a reverse in the alterations of various measures. If this is a NSPPM effect, then a P-process within the NSPPM need not be considered except that such processes should be predicted within the natural world prior to determining which measures will be altered.

[9] The derivation that appears here is the correct simplified derivation and replaces the the overly complex derivation that appears in the published version Herrmann, R. A. An operator equation and relativistic alteration in radioactive decay, Internat. J. Math. and Math. Sci., 19(2)(1996):397-402. This published version also contains some notational errors.

[10] Relative to equation (28), the d is selected for the obvious purpose. Although the d is used, with $v = 0$, this, of course, can be reversed. Further, there are two superimposed aspects within the universe. One is where v is considered as an actual velocity and the other is where v is considered as a potential velocity. For consistency, it might be that the same two aspects can be used with equation (28). This is the line-element that leads to the expansion redshift. But, it is possible that a superimposed second effect can occur. A natural property of some fields is a tension property. Thus there might be a superimposed second aspect relative to such a tension property. Then the d would represent such a tension. In this case, the tension could be both NSP-world position and time dependent. Following the exact same procedures as previously presented, such a tension could also alter physical processes. For example, it could "slow them down" so to speak with respect to a standard. There is also one other interesting aspect to all of these line-elements. If either v or d are say pure nonzero complex numbers, then the exact same methods used to determine alterations in physical measures can be applied and will yield the exact reverse of such alterations. If an alteration for a real v or d is a decrease in some measure, then the alteration in a measure using a vi or di would be an increase in the measure.

[11] (29 MAY 1997) The most absurd statement ever made by intelligent individuals is that physical processes or entities actually alter the behavior of the concept called "absolute time" and such an alteration is reflected by alterations in natural processes or in the characteristics of various physical entities. The same can be said for those that rejected such a "time" alteration and replaced it with an alteration in the concept of "absolute length." The most basic assumption within natural science is that all natural-system behavior is altered either by an alteration in characteristics of the entities themselves or such behavior is altered by an interaction with natural entities. Unless "time" is a natural entity, a particle or a field or whatever, then such a statement is absurd. It has never been demonstrated that "time" corresponds to one of these types of physical entities. What is altered is observer time.

Although I have mentioned it previously, the results in this book do not overthrow the Einsteinian General Theory of Relativity. What has been altered is the very basic interpretation and foundations of the Einsteinian theory. It is well-known that the Hilbert-Einstein gravitational field equation has solutions that do not correspond to the universe that many members of the scientific community accept. Full Kerr or Kruskal geometries contradict the standard cosmological model. What is being established is that the language of Riemannian geometry is not the language of reality. Riemannian geometry is but an analogue model for behavior within a gravitational field. The Patton and Wheeler remarks state strongly this same conclusion. "Riemannian geometry likewise provides a beautiful vision of reality; but it will be useful as anything we can do to see in what ways geometry is inadequate to serve as primordial building material . . . 'geometry' is as far from giving an understanding of space as 'elasticity' is from giving an understanding of a solid." Such phrases as "curved space-time" are but technical phrases that are not to be associated with real physical entities according to the basic ideas associated with the concept termed a "pre-geometry." As demonstrated the properton field and the NSPPM model may be the true objective reality.

After the basic concepts that associate gravitational fields with geometric terminology are introduced, Marzke and Wheeler, using such concepts, describe the construction of a type of absolute clock they call the "geometrodynamic clock." This clock is similar to my infinitesimal light-clock. However, the infinitesimal light-clock is a fundamental entity within the theory presented here and is not introduced after the model is constructed. The generation of certain line elements from physical considerations, **not** related to the language of Riemannian geometry, is significant in that it tends to indicate that all physically meaningful line-elements that satisfy the Hilbert-Einstein gravitational equation could also be so generated. From these considerations, one could conclude that all of the consequences of the Einsteinian theory that apply to an actual physical universe should be interpreted in terms of infinitesimal light-clocks. That is; these conclusions alter such light-clock behavior. How does this influence our view of the actual relationship between gravitational fields and those physical entities the fields are predicted to affect?

In 1904 at the International Congress of Arts and Sciences held in St. Louis, Poincaré gave a talk entitled "The present and future of mathematical physics." In his researches, he could not eliminate a certain constant c, the velocity of light in a vacuum, from any of his conclusions. He explained this fact as follows: "(1) Either there exists nothing in the universe that is not of electromagnetic origin; (2) or, this, which is common to all physical phenomena, appears only because it relates our methods of measurements." As discussed above, the material in this book shows that Poincaré may have been partially correct. For, relative to this re-interpretation and the properton field pre-geometry, it is probable that all natural-system behavior is related to the properties of electromagnetic radiation and this relation is developed by considering one and only one mode of measurement; the light-clock.

What appears in this little book is that there is a measure that can be used as an model for alterations in certain behavior of the natural process called the propagation of electromagnetic radiation. This is what leads to alterations in natural-system behavior. The alterations can best be comprehended by introducing the nonstandard physical world (NSP-world) model. Further, verification of each prediction made by the theory presented here or the re-interpreted Einsteinian theory gives strong, albeit indirect, evidence that something like the NSP-world might exist in objective reality. However, rejection of the reality of the NSP-world does not preclude the use of such a concept as a model.

(18 JULY 1999) An external approach has been used to obtain the general line-elements discussed in this book. This means that no attempt has been made to associate changes of infinitesimal light-clocks with any modern field or particle theory other than the basic requirement that it all be properton controlled. There has been an approach that postulates a natural world vacuum electromagnetic zero-point field (ZPF) (Puthoff, 1989) and attributes the potential used above to obtain the Schwarzschild line-element to that induced by *Zitterbewegung* motion on a charged particle, where it is assumed that all matter is composed of charged particles and the *Zitterbewegung* motion is induced by the ZPF. This potential is associated directly with the kinetic energy associated with *Zitterbewegung* motion and this kinetic energy is considered as the gravitational mass effect. Of course, infinitesimal light-clocks are ideal approximators for natural world light-clocks. Haisch, Rueda and Puthoff (1997), state that the ZPF theory needs to be correlated to curved spacetime. If the results using ZPF can be related to light-clocks, then such a correlation would be, at least

partially, achieved.

[12] (18 JULY 1999) The superscript and subscript s represents local measurements about the s-point, using various devices, for laboratory standards and using infinitesimal light-clocks or approximating devices such as atomic-clocks. [Due to their construction atomic clocks are effected by relativistic motion and gravitational fields approximately as the infinitesimal light-clock's counts are effected.] All measures, rate of changes and the like, should be viewed via comparison. [See note 18.] The superscript or subscript m, for the Special Theory, indicates how, with respect to the measures s, the motion of the m-point with a specific relative velocity yields physical behavior that differs from that at the s-point. For Special Theory, Π_m for expressions (2) and (3) are obtained as follows: $t_E^{(m)} = (t_1 + t_3)/2$. Then consider $\Pi_m = (\overline{\Pi}_s^{(1)} + \overline{\Pi}_s^{(3)})/2 - (\Pi_s^{(1)} + \Pi_s^{(3)})/2)$ Now Π_m need not be a member of $\mathbb{N}_\infty^+$. If any of the Π is an odd hyperinteger, then replace it with $\Pi + 1$. Then for nonzero $\mathtt{st}(u\Pi_m)$, each term when divided by 2 is a member of $\mathbb{N}_\infty^+$. Hence, in this case, Γ_m can be used in place of Π_m since $\mathtt{st}(u\Pi_m) = \mathtt{st}(u\Gamma_m)$. The Γ_m is an equivalent infinitesimal light-clock count. Indeed, the inf. light-clocks used could have a counter that incorporates this process.

Recall, that due to the presence of the NSPPM, there are absolute physical standards. These are what would be measured from a point f-point fixed in the NSPPM, where the NSPPM relative velocities when viewed in our physical world follow the unusual behavior indicated by equation (4) on page 48. (Added 22 NOV 2007 and extended on 24 JUL 2009.)

For the interpretation of the "s" and "m" for the General Theory see the appendix starting at page 93 on "Gravitational Time-dilation." Previously, infinite Robinson numbers are used to model Einstein measures. Let the infinite number Π denote the infinitesimal light-clock counts that yield, as an example, time measure. The difference between two such measures is denoted by Π'. These differences can be a natural number or even, in some cases, an infinite number and in both cases $u\Pi' \in \mu(0)$. Then the symbol dt^s, generally, means $dt^s \approx u\Pi'$ which includes the interpretation $dt^s = u\Pi'$ in the NSP-world. But for this behavior to be realized in the physical world, then point behavior expressed in terms of such notation needs to be related to standard intervals as is done (6) and (7). Depending upon the usual function requirements that lead to the notions of the definite integral, when passing from the monadic NSP-world to the standard world, the behavior of dt^s and the other differentials in a metric are considered as being infinitely close of order one to the term containing the corresponding altered differential. Further, since all functions are considered as continuous, a gravitational field is closely approximated by a constant field over "small" neighborhoods. This is why comparisons are made relative to the chronotopic or a transformed chronotopic line element.

[13] (9 AUG 1999) In my view, one of the possible causes for ambiguity or contradiction within the General Theory is that, although mathematically such transformations are allowed, physically they need to be interpreted via the theory of correspondence. It is this interpretation that leads to such difficulties. This does not occur in this analysis.

[14] (10 AUG 1999) It is assumed that it is the operator equation that will reveal the alterations in physical behavior. In order to determine these alterations, something needs to be fixed. The technique used is to investigate what physical behavior modifications would be needed so that the equational statements, that follow this note in the article, hold. For example, it can be argued that if the R varies in "time," then R may be a factor of a universal function. In this case, R may be represented by two possibly distinct functions r^s and R^m that have the property that $r^s(t^s) = R^m(t^m)$. This technique is based upon the acceptance that a concept can be represented by a universal function. Notice, however, that this requirement is not very restrictive. It is only

a "form" restriction. There may be confusion when the "technique" is applied to determine a "relation" between the standard infinitesimal light-clock measured quantities and the quantities that are measured by other altered infinitesimal light-clocks. It is this technique that allows for the equational statements $h(x_1^s,\ldots,x_n^s) = H(x_1^m,\ldots,x_n^m),\ f(t^s) = F(t^m)$ and, hence, the technique statement that $T(x_1^s,\ldots,t^s) = T(x_1^m,\ldots,t^m)$. It is usually a simple matter to argue for the universal function restriction. It's implicit in this work that the Special and General Theories need not be universal in application. The scenario and physical property investigated must satisfy all of the constraints of this technique; constraints that formally yield alterations in physical behavior. These theories may not apply to certain informational transmissions. On the other hand, since the selection of a line-element is often scenario dependent, the universal function or other aspects of this technique could be postulated. Such postulation would need to be verified by experimentation before actual acceptance could be considered. If verified, this would imply, at the least, one new property for the physical entity under investigation.

Notice that the method used to derive such expressions as (13) and (14) are obtained by starting with the Minkowski Special Theory line-element. The potential velocity statement $(v+d)$ assumes the usual infinitesimal statement that $(v+d)$ behaves as if it is a constant over the monadic neighborhood. Using the fact that most functions, and especially continuous ones defined on a compact domain, can be approximated to any degree of approximation by step (constant) functions, for the monadic neighborhood $\mu(t_0)$, the same thing holds where a standard continuous function, say $v(t)$, is considered as behaving like the constant value $v(t_0)$ over $\mu(t_0)$ (i.e. ${}^*v(t) \approx v(t_0)$.) (Of course, if v is differentiable, then $v(t)$ can also be considered as behaving like a linear function over $\mu(t_0)$.) Using this result, the extension of the "constant" potential-type velocity statement to a piecewise continuous function is an acceptable modeling technique.

(3 FEB 2004) Rather than use $v+d$, for certain line-elements, a more complex monadic behavior function $f(v,d)$ may be necessary. For example, considering the vector $\langle v,d\rangle$ and the Euclidean norm $\|\langle v,d\rangle\|$ in place of $v+d$, the modified Schwarzschild line-element is obtained using one form for the cosmological constant Λ.

[15] (16 AUG 1999) I thought that the following was obvious. But, it appears that a formal presentation is necessary. If the physical effect is the reverse of the P-process used to obtain a particular line-element, then this can be modeled by considering a complex velocity vector $((v+d)i+c)dt^s$ in expression (8) and within a monadic neighborhood, as it is done in many two dimensional fluid flow problems. All of the analysis that leads from equation (8) through and including equations (13) and (14) holds with only one alteration in the λ. In this case, $\lambda = 1 + (v+d)^2/c^2$.

The basic derivation method uses the notion of a physical-like photon behavior. I do not accept unconstrained line element transformations. Transformations need to be constrained due to physical conditions, one of which is a reasonable photon behavior requirement.

[16] (23 AUG 1999) From the derivations for the line-elements $(13)_\mathrm{a}$, $(13)_\mathrm{b}$, $(14)_\mathrm{a}$, $(14)_\mathrm{b}$, it is obvious that application of these line-elements must be carefully considered. Please note the behavior being investigated does not alter ϕ^s nor θ^s. Hence, $\phi^s(t^s) = \phi^m(t^m)$ and $\theta^s(t^s) = \theta^m(t^m)$ although these are not considered as universal functions. These line-elements are only applicable to alterations in radial or linear behavior. Further, one must be convinced that they hold for a particular scenario. Notice that they can be written entirely in terms of the standard measures and then compared with the Minkowski form. For example, this yields for $(13)_\mathrm{a}$ the general identity $(cdt^s)^2 - (dR^s)^2 = \lambda(cdt^m)^2 - (1/\lambda)(dR^m)^2$, which cannot be solved unless other conditions are

met. The arguments, for the variations in measures, are based upon the necessity to show that the line-elements apply and then to solve this expression for the variations in infinitesimal light-clock measures.

[17] (17 SEPT 1999) [Ref. note 12.] Notice that the expression $\gamma dt^m = dt^s$ (i.e. NSPPM proper time) used along with the universal function concept to obtain the alterations in physical behavior is a unique representation for one of the ambiguous forms discussed in Article 2 section 8. Although it represents an alteration in infinitesimal light-clock, by considering $u\,dt^m = (u/\gamma)dt^s$, one might comprehend this alteration in terms of what appears to be an N-world alteration in the time unit.

[18] (31 DEC 1999) In article 1, the unit adjusting number u is used. To obtain this number, where it is assumed that no relativistic physical alterations occur, simply note that $u = L/c$ from the NSPPM viewpoint. Thus the u units being considered are entirely related to the units used to express the c velocity. Hence, it is not the "units" of measure that is being altered, but as shown in Special Theory note [2], it is a NSPPM hyperbolic velocity-space behavior that yields infinitesimal light-clock count alterations and alterations in the physical world.

Almost no mathematical structure involving real or complex numbers is a perfect model for the measured natural system behavior, macroscopic, large scale or otherwise. One must always constrain the predicted results by physical conditions and arguments. This often has to do with such ideas as negative length, negative mass, negative energy and the like. If you substitute the derived α and β into equations (A) and (B) you get statements relative only to infinitesimals, in general, infinitesimals that, in some cases, would not lead to N-world effects. For example, the expression dR^m/dT^m is the derivative of an assumed differentiable standard function $R^m(T^m)$ in terms of an altered distance and time measuring infinitesimal light-clocks. Technically, one needs to consider both positive and negative infinitesimals as well as all members of $\mu(0)$. We have not used a physical argument for all infinitesimals, but have extended our results to all members of $\mu(0)$ by considering physical behavior for those infinitesimals obtained from infinitesimal light-clock behavior. When ${}^*dR^m/dT^m$ is evaluated over a monadic neighborhood, we have set the standard part equal to zero. Thus, there is some standard real neighborhood where the rate of change of R^m with respect to T^m is zero. This, however, from the most basic aspect of relativity is what one would expect since alterations in the two infinitesimal light-clocks caused by the P-process would need to counter each other with respect to this rate of change. When it comes to relativistic alterations in natural system behavior, one is interested in comparing non-influenced effects with influenced effects.

[19] (7 JAN 2000) [Cross reference note [4]]. Concerning the existence of a properton (i.e. sub-quantum) region, Special Theory alterations are also distinct from those of gravitational alterations since any such sub-quantum region that might produce these alterations does so in such a manner that measuring devices only yield the same relative velocity measures and also, due to the countering of the alterations, no device using electromagnetic properties will reveal any constant linear motion through this sub-quantum region. This should not be the case with respect to acceleration, however.

The derivation of the linear effect line-element is different from that of the Schwarzschild and this fact is profound in its consequences. We argued for the Schwarzschild that $R^s = R^m$. The same argument does not hold for the linear effect line-element. However, what does hold is the fact that this line-element deals entirely with but two measurements within the natural world "time" and "length" and how such measurements are altered by properties of the sub-quantum monadic cluster. The facts are that to measure a distance alteration relative to a moving object, the alteration would only appear if measurements where made simultaneously. Also the "timing" and "distance" measuring infinitesimal light-clocks are the same "clock" undergoing alterations in c. To incorporate this "simultaneous" measurement requirement into this line-element, we need to consider that when $dt^m = 0$, then $dt^s = 0$. In this case, the invariance leads to the requirement that $(dr^m)^2 = \lambda(dr^s)^2$. Equating the two line-element forms, would require that we replace dr^s in the derivation with a dr^m to obtain $(14)_a$ and $(14)_b$. (A second justification for this requirement is that $dr^s/dt^s = dr^m/dt^m = v$.)

[20] (2/9/2005) This is relative to article 2. Expression (6.9) (p. 37) is the standard two coordinate location "length" contraction expression (6.8) viewed using operational infinitesimal light-clocks relative to the corrected properton field hyperbolic diagram (p. 52). The basic scenario, as mentioned, is that when F_1 and F_2 coincide a single light pulse is sent to P that does not coincide with $F_1,\ F_2$ (p. 52) In the diagram, since it is a position and velocity diagram, the "lengths" of the sides of the triangle correspond to the properton field velocities. To obtain (6.5), consider the scenario where P coincides with F_1. This is equivalent to $\omega_1 = 0$. This gives the stated values for θ and ϕ, where if standard values are considered the $\approx$ is replaced by $=$, and yields $L(\lambda^{(1)} - \eta^{(1)}) \approx 0$.

The expression (6.8) is obtained by considering two coordinate locations for $F_1,\ F_2$ while all other aspects of the diagram remove fixed. That is, while the velocities $\omega_i = \overline{\omega}_i$ and $\overline{\theta} = \theta,\ \overline{\phi} = \phi$. In general, the values of the properton field velocities $\omega_i,\ i = 1, 2, 3$, are not related and it is these values that determine the infinitesimal light-clock counts. Within the diagram, the $\omega_i,\ i = 1, 2, 3$, are related to the $\theta,\ \phi$ in that $\omega_1 \cos\theta + \omega_2|\cos\phi| = \omega_3$. The Einstein measures of the relative velocities are, in general, not related. That is, they are, at least, relationally independent. If, in (6.9), ${}^*\!\cos\theta$ is not infinitesimal, then the proper definition of length also depends upon the diagrammed circumstances.

> (a) Alterations in the values for $\theta,\ \phi$ simply imply that the values for the standard Einstein coordinates, such as $\mathtt{st}(x^{(i)}_{Ea}),\ i = 1, 2$, as well as length, must be altered under altered circumstances.

The over-long analysis that leads to (6.12) or (6.13) (p. 38) shows how to obtain, for the infinitesimal light-clocks, the same "form" within the NSPPM as that of expression (6.8).

I have not given an argument that yields (6.14) on page 38. That is,

$$u((\overline{\lambda}^{(1)} + \overline{\eta}^{(1)}) - (\lambda^{(1)} + \eta^{(1)})) \approx \beta u((\overline{\lambda}^{(2)} + \overline{\eta}^{(2)}) - (\lambda^{(2)} + \eta^{(2)})). \tag{6.14}$$

To derive (6.14), first consider the general expression

$$\overline{t}^{(1)}_E - t^{(1)}_E = \mathtt{st}(\beta)(\overline{t}^{(2)}_E - t^{(2)}_E), \qquad [20.1]$$

and make the substitution from (6.3). This yields

$$u[(\overline{\lambda}^{(1)} + \overline{\eta}^{(1)}) - (\lambda^{(1)} + \eta^{(1)})] \approx (\beta u)[(\overline{\lambda}^{(2)} + \overline{\eta}^{(2)})(1 - \overline{\alpha}) - (\lambda^{(2)} + \eta^{(2)})(1 - \alpha)], \qquad [20.2]$$

where finite $\alpha = K^{(3)}K^{(2)}\,{}^*\!\cos\phi,\ \overline{\alpha} = \overline{K}^{(3)}\overline{K}^{(2)}\,{}^*\!\cos\overline{\phi}$.

Let $\omega_1,\ \overline{\omega_1}$, be fixed and consider the standard part of [20.2]. Then we have the contradiction that the infinitesimal light-clock measurement for the event at P as determined by F_1 depends upon $\mathtt{st}((\lambda^{(2)} + \eta^{(2)})\alpha - (\overline{\lambda}^{(2)} + \overline{\eta}^{(2)})\overline{\alpha})$. However, for this scenario, ϕ and $\overline{\phi}$, are arbitrary, where it is only required that $\pi/2 \leq \phi, \overline{\phi} \leq \pi$. Thus

$$[(\lambda^{(2)} + \eta^{(2)})\alpha - (\overline{\lambda}^{(2)} + \overline{\eta}^{(2)})\overline{\alpha}] \approx 0. \qquad [20.3]$$

This yields (6.14).

(b) The infinitesimal light-clock expression (6.14) is universal in that it is not altered by the diagrammed circumstances.

It is claimed that expression (6.14) (i.e. [20.1]) written as (†) $\Delta t^m = \mathtt{st}(\beta)\Delta t^s$ indicates that "rates of change," via a change in the "time" unit, are altered with respect to relative motion. However, more than rates of change might be altered and so as to eliminate the model theoretic error of generalization all individual alterations in behavior need to be derived. Technically, such an expression as (†) cannot be physically infinitesimalized for any clock. Expressions $(5)_a$ and $(5)_b$ (p. 56) are relative to light propagation via the chronotopic interval and along with the linear-effect line-element leads to (**) (p. 62). It is the light propagation determined linear effect line-element that yields the infinitesimalized version of (†), where $\gamma = \beta^{-1},\ d = 0$. It is the line-element method that displays the correct alterations, alterations that are employed to derived altered physical behavior, where the basic alteration is the alteration of c in the inf. light-clocks. This method leads to alterations in measures of mass, energy, etc.

As previously mentioned, Einstein originally used partial derivatives in his derivation and, regardless of the derivation method used, the differential calculus is the major classical tool. Einstein had to synchronize his clocks using "light" signals via the "radar' method. This and other requirements signify that this theory and any theory that must reduce to the Special Theory, under certain circumstances, is but a light propagation theory.

In order to apply the differential calculus to any physical measure in a reasonably accurate many, especially for macroscopic behavior, one uses an ideal physical entity and measures that can be"infinitesimalized." Almost no "clock" corresponds to an "ideal" clock that can be infinitesimalized. Almost no clock mechanism that displays standard time can be "smoothed-out" and infinitesimalized in a reasonable manner. But, the basic notion of "length" is smoothed-out and infinitesimalized. Further, since the theory uses the language of light (i.e. electromagnet) propagation, then one should not generalize beyond this language. There is one physical mechanism that uses light propagation as its basic mechanism and can be infinitesimalized relative to lengths of light-paths. The clock is the light-clock.

One needs only consider two viewpoints relative to the implications of this theory to see that the use of the standard methods and incorrectly generalizing leads to contradictory yet viable philosophic views.

Dingle (1950) considers the contraction of "length" as physical nonsense. He states relative to the usual expression for length-contraction $(\overline{x}' - x') = (\overline{x} - x)(1 - v^2/c^2)^{-(1/2)}$, "The implication of this choice is often expressed by the statement that a body contracts on moving, but the expression is unfortunate: it suggests that something happens to the body, whereas the 'movement' may be given it merely by our mental change of the standard of rest, and we can hardly suppose that the body shrinks on becoming aware of it" (p. 30). He also rejects the notion that"space" changes and contends that ". . . our province is simply that of physical measurements, and our object is simply to relate them with one another accurately and consistently . . . . this is completely achieved by a re-definition of length . . ." (p. 31). All this comes about since it claimed that "length is not an intrinsic property of the body" (p. 30). But these remarks assume that there is no æther, no privileged observer with privileged frame of reference.

As to time-dilation, Dingle claims that this comes about only due to the way science defines velocity, a defining method that need not be used. A magnetic form of speedometer on a specific vehicle can simply be marked off in speedometer units as a measure of velocity is one of his examples.

One then uses the length-contraction statement and obtains the necessary time-dilation expression. Indeed, he claims for this time expression the following: "A very familiar expression of this result is that statement that the rate of a clock is changed by motion, and by this we are intended to understand that some physical change occurs in the clock. How false this is can be seen, just as the falsity of the corresponding statement for space-measuring rods, by remembering that we can change the velocity of the clock merely by changing our minds" (p. 39-40). He does not mention and explain in this book, using his definition notion, the Ives-Stillwell 1938 experiment (frequency changes in emitted "light" from hydrogen canal rays) nor changes in decay rates that are attributed to time-dilation.

Then we have Lawden's (1982) statements about length contraction. "The contraction is not to be thought of as the physical reaction of the rod to its motion and as belonging to the same category of physical effects as the contraction of a metal rod when it is cooled. It is due to a changed relationship between the rode and the instruments measuring its length. . . . It is now understood that length, like every other physical quantity, is defined by the procedure employed for its measure and it possesses no meaning apart from being the result of this procedure. [Notice the use of the term "quantity." Physical properties exist in reality. But, the properties are distinct from the methods used to measure the properties.] . . . [I]t is not surprising that, when the procedures must be altered to suit the circumstances, the result will also be changed. It may assist the reader to adopt the modern view of the Fitzgerald contraction if we remark that the length of the rod considered above can be alerted at any instant simply by changing our minds and commencing to employ the S frame rather than the S' frame. Clearly, a change of mathematical description can have no physical consequences" (p. 12).

Lawden takes the observer time-dilation expression as the one that has physical significance ". . . all physical processes will evolve more slowly when observed from a frame relative to which they are moving" (p.13). However, no further explanation is possible for this effect since once again no æther is assumed. But, are these time-dilation alterations actual mean physical changes in the measuring machines or are they but observational illusions?

It appears significant that there was no rigorous basis for the philosophic stances of Dingle and Lawden. This all changes with the use of infinitesimal light-clock theory and this note. When infinitesimal light-clocks are used to measure the length of a rod with respect to linear N-world relative motion, (a) shows that there is no fixed <u>N-world</u> expression for such length "contraction" independent of the parameters. The idea that the expressions simply imply altered "definitions" is viable, but only for the N-world.

On the other hand, with respect to linear relative motion, (b) shows that the alterations in the infinitesimal light-clocks used to measure "time" are independent from the circumstances (i.e. the two parameters) and they are a universal requirement in that the time-dilation model determines what physical changes occur. Hence, (b) rejects the Dingle notion that (infinitesimal light-clock measured) time-dilation is simply a problem of measure and definition and verifies that it must represent actual physical or observed alterations in behavior if such a notion is actually applicable to the physical world. This "time" alteration is not in absolute time but rather in observer time and is related to the NSPPM æther via $L/u = c$. The linear-effect line-element is used to derive Special Theory alterations in behavior. But, using the line-elements associated with the General Theory, the exact same infinitesimal time-light clock differential expression is obtained as used for the Special Theory. The exact same derivations yield the gravitational relativistic alterations in behavior where the "velocities" are but potential. Few doubt that the gravitational alterations are physically real.

This yields additional very strong evidence that similarly derived Special Theory alterations are physically real, at the least, with respect to the NSPPM, while infinitesimal light-clock alterations lead to physical manifestations within the natural-world.

[21] (25 NOV 2007) (a) It is assumed that this approach is a strong classical approach. As such, solutions to the line-elements presented are related to, at least, the Riemann integral and the additional requirement that they be integrable over a closed "interval" and continuous at the point within the interval under consideration. As shown by Theorem 5.1.1 in Herrmann (1994a), such integrals are independent from the differential chosen. Thus, restricting each $d\xi$ to specific $L\Pi'$ or $u\Pi'$ infinitesimals, where $\Pi' \in {}^*\mathbb{N}$, is sufficient.

(b) It is clear from statement (*) as it relates to (9.2) and the actual observed behavior that (*) predicts that the idea of the infinitesimal light-clock is the correct approach to relativistic physics and the only one that includes the required light propagation language. This includes the General Theory.

[22] (18 JUL 2009) (a) Since we are comparing results at different locations in a gravitational field or flat-space and the medium, the L and u do not change, then Planck's constant is not altered from what it would be at an s-point or its assumed value at the m-position (or other "viewing" positions).

(b) It should not be forgotten that the times used for the Special Theory line elements is Einstein time. The alterations in inf. light-clock measurements are required to maintain a NSPPM hyperbolic velocity-space. Notice that local (or flat-space) measurements or equivalent will always yield the constant c. This is modeled by $(5)_a$, where $dS = 0$.

(c) For gravitational effects, each inf. light-clock count alteration follows from $\gamma dt^m = \gamma u\Pi_m = dt^s = u\Pi_s$, $\Pi_m, \Pi_s \in {}^*\mathbb{N}$. Since u does not vary, then, from light-clock construction transferred to inf. light-clocks, the only physical way that this can happen is that, for the s-clock, the actual velocity of light within the clock is γc. Since inf. light-clocks are used, this implies that such alterations in behavior probably correspond to subatomic photon behavior. Notice that for the Robinson-Walker line element, the alteration follows from $c\gamma(1/\lambda.)$

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NOTES

Appendix-B
Gravitational Time-dilation.

1. Medium Time-dilation Effects.

Within a gravitational field, the superscript s represents local measurements taken at a spatial point Q using specific devices. Using identically constructed devices, the superscript m represents local measurements taken at an m-point Q_1 or at $+\infty$, where there is no gravitational field. These local m-point measures are compared with the local measures made at point Q.
Equation (**) on page 62, when expressed for the general physical metric for a fixed spatial point is

$$\sqrt{g_1}dt^m = dt^s. \tag{B1}$$

(Note that many authors denote g_1 as g_4 and the term "clock" is specifically defined.) Consider another spatial point R within the gravitational field, where for the two points $P,\ R$ the expression g_1 is written as $g_1(P),\ g_1(R)$, respectively. Considering the point effect at each pont and applying the relativity principle, this gives, in medium t_3 time, that

$$\frac{\Delta t^s_P}{\sqrt{g_1(P)}} = \Delta t^m = \frac{\Delta t^s_R}{\sqrt{g_1(R)}} \tag{B2}$$

Equations like (B2) are comparative statements. This means that identical laboratories are at P and R and they employ identical instrumentation, definitions, and methods that lead to the values of any physical constants. Since infinitesimal light-clocks are being used, standard "clock" values can take on any non-negative real number value. The $\Delta t^s_P,\ \Delta t^s_R$ represent the comparative view of the gravitationally affected "clock" behavior as observed from the medium where there are no gravitational effects. (The $1/\sqrt{g_1}$ removes the effects.) Assume a case like the Schwarzschild metric where real $\sqrt{g_1} < 1$. Consider two different locations P, R along the radius from the "center of mass." (A "tick" is a one digit change in a light-clock counter. As discussed below, there can be "portions" of a tick.) Then there is a constant r_s such that

$$\sqrt{1 - \frac{r_s}{r_P}}\ \Delta t^s_R \text{ (in R−ticks)} = \sqrt{1 - \frac{r_s}{r_R}}\ \Delta t^s_P \text{ (in P−ticks)}. \tag{B3}$$

where $r_s \leq r_P,\ r_R$. [The cosmological "constant" Λ modification (Λ is not assumed constant) is

$$\sqrt{1 - \frac{r_s}{r_P} - (1/3)\Lambda\frac{r_P^2}{c^2}}\ \Delta t^s_R = \sqrt{1 - \frac{r_s}{r_R} - (1/3)\Lambda_1\frac{r_R^2}{c^2}}\ \Delta t^s_P.] \tag{B3)'$$

Of course, these equations [(B3), (B3)'] are comparisons that must be done with the same type of "clocks." As an example for (B3), suppose that $r_s/r_P = 0.99999$ and $r_R = 100,000r_P$. Then $r_s/r_R = .000009999$. This gives $0.003162278\Delta t^s_R = 0.999995\Delta t^s_P$. Hence, $\Delta t^s_R = 316.2262\Delta t^s_P$. Thus, depending upon which "change" is known, this predicts that "a change in the number of R-ticks" equals "316.2262 times a change in the number of P-ticks." Suppose that at P undistorted information is received. Observations of both the "P-clock" and the "R-clock" digit changes are made. (The fact that it takes "time" for the information to be transmitted is not relevant since our interest is in how the ticks on the "clocks" are changing.) Hence, if the "clock" at P changes by 1-tick, then the change in the R-ticks is 316.2262. (What it means to have a "portion" of a tick is discussed later in this appendix.)

The careful interpretation of such equations and how their "units" are related is an important aspect of such equations since (B2) represents a transformation. Using a special " clock" property, if the "R-clock" changes its reading by 1, then at P the "P-clock" shows that only 0.003162 "P-clock" time has passed. If you let $R = \infty$, then $\Delta t^s_R = 316.2278 \Delta t^s_P$ and, in a change in the reading of 1 at P, the R-reading at ∞ is 316.2278. Is this an incomprehensible mysterious results? No, since it is shown previously, the gravitational field is equivalent to a type of change in the infinitesimal light-clock itself that leads to this result. But, for our direct physical world, thus far, the answer is yes if there is no physical reason why our clocks would change in such a manner. The equation (B3) $[(B3)']$ must be related to physical clocks within the physical universe in which we dwell.

2. The Behavior of Physical Clocks.

Einstein did not accept general time-dilation for the gravitation redshift but conjectured that such behavior, like the gravitational redshift, is caused by changes within atomic structures rather than changes in photon behavior during propagation. This was empirically verified via atomic-clocks. To verify Einstein's conjecture theoretically and to locate the origin of this atomic-clock behavior, the comparative statement that $dt^s = \sqrt{g_1} dt^m$ is employed. It has been shown using time-dependent Schrödinger equation, that certain significant energy changes within atomic structures are altered by gravitational potentials. Once again, consider identical laboratories, with identical physical definitions, physical laws, construction methods etc. at two points P and R and within the medium. When devices such as atomic-clocks are used in an attempt to verify a statement such as (B3), the observational methods to "read" the clocks are chosen in such a manner that any known gravitational effects that might influence the observational methods and give method-altered readings is eliminated. For point P, let E^s_P, denote measured energy. (*The superscript s represents local measurements for a specific event at a spatial point Q where gravitational effects are non-zero. The superscript m represents such measures as they are viewed from a point Q_1 or from $+\infty$, where there is a absence of gravitational potentials, the medium, and where identical modes of measurement are used and compared with those from Q.*) In all that follows, comparisons are made. Using the principle of relativity, the following equation (B4) (A) holds, in general, and if g_1 is not time dependent, then (B) holds.

$$\text{(A)}\ \sqrt{g_1(P)}dE^s_P = dE^m = \sqrt{g_1(R)}dE^s_R,\ \text{(B)}\ \sqrt{g_1(P)}\Delta E^s_P =$$

$$\Delta E^m = \sqrt{g_1(R)}\Delta E^s_R. \qquad (B4)$$

This is certainly what one would intuitively expect. It is not strange behavior. Hence, in the case that g_1 is not time dependent, then

$$\sqrt{g_1(P)}\Delta E^s_P = \sqrt{g_1(R)}\Delta E^s_R, \qquad (B5)$$

For this application, equation (B4) corresponds to the transition between energy levels relative to the ground state for the specific atoms used in atomic-clocks. But, *for this immediate approach, the atomic structures must closely approximate spatial points.* Further, at the moment that such radiation is emitted the electron is considered at rest in the medium and, hence, relative to both P and R. The actual aspect of the time-dependent Schrödinger equation that leads to this energy relation is not the spatial "wave-function" part of a solution, but rather is developed from the "time-function part."

The phrase "measurably-local" means, that for the measuring laboratory the gravitational potentials are considered as constants. Diving each side of (B) in (29) by Planck's (measurably-local) constant in terms of the appropriate units, yields for two observed spatial point locations $P,\ R$ that

$$\sqrt{g_1(P)}\nu_P^s = \sqrt{g_1(R)}\nu_R^s, \tag{B6}$$

Equation (B6) is one of the expressions found in the literature for the gravitational redshift [6, p. 154] but (B6) is relative to medium "clocks." Originally, (B6) was verified for the case where $\sqrt{g_1(R)} \ll \sqrt{g_1(P)}$ using a physical clock. Note that since the P and R laboratories are identical, then the numerical values for ν_P^s and ν_R^s as measured using the altered medium "clocks" and, under the measurably-local requirement, are identical. Moreover, (B6) is an identity that is based upon photon behavior as "clock" measured.

What is necessary is that a comparison be made as to how equation (B6) affects the measures take at R compared to P, or at P compared to R. Suppose that $|\nu_A^s|$ indicates the numerical value for ν_A^s at any point A. To compare the alterations that occur at P with those at R, $|\nu_R^s|_P$ is symbolically substituted for the ν_P^s and the expression $\sqrt{g_1(P)}|\nu_R^s|_P = \sqrt{g_1(R)}\nu_R^s$ now determines the frequency alterations expressed in R "clock" units. As will be shown for specific devices, this is a real effect not just some type of illusion. *This substitution method is the general method used for the forthcoming "general rate of change" equation.* As an example, suppose that for the Schwarzschild metric $R = \infty$ and let $|\nu_R^s| = \nu_0$. Then $\nu_\infty^s = \nu = \sqrt{1 - r_s/r_P}\,\nu_0$. This result is the exact one that appears in [1, p. 222]. However, these results are all in terms of the behavior of the "clocks" and how their behavior "forces" a corresponding alteration in physical world behavior and not the clocks used in our physical world. These results need to be related to physical clocks.

Consider atomic-clocks. At P, the unit of time used is related to an emission frequency f of a specific atom. Note that one atomic-clock can be on the first floor of an office building and the second clock on the second-floor or even closer than that. Suppose that the identically constructed atomic-clocks use the emission frequency f and the same decimal approximations are used for all measures and f satisfies the measurably-local requirement. The notion of the "cycle" is equivalent to "one complete rotation." For point-like particles, the rotational effects are not equivalent to gravitational effects [8, p. 419] and, hence, gravitational potentials do not alter the "cycle" unit C. Using the notation "sec." to indicate a defined atomic-clock second of time, the behavior of the f frequency relative to the "clocks" requires, using equation (B6), that

$$\sqrt{g_1(P)}\frac{1\mathrm{C}}{\mathrm{P{-}sec.}} = \sqrt{g_1(R)}\frac{1\mathrm{C}}{\mathrm{R{-}sec.}}. \tag{B7}$$

$$\sqrt{g_1(P)}\frac{1}{\mathrm{P{-}sec.}} = \sqrt{g_1(R)}\frac{1}{\mathrm{R{-}sec.}}. \tag{B7$'$}$$

For measurably-local behavior, this unit relation yields that

$$\sqrt{g_1(P)}(\overline{t_R} - t_R)(\mathrm{R{-}sec.}) = \sqrt{g_1(R)}(\overline{t_P} - t_P)(\mathrm{P{-}sec.}). \tag{B8}$$

Hence, in terms of the atomic-clock seconds of measure

$$\sqrt{g_1(P)}\Delta t_R = \sqrt{g_1(R)}\Delta t_P. \tag{B9}$$

Equation (B9) is identical with (B3), for the specific g_1, and yields a needed correspondence between the "clock" measures and the atomic-clock unit of time. Corresponding "small" atomic structures to spatial points, if the gravitational field is not static, then, assuming that the clocks decimal notion is but a consistent approximation, (B9) is replaced by a (B3) styled expression

$$\sqrt{g_1(P,t_P)}dt_R^s = \sqrt{g_1(R,t_R)}dt_P^s \tag{B10}$$

and when solved for a specific interval correlates directly to atomic-clock measurements. Also, the Mean Value Theorem for Integrals yields

$$\sqrt{g_1(R,t'_P)}(\overline{t_R} - t_R) = \sqrt{g_1(R,t'_R)}(\overline{t_P} - t_P), \tag{B11}$$

for some $t'_P \in [t_P, \overline{t_P}]$, $t'_R \in [t_R, \overline{t_R}]$. Equations (B9), (B10) and (B11) replicate, via atomic-clock behavior, the exact "clock" variations obtained using the medium time, but they do this by requiring, relative to the medium, an actual alteration in physical world photon behavior. The major interpretative confusion for such equations is that the "time unit," as defined by a specific machine, needs to be considered in order for them to have any true meaning. As mentioned, the "unit" notion is often couched in terms of "clock or observer" language. The section 1 illustration now applies to the actual atomic-clocks used at each location.

For quantum physically behavior, how any such alteration in photon behavior is possible depends upon which theory for electron behavior one choices and some accepted process(es) by which gravitational fields interaction with photons. Are the alterations discrete or continuous in character? From a quantum gravity viewpoint, within the physical world, they would be discrete if one accepts that viewpoint. This theoretically establishes the view that such changes are real and are due to "the spacings of energy levels, both atomic and nuclear, [that] will be different proportionally to their total energy" [3, pp. 163-164]. Further, "[W]e can rule out the possibility of a simple frequency loss during propagation of the light wave. . . ." [8, p. 184].

Although the time-dependent Schrödinger equation applies to macroscopic and large scale structures via the de Broglie "guiding-wave" notion, the equation has not been directly applied, in this same manner, to such structures since they are not spatial points. However, it does apply to all such point-approximating atomic structures since it is the total energy that is being altered. One might conclude that for macroscopic and large scale structures there would be a cumulative effect for a collection of point locations. (From the "integral" point of view relative to material objects, such a cumulative procedure may only apply, in our physical world, to finitely many such objects.) Clearly, depending upon the objects structure, the total effect for such objects, under this assumption, might differ somewhat at different spatial points. However, the above derivation that leads to (B9) is for the emission of a photon "from" an electron and to simply extend this result to all other clock mechanisms would be an example of the model theoretic error in generalization unless some physical reason leads to this conclusion.

As mentioned, equation (B9) is based upon emission of photons. Throughout all of the atomic and subatomic physical world the use of photon behavior is a major requirement in predicting physical behavior, where the behavior is not simply emission of the type used above. This tends to give more credence to accepting that, under the measurably-local requirement, each material time rate of change, where a physically defined unit U that measures a Q quality has not been affected by the gravitational field, satisfies

$$\sqrt{g_1(P)}\Delta Q_P \text{ in a P--sec.} = \sqrt{g_1(R)}\Delta Q_R \text{ in an R--sec.},$$

$$\Delta Q_R \text{ in an R--sec.} = \frac{\sqrt{g_1(P)}}{\sqrt{g_1(R)}}|\Delta Q_R|_P, \tag{B12}$$

Equations (B12) give comparative statements as to how gravity alters such atomic-clock time rates of change including rates for other types of clocks.

Prior to 1900, it was assumed that a time unit could be defined by machines that are not altered by the earth's gravitational field. However, this is now known not to be fact and as previously indicated, such alterations in machine behavior is probably due to an alteration in photon behavior associated with a NS-substratum position that undergoes two types of physical motion, uniform or accelerative. There is a NSPPM process that occurs and that alters photon behavior as it relates to the physical world. These alterations in how photons physically interact with atomic structures and gravitational fields is modeled (mimicked) by the defining machines that represent the physical unit of time, when the mathematical expressions are interpreted. The observed accelerative and relative velocity behavior is a direct consequence of this process. As viewed from the NS-substratum, every a nonzero uniform velocity obtained from a zero velocity first requires acceleration. This is why the General Theory and the Special Theory are infinitesimally close at a standard point.

It is claimed by some authors that regular coordinate transformations for the Schwarzschild solution do not represent a new gravitational field but rather allows one to investigate other properties of the same field using different modes of observation. When such transformations are discussed in the literature another type of interpretation appears necessary [6, p. 155-159]. Indeed, what occurs is that the original Schwarzschild solution is rejected based upon additional physical hypotheses for our specific universe that are adjoined to the General Theory. For example, it is required that certain regions not contain physical singularities under the hypotheses that physical particles can only appear or disappear at chosen physical "singularities." Indeed, if these transformations simply lead to a more refined view of an actual gravitational field, then the conclusions could not be rejected. They would need to represent actual behavior. One author, at least, specifically states this relative to the Kruskal-Szekeres transformation. In [10, p. 164], Rindler rejects the refined behavior conclusions that would need to actually occur within "nature." "Kruskal space would have to be *created in toto*: . . . . There is no evidence that full Kruskal spaces exist in nature."

One way to interpret the coordinate transformation that allows for a description of "refined" behavior is to assume that such described behavior is but a "possibility" for a specific gravitational field and that such behavior need not actually occur. This is what Rindler appears to be stating. Of course, such properly applied coordinate transformations also satisfy the Einstein-Hilbert gravitational field equations. For the medium view of time-dilation, this leads to different alterations in the atomic-clocks for any collection of such "possibilities."

These results, as generalized to the behavior exhibited by appropriate physical devices, imply that no measures using these devices can directly determine the existence of the medium. Although Newton believed that infinitesimal values did apply to "real" entities and, hence, such measures exist without direct evidence, there is a vast amount of indirect evidence for existence of such a medium.

3. Infinitesimal Light-Clocks, in General.

For applications, everything in the infinitesimal-world is composed of "simple" Euclidean or physical notions. There are no curves or curved surfaces and the like only objects that are "linear" in character. This follows from the nonstandard version of the Fundamental Theorem for Differentials in terms of a linear operator. For physical problems, when one attempts to find the appropriate nonstandard approach the closer the approach approximates physical behavior the more likely it will yield acceptable results. (Sometimes the approach used today by those that do not use the formal infinitesimals leads to statements that may appear to be mathematical but they are not. A foremost example of this is the Feynman integral.)

Using a photon language, we further analyzed light-clocks. In the case being considered, light-clocks have a light source and two reflecting surfaces (A) and (B). At one "mirror" (A) a very short pulse (of photons) is emitted. The pulse is reflected at (B) and returns to (A). A detector at (A) registers its return. Then immediately the pulse returns to (B), etc. Of course, the pulse may need to be replenished with a new pulse after a while. Light-clocks are used since they mimic the behavior of a type of Einstein time for stationary objects.

The distance between the mirrors is M. The distance traveled by a very short pulse is very nearly $2M$. Within our observable world, the M cannot be any positive small number. Is there an "assumed" physical process that uses a "very small length L," as compared to a standard meter, that closely approximates this process?

Consider a theoretical reason why an electron and a proton are kept within a close range in the hydrogen atom. Photons are emitted by the proton, absorbed by the electron, and emitted by the electron and absorbed by the proton. One could assign a general approximate L to the "distance" between an electron and the proton and, hence, the distance each interacting photon covers. Due to the linear requirements for the infinitesimal-world, a viewed from this world often requires idealization. (This does not mean that the NS-substratum view is not what might actually be happening.) In this case, a linear photon path is used. Consider that just at the moment a photon is absorbed by the proton that the proton emits a photon and, when this is absorbed by the electron, the electron immediately emits another photon, etc. Although there is no counting-device, for this back-and-forth process one surmises that over a standard period of time, an "extremely large number" of interactions take place.

Since the L involved is extremely small as compared to a standard meter, this "smallness" allows one to "model" an infinitesimal light-clock (inf-light-clock). The counting numbers that correspond to nonzero measures are all members of $\mathbb{N}_\infty$. The number L uses the same unit as used to measure c locally, say meters. Further, the number L needs to be taken from an infinite set of special infinitesimals. Why? By Theorem 11.1.1 (11, p. 108) given such an L and any nonzero real number r, then there is an $A \in \mathbb{N}_\infty$ such that $2AL \approx r$. When $\mathtt{st}$, is applied to A(2L) the result is r. Thus A(2L) gives a measure of how far the entire collection of interchanged photons has "traveled" linearly in the inf-light-clock.

Consider measuring a local distance between two fixed points $F(1)$ and $F(2)$. Since the velocity of light as measured locally will be c, such an inf-light-clock can calculate a measure for the "light" distance between $F(1)$ and $F(2)$. Let A be the count at the moment a photon leaves point $F(1)$ and B the count for the same or a synchronized inf-light-clock when the photon registers its presence at $F(2)$. The (light) distance from $F(1)$ to $F(2)$ is $2L(B - A)$. Applying $\mathtt{st}$ yields $r(2) - r(1)$, which is a very accurate distance measurement.

The same inf-light-clock can be used to measure "the (light) time" between two local events using the time unit u. If L is in meters, then "seconds" can be used for u. The time between two successive events $E(1)$ and $E(2)$ occurring at the same point, where inf-light-clock counts B for event $E(2)$ and A for event $E(1)$ is $(2L/c)(B - A)$. (As with "ticks" there can be portions of a counting number.) Applying $\mathtt{st}$, this yields the standard time measurement. Letting a photon have the ballistics property within an infinitesimal neighborhood, the basic derivation yields that, when it "moves" from one neighborhood to another in our physical universe, it acquires the wave property that the standard locally measured velocity c is not altered by the velocity of the source. Atomic clocks also function using photon properties.

The calculus is the most successful mathematical theory ever devised. But, for the question of whether something actually exists in some sort of reality that is akin to these infinitesimal entities and we use such analogue models because we can neither describe nor comprehend the infinitesimal-world in any other way, please consider the following as written by Robinson.

"For phenomena on a different scale, such as are considered in Modern Physics, the dimensions of a particular body or process may not be observable directly. Accordingly, the question whether or not the scale of non-standard analysis is appropriate to the physical world really amounts to asking whether or not such a system provides a better explanation of certain observable phenomena than the standard system. . . . The possibility that this is the case should be borne in mind."
Fine Hall,
Princeton University.

One of these better explanations might be a NSPPM process that gives photons particle properties and one wave property, even if the frequency property is only a probabilistic statement.

4. Infinitesimal Light-clocks and Gravitational Fields.

In what follows, the Π objects are members of $\mathbb{N}_\infty$. Let F_s be a position where the gravitational potential is not zero and Π_s an inf-light-clock count at F_s. Considered an identical inf-light-clock located at position F_m with inf-light-clock count Π_m, where there is no gravitational potential. In the usual manner when compared, usually, $\Pi_s < \Pi_m$. How is this possible?

The basic assumption used here and within modern physical science is that "length" L is not altered. The infinitesimal $u = 1/(c10^\omega),\ \omega \in \mathbb{N}_\infty$, used at F_s and at F_m does not vary when the velocity of light is "measured" at F_s, it will measure to be c. The reason for this is that due to the change in energy at F_s (compared to F_m) produced by a gravitational potential any form of "timing" device used to measure the velocity of light has also been affected by the gravitational potential F_s. To make such a comparisons physically, consider information as propagated by "light" from F_s to F_m. If during propagation the slowing of light by gravitational potentials is assumed, than as the light propagates through the gravitational field and arrives at F_m it would regain the original velocity c. Under this assumption, comparatively, c_s used at F_s, when "viewed" from F_m, is less than the c without a gravitational field. Does this comparative "slowing" of the velocity of light follow from the theory of inf-light-clocks?

Consider $\sqrt{g_1}\, u(\Pi_m - \Pi'_m)$ and nonzero $\mathtt{st}(u\Pi_m) = r,\ \mathtt{st}(u\Pi'_m) = r'$. Then, by Theorem 11.1.1 (11, p. 108), there exist $\Gamma_m,\ \Gamma'_m \in \mathbb{N}_\infty$ such that $\sqrt{g_1}\, u\Pi_m \approx \sqrt{g_1}\, r \approx u\Gamma_m,\ \sqrt{g_1}\, u\Pi'_m \approx \sqrt{g_1}\, r \approx u\Gamma'_m$. Hence,

$$\sqrt{g_1}\, u(\Pi_m - \Pi'_m) = u(\Gamma_m - \Gamma'_m) + \epsilon, \tag{B13}$$

where $\epsilon \in \mu(0)$. Technically, the ϵ cannot be removed from (B13). But, equation (B1), if written in inf-light-clock form, appears to lead to a contradiction for the expression $\sqrt{g_1} u\Delta t^m = u\Delta t^s$ when u is divided and the result is viewed from the infinitesimal-world. This occurs since $\sqrt{g_1}$ need not be a member of the nonstandard rational numbers ${}^*Q$, while $\Delta t^s/\Delta t^m \in {}^*Q$. This difficulty does not occur if the clock being used is assumed to vary over an interval $[a, b]$ or the entire nonnegative real numbers.

This "contradiction" is eliminated, when $\Delta t^m,\ \Delta t^s$ are translated into inf-light-clock notation, by including the count units in the notation. Recall that $L = 1/10^\omega$ is in meters and u is in seconds. Let T_m be interpreted as count "ticks" at F_m and T_s the count "ticks" at F_s. The translations are

$$\sqrt{g_1}\, u(\Pi_m - \Pi'_m)(\mathrm{m-sec.}) = u(\Pi_s - \Pi'_s)(\mathrm{s-sec.}),$$

$$\sqrt{g_1}\, u(\Pi_m - \Pi'_m)T_m = u(\Pi_s - \Pi'_s)T_s. \qquad (B14)$$

As an example, let $\sqrt{g_1} = 1/\pi$. Then diving by non-zero u yields

$$(\Pi_m - \Pi'_m)(\text{in m} - \text{ticks}) = \pi\,(\Pi_s - \Pi'_s)(\text{in s} - \text{ticks}) \qquad (B15),$$

where $(\Pi_m - \Pi'_m),\ (\Pi_s - \Pi'_s) \in {}^*\mathbb{N}$.

Since the L is invariant and identical inf-light-clocks are used, there is only one way that equations (B14), (B15) can be interpreted to avoid a contradiction. The irrational π implies that there can be "partial" ticks as well as "partial" seconds. For identical non-infinitesimal light-clocks, a partial tick comes about when the photons that produce the tick have not traversed the entire $2M$ distance. A basic reason why this can occur is that, in comparison and for a gravitational field as a propagation medium, the velocity of light has been altered. Assuming that the mathematical model faithfully represents such physical aspects and that the process of "counting" is a universal process in that the human "concept" of counting is not somehow of other altered by the field, then making an informal *-transfer of this yields

$$\sqrt{g_1}\, c_m = \sqrt{g_1} c = c_s. \qquad (B16)$$

Equation (B16) also explains (B3) and the atomic-clock measures of time in terms of portions of a sec.

5. Inf-light-clocks and continuity.

Suppose that the variations in a static field potential are continuous in terms of the distance r from a center of mass. Then, for the field being considered, $\sqrt{g_1}$ is a continuous function in r. From (B16), this implies that c_s is a continuous function in r. Let $r \in [a,b],\ b \neq a \geq 0$. If an ideal physical light-clock is employed, then, for each member of $[a,b]$, there would exist distinct counting numbers registered by the light-clock. Hence, this gives a one-to-one function $f\colon [a,b] \to \mathbb{N}$. Assuming r is modeled in this "trivial" fashion, then this is impossible. But, this "impossibility" is removed when inf-light-clocks are utilized.

The basic Theorem 11.1.1 [12, p. 108] shows that for every $0 \neq r \in [a,b]$ there exists an $\Gamma_r \in \mathbb{N}_\infty$ such that $\mathtt{st}(u\Gamma_r) = r$. There are, however, infinitely many $x \in \mathbb{N}_\infty$ that have this same property since, at the least, for each $a \in \mathbb{N}$, $\mathtt{st}(u(\Gamma_r + a)) = r$. For $q \in \mu(p)$, let $m(q,p) = \{q + x \mid x \in \mu(0)\}$. If $t \in \mu(q,p)$, then $t \approx q \approx p$ yields $t \approx p$ and $t \in \mu(p)$. In like manner, if $t \in \mu(p)$, then $t \in \mu(q,p)$ implies that $\mu(q,p) = \mu(p)$. Let $M(\Gamma_r) = \{\Gamma_r/(c10^\omega) + x \mid x \in \mu(0)\}$. Then $M(\Gamma_r) = \mu(r)$. If $p \in [a,b],\ r \neq p$, then $\mu(r) \cap \mu(p) = M(\Gamma_r) \cap M(\Gamma_p) = \emptyset$. Thus, by the Axiom of Choice, there is a one-to-one map $g\colon [a,b] \to \mathbb{N}_\infty$. Significantly, there is a many-to-one surjection $k\colon \mathcal{B} = \bigcup\{M(\Gamma_x) \cap {}^*[a,b] \mid x \in [a,b]\} = \bigcup\{\mu(x) \cap {}^*[a,b] \mid x \in [a,b]\} \to [a,b]$, where $k[M(\Gamma_x) \cap {}^*[a,b]] = \{x\}$. The function k is actually the restriction of the standard part operator, $\mathtt{st}$, that is defined on the set $G(0) \subset {}^*\mathbb{R}$, where $G(0) = \bigcup\{M(\Gamma_x) \mid x \in \mathbb{R}\}$. In this new notation, if an inf-light-clock count is Π_r and $\mathtt{st}(u\Pi_r) = r$, then $M(\Pi_r) = \mu(r)$.

The set of all "open" sets τ, where each is contained in $\mathbb{R}$, is called a "topology" for (on) $\mathbb{R}$. The set ${}^*\tau$ does not, in general, form a topology for ${}^*\mathbb{R}$. There is a topology $\mathcal{T}$ for ${}^*\mathbb{R}$ called the Q-topology, where ${}^*\tau \subset \mathcal{T}$ and the set ${}^*\tau$ is used as a base for $\mathcal{T}$. A member of $\mathcal{T}$ is called a Q-open set. For the Q-topology, the $\mathtt{st}$ operator is a Q-continuous mapping on $G(0)$ onto $\mathbb{R}$ and $\mu(r)$ and $G(0)$ are Q-open sets [13]. In general, $\mu(r) \notin {}^*\tau$. Any function g defined on ${}^*[a,b]$ is "microcontinuous" if and only if for each $p \in [a,b]$ and $q \in {}^*[a,b]$, where $q \approx p$, $g(q) \approx g(p)$ [11].

The operator $\mathtt{st}$ is also "microcontinuous" on ${}^*[a,b]$ for if $p \in [a,b]$, $q \in {}^*[a,b]$ and $q \approx p$, then $q \in G(0)$ and $\mathtt{st}(q) = \mathtt{st}(p) = p$. Further, as expected, the restriction of $\mathtt{st}$ to ${}^*[a,b]$, in the induced Q-topology, is a Q-continuous operator.

For comparison using the "M" notation, a function $f\colon [a,b] \to \mathbb{R}$, is (standard real number) continuous on $[a,b]$ if and only if for each $r \in [a,b]$, ${}^*f[M(\Gamma_r) \cap {}^*[a,b]] \subset M(\Gamma_{f(r)})$. The function ${}^*f$ is also microcontinuous and Q-continuous on ${}^*[a,b]$. Further, for compact $[a,b]$, it follows that ${}^*f[M(\Gamma_r) \cap {}^*[a,b]] = M(\Gamma_{f(r)}) \cap [c,d]$, where, since the image is compact and connected, $f[[a,b]] = [c,d]$. But, $\mathtt{st}(M(\Gamma_r) \cap {}^*[a,b]]) = \{r\}$. Thus, based upon the compact and connected properties of $[a,b]$ and image $f[[a,b]] = [c,d]$, in general, the Q-continuity of $\mathtt{st}$ is a very specific and a "stronger" type of continuity than standard continuity. This follows since ${}^*f[M(\Gamma_r) \cap {}^*[a,b]] = M(\Gamma_{f(r)}) \cap [c,d]$, while the Q-continuity of $\mathtt{st}$ requires that $\mathtt{st}[M(\Gamma_r) \cap {}^*[a,b]] = \mathtt{st}(\{r\}) = \{r\}$. The Q-continuity of $\mathtt{st}$ on $G(0)$ is not related to a standard field continuity that might be a property of $\sqrt{g_1}$. Q-continuity on $G(0)$ applies to any form of alteration in $\sqrt{g_1}$, even an abrupt quantum physical alteration. This follows since, obviously, for any function $f\colon [a,b] \to \mathbb{R}$, $\mathtt{st}({}^*f(p)) = f(p)$. Hence, the operator $\mathtt{st}$ has no affect upon the values of $f(p)$ for any $p \in [a,b]$ in the sense that $\mathtt{st}$ merely mimics many of the standard f-characteristics.

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NOTES

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