Special Relativity and
the Nonstandard Photon-Particle Medium:
The NSPPM.

Robert A. Herrmann

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Abstract: This paper is a general presentation of a physical-like medium that accommodates photon propagation. Using modern infinitesimal analysis, and simple Galilean behavior, variations in physical behavior predicted by the controversial and logically invalid original (1905) Special Theory of Relativity are rigorously obtained without logical error. Completely detailed derivations appear in various published journal articles and a book obtainable at arxiv.org. One postulated aspect for photon behavior predicts these behavioral variations. *

1. Introduction.

In 1991, Abraham Robinson solved the 300-year old problem of Newton and Leibniz (Robinson, 1966). The problem was to find a rigorous foundation for their notions of the "infinitely small" and "infinitely large." These concepts, especially the infinitely small, are the actual foundations for the calculus. There properties were intuitively learned. For example, in calculus books published until the late 1800s a curve is defined as "an infinite collection of infinitely small line-segments." Able (1826) showed that the intuitive notions could lead to contradictions. The modern notion of the limit replaced the language of the infinitesimals, but in so doing many intuitive notions were lost. Indeed, even today when the calculus is applied the term "infinitesimal" is still employed.

The Robinson approach actually applies to mathematics in general not merely the infinitesimals. Unfortunately, only few have any experience with these rigorous methods and for this reason certain details only appear in the referenced articles and books. Books that present Nonstandard Analysis (NSA) are commercially available. Moreover, two books are available from arxiv.org and on the referenced website (Herrmann, 1999, 2003).

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* Due to discrimination now being practiced by arxiv.org, important book updates now appear only at the website listed in the references.

Do infinitesimal measures correspond to some type of physical reality? Robinson (1961) states,

> "For phenomena on a different scale, such as considered in Modern Physics, the dimensions of a particular body or process may not be observable directly. Accordingly the question whether or not a 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 of real numbers. The possibility that this is the case should be borne in mind."

Fine Hall,
Princeton University.

2. The Infinitesimal and R-infinite Numbers.

It is well known that modern group theory is of considerable significance to modern physics. But, modern infinitesimals and Robinson infinite numbers (R-infinite) follow a more structured system. The notions of what constitutes a "non-standard model" and a "superstructure" are not well known within the physics-community. This is particlar so for the ones used in NSA. It is enough to say that these are set-theoretic objects that, at the least, appear to contain all the known mathematical objects used within all of physical-science (the standard ones) plus many additional ones.

[Note: In what follows, certain notational simplifications are used. This notion does not alter the behavior that the symbolism implies.] Do physical scientists use the algebra of ring theory? Consider the set $\mu(0)$ of all *infinitesimals.* The real number $0 \in \mu(0)$. [One basic model uses equivalence classes of sequences that represent "numbers" with algebraic properties. Consider the sequence R of rational numbers defined by $R_0 = 0,\ R_n = 1/n$, where n is a nonzero natural number. Then R is a member of an equivalence class $[R]$. This equivalence class is an example of a nonzero infinitesimal. The equivalence class symbolism is not used but symbols like r represent a class like $[R]$.] Let $\mathbb{R}$ denote the set of real numbers and define for each $p \in \mathbb{R},\ \mu(p) = \{x \mid (x = y + p) \& (y \in \mu(0))\},$, where $+$ behaves like ordinary real number addition. Then defined the set of all *finite* or *limited* numbers as $G(0) = \bigcup\{\mu(p) \mid p \in \mathbb{R}\}$ (i.e. $x \in G(0)$ if and only if there is a $p \in \mathbb{R}$ such that $x \in \mu(p)$. The set $G(0)$ has a defined order, $<$, that is like that of the real numbers, it is an ordered commutative ring. For $x \in {}^*\mathbb{R}$, where ${}^*\mathbb{R}$ is discussed below, $x \in G(0)$

if and only if there is a $y \in \mathbb{R}$ such that $|x| < y$. The set $G(0)$ forms a *commutative ring with identity* with respect to multiplication and addition operations, which are restrictions of the operations as defined on the nonstandard extension of the real numbers ${}^*\mathbb{R}$. These operations when restricted to $\mathbb{R}$ are identical with those of $\mathbb{R}$.

An $\epsilon \in \mu(0)$ if and only if, for each nonzero real number x, $-|x| < \epsilon < |x|$. Athough the set $\mu(0)$ is bounded "above" [resp. "below"] by *any* positive [resp. negative] real number, $\mu(0)$ neither has a least upper bound nor a greatest lower bound. However, there are infinite sets of infinitesimals that contain a maximum and a minimum member. The set $G(0)$ is a subset of the field ${}^*\mathbb{R}$, which is an extension of the real numbers. But, ${}^*\mathbb{R}$ is not a complete field. The set $\mathbb{R}_\infty = \{1/x \mid 0 \neq x \in \mu(0)\}$ and is the set of all *R-infinite* or *infinite* numbers. Let $0 \leq x \in {}^*\mathbb{R}$, $0 \leq r \in G(0)$ and $x < r$. Then there is an $\epsilon \in \mu(0)$ and $p \in \mathbb{R}$ such that $r = p + \epsilon < p + 1 \in \mathbb{R}$. Thus, $|x| < p + 1$. (In like manner, for $x < 0$.) Hence, $x \in G(0)$. Thus, the set ${}^*\mathbb{R} = G(0) \cup \mathbb{R}_\infty$ (i.e. $x \in {}^*\mathbb{R}$ if and only if $x \in G(0)$ or $x \in \mathbb{R}_\infty$.) Further, $\mu(0)$ is a subset $G(0)$ and $G(0)$ is disjoint from $\mathbb{R}_\infty$.

The set $\mu(0)$ only satisfies the algebra for an ordered ring without identity. No $\epsilon \in \mu(0)$ has an multiplicative inverse in $\mu(0)$. Thus, the infinitesimals do not form a field. All of these notions can be extended easily to the complex numbers and the n-dimensional space $\mathbb{R}^n$ (Herrmann, 1999). An important aspect of $\mu(0)$ is that it is an ideal in $G(0)$. This means that for any $\epsilon \in \mu(0)$ and any $x \in G(0)$, the product $\epsilon\, x \in \mu(0)$. Finite sums of infinitesimals are infinitesimal. If one exams Newton's or Leibniz's writings, these rigorous properties are exactly those used for the "infinitely small." However, it is the next property that was not used and was the major reason for the "calculus" controversy.

The monads $\{\mu(p) \mid p \in \mathbb{R}\}$ are disjoint. Hence, for any $x \in G(0)$, there is a unique $p \in \mathbb{R}$ such that $x \in \mu(p)$. This yields a well defined function `st` that can be considered as defined on $G(0)$. This function's properties can be obtained directly from this definition. But, these properties can also be obtained directly from ring theory since $\mu(0)$ is a maximum ideal. (The properties of `st` yield the standard limit properties when `st` is applied to standard sequences and functions.) This function `st` is the *standard part* operator or function and is the primary operator that removes the calculus controversy.

3. Simple Behavior.

When physical behavior or measures were first investigated by the calculus, complex behavior was considered as faithfully approximnated by hypothesized infinitesimal simple behavior. That is, the behavior is consider the results of simple Euclidean, linear, constant and other behavior like Galilean motion. Going from apparent complex behavior to corresponding "simple" behavior is called "infinitesimalizing." The infinitesimalizing idea has not been changed, but for physical applications it has been suppressed. The reason for this is that the previous algebraic methods were not mathematical consistent. Now, however, this has been corrected and infinitesimalizing can be rigorously applied (Herrmann, 1999).

As a physical example, it is rather remarkable that Maxwell used what now has a rigorous definition to produce his 20 differential equations that depict the behavior of the electromagnetic field. He considered a neighborhood of space that he assumed contains an infinite collection of "lines of force." Then he infinitely magnified the region until the magnified region only reveled a finite collection of lines of force. For applications, the same magnification procedure can be rigorously applied and used for geometry and other disciplines and, due to a calculus fundamental theorem for derivatives and the definite integral construction, the view one obtains is that of simple Euclidean geometric configuration or simple behavior. However, the converse is what was originally used to create the calculus expressions in the first place, where infinitesimal entities were simply postulated.

4. The Subparticle

For this paper, it is not necessary that the subparticle notion be describe in-depth. Subparticle details are found in Herrmann (1993, 2006) and were first called "infants" in Herrmann (1982). Indeed, its necessary that the procedures that use the language of nonstandard analysis be minimized since, at present, few members of the physical-science community have the requisite knowledge. Photons, due to their continuous energy spectrum, have been infinitesimalized directly using a new process called the "general paradigm" (Herrmann, 1994, Section 9.3).

Consider a 2010-list of objects or processes termed as physical as they are defined by secular science-communities. Subparticle behavior is highly distinct from the behavior of any item that is presently a member of this list. This does not mean that they need to be excluded from the list. Thus far, however, they have been excluded and relegated to a region termed the substratum or background universe. Whether one includes them as part of the physical-world is a philosophic stance. What they do is to produce all the manifestations that appear in the 2010-list when the operator `st` is applied.

One problem with subparticle theory is that it impinges upon the human tendency to rely upon images. Subparticle behavior, as mathematically modeled, is defined operationally. Any images associated with subparticle behavior must be considered as purely analogue in character. That is, images that but aid our comprehension of behavior, behavior that we may not be able to otherwise comprehend. On page 171 of Herrmann (2002) is an image of the "vague" or "cloudy" view we would have if we could view the behavior of the subparticles that "surround" a standard physical point. The paragraph that follows this illustration explains that the modeling procedure specifically indicates that it is most likely that there is a large amount of behavior that we cannot comprehend. The is called the predicted "lack of knowledge" aspects. This does not mean that information we do glean is insignificant.

5. The Special Theory of Relativity (SR), Derivation Part 1.

The history and controversies about SR are well know and are discussed in many books and articles including in Herrmann (1995). The derivation presented in this paper was first discussed in Herrmann (1992) and portions were published in Herrmann (1994). It is based upon simple properties for infinitesimal-world behavior. The substratum behavioral statements that yield SR constitute the Nonstandard Photon-Particle Medium (NSPPM). About each spatial standard point within the substratum is a region called a *monadic cluster* or *monadic neighborhood*. Whether this is composed of a dense collection of subparticles or not is a matter of choice as to how one conceives of substratum photon propagation. That is, does a photon propagate through this neighborhood as a single entity or are the members of the cluster simply linearly influencing each other, as in the older wave-theory medium concept, and the "disturbance" propagates. It does not matter which stance one chooses since the modeling is fundamentally based only upon photon behavior.

In this modeling, various functions are defined that measure speeds (velocities) and distances in terms of conceptual substratum time and distance. These measures are not altered by any physical processes within the substratum that correspond to physical processes that exist in a physical universe. After the derivation, these conceptual notions are replaced with "infinitesimal light-clocks" and a fixed ruler. Assume that this has been done for standard NSPPM times. The derivation shows that the behavior of infinitesimal light-clocks can be approximated in the physical-world by atomic-clocks used as a physical standard and a process assumed in QED.

It is not well known that a complete and non-controversial derivation does require a few notions from the differential and integral calculus. Although Einstein's original derivation used partial differential calculus, the first translators of his 1905 paper suggested that an invariant value and form method be used. Using a suggestion of Minkowski, this is the one used in most texts today. The fact is that the derivation discussed here does rely upon one aspect of the different calculus.

6. Derivation Part 2.

Two functions q and ℓ are defined with respect to conceptual time t and a conceptual ruler. The function q is a substratum distance function and ℓ a substratum speed function for the substratum speed of a photon. The function ℓ is not assumed to be constant within a monadic cluster. The functions q and ℓ are given an additional NSA property akin to standard continuity termed S-continuity. Also this simplified substratum propagation is linear within a monadic cluster.

The most significant property within the NSPPM may seem to contradict observation. But, there is no contradiction if it only occurs within the substratum. It produces a physical explanation for the dual particle and wave properties associated with photons even if the wave property is interpreted probabilistically. The monadic cluster surrounds, so to speak, each physical-world point p. Let p be the source of the photon and let p have a linear substratum speed of w. The principle states that in the NSPPM the photon satisfies the classical ballistic property in that the photon speed is additionally increased by w. This happens to photons, in particular, since they are the only physical entity that can be infinitesimalized directly. *After the derivation it is observed that this monadic behavior models photon interactions with other entities.* The important word here is "models." Hence, although other interacting bodies do not share the speed, they do acquire some other speed-like properties such as momentum.

Two members $m,\ n \in G(0)$ are infinitely close ($m \approx n$) if here is some $\epsilon \in \mu(0)$ such that $m = n + \epsilon$. Thus, for $m,\ n \in G(0)$, $m \approx n$ if and only if there is a $p \in \mathbb{R}$ such that $m,\ n \in \mu(p)$. For the differential calculus of the first-order, it is not enough that $m \approx n$ but they must be "close" in a special way. Let $\epsilon \in \mu(0)$. Then $\epsilon \approx 3\epsilon$. But. $\frac{\epsilon}{\epsilon^2} \not\approx \frac{3\epsilon}{\epsilon^2}$. (Each of these quotients is a R- infinite number.) Let nonzero $dt \in \mu(0)$. Then m, and n are infinitely close of the first-order dt ($m \sim n \bmod o(dt)$) if any only if $m/dt \approx n/dt$. Notice that, for any $a \neq 3,\ 3dt + 10dt^2 \sim 3dt \bmod (o(dt)$ since $3dt + 10dt^2 \approx 3dt$, but $3dt + 10dt^2 \not\sim adt$. This property is used to combine the simple Galilean composition of speeds via the term "indistinguishable." The differential calculus is based upon infinitesimal measures that are infinitely close (indistinguishable) relative to rates of change. Hence, one needs infinitesimal measures that are infinitely close and that maintain this property under division by nonzero infinitesimals.

[In all that follows, the equation identifiers are as they appear in Herrmann (1995). Further, all substratum time measurements are made by infinitesimal light-clocks.] For any nonzero $dt \in \mu(0) \cap {}^*[a,b]$ $(a > 0)$ (i.e. dt is a common member of $\mu(0)$ and the hyperinterval ${}^*[a,b]$) and NSPPM time $t \in [a,b]$, rigorous NSA leads to the relation

$$q(t+dt) - q(t) \sim \left(\ell(t) + \frac{q(t)}{t}\right) dt. \tag{3.7}$$

In order to achieve physical-world behavior, the function q is taken to be ${}^*s$, where s is continuously differentiable on $[a,b]$. This yields

$$\frac{{}^*s(t+dt)}{dt} \approx \ell(t) + \frac{s(t)}{t}. \tag{3.8}$$

For each $t \in [a,b]$, $\ell(t) \in G(0)$. Application of NSA yields that $\mathtt{st}(\ell(t)) = v(t) \in \mathbb{R}$ and v is a continuous function on $[a,b]$. Equation 3.8 yields

$${}^*\left(\frac{d(s(t)/t)}{dt}\right) = \frac{{}^*v(t)}{t}, \tag{3.9}$$

which holds for each $t \in {}^*[a,b]$. [At end points consider the left or right derivative.]

Now within the substratum consider a standard point F_1 from where a photon begins, at t_1, to propagates to point F_2. Viewing integrals as operators, the *-(definite) integral is applied to each side of equation (3.9) and this yields

$$\frac{s(t)}{t} = {}^*\!\int_{t_1}^{t} \frac{{}^*v(x)}{x} dx, \tag{3.10}$$

for NSPPM measured $t_1 \in [a,b]$ and $s(t_1)$ is initialized to be zero.

It is the standard function in (3.10) that allows us to cross over to other monadic clusters. Thus, substituting into (3.7) yields, since the propagation behavior in each monadic cluster is identical,

$${}^*s(t+dt) - s(t) \sim \left({}^*v(t) + \left({}^*\!\textstyle\int_{t_1}^{t} ({}^*v(x)/x) dx\right)\right) dt, \tag{3.11}$$

for every $t \in [a,b],\ t + dt \in \mu(t) \cap {}^*[a,b]$

Consider a second standard position F_2 at which electromagnetic reflection occurs at $t_2 \in [a,b],\ t_2 > t_1,\ t_2 + dt \in \mu(t_2) \cap {}^*[a,b]$. Then (3.11) becomes

$$ {}^*\!s(t_2+dt)-s(t_2) \sim \left({}^*v(t_2)+\left({}^*\!\int_{t_1}^{t_2}({}^*v(x)/x)dx\right)\right)dt. \tag{3.12} $$

The classical ballistics property holds with respect to electromagnetic propagation within the NSPPM. For the photon NSPPM speed $v(t)$ at $t \in [a,b]$, let a photon have the additional speed w within the NSPPM. Using the indistinguishable concept, this means that the distance traveled ${}^*\!s(t_2+dt)-s(t_2)$ is indistinguishable from $({}^*v(t_2)+w)dt$. Hence,

$$ ({}^*v(t_2)+w)dt \sim {}^*\!s(t_2+dt)-s(t_2) \sim \left({}^*v(t_2)+\left({}^*\!\int_{t_1}^{t_2}\frac{{}^*v(x)}{x}dx\right)\right)dt. \tag{3.13} $$

Expression (3.13) implies that

$$ {}^*v(t_2)+w \approx {}^*v(t_2)+\left({}^*\!\int_{t_1}^{t_2}\frac{{}^*v(x)}{x}dx\right). \tag{3.14} $$

Since $\mathtt{st}(w)$ is a standard number, (3.14) becomes after taking the standard part operator,

$$ \mathtt{st}(w)=\mathtt{st}\left({}^*\!\int_{t_1}^{t_2}\frac{{}^*v(x)}{x}dx\right). \tag{3.15} $$

After reflection, a NSPPM disturbance returns to the first position F_1 arriving at $t_3 \in [a,b],\ t_1 < t_2 < t_3$. Notice that the function s does not appear in equation (3.15). Using the non-favored position concept, a reciprocal argument entails that

$$ \frac{s_1(t_3)}{t_3}=\mathtt{st}\left({}^*\!\int_{t_2}^{t_3}\frac{{}^*v_1(x)}{x}dx\right), \tag{3.16} $$

$$ \mathtt{st}(w)=\mathtt{st}\left({}^*\!\int_{t_2}^{t_3}\frac{{}^*v_1(x)}{x}dx\right), \tag{3.17} $$

where $s_1(t_2)$ is initialized to be zero. It is not assumed that ${}^*v_1 = {}^*v$.

The weighted mean value theorem for integrals in nonstandard form, when applied to equations (3.15) and (3.17), states that there are two NSP-world times $t_a,\ t_b \in {}^*[a,b]$ such that $t_1 \leq t_a \leq t_2 \leq t_b \leq t_3$ and

$$ \mathtt{st}(w)=\mathtt{st}({}^*v(t_a))\int_{t_1}^{t_2}\frac{1}{x}dx=\mathtt{st}({}^*v_1(t_b))\int_{t_2}^{t_3}\frac{1}{x}dx. \tag{3.19} $$

Now suppose that within the local physical-world an $H_1 \to H_2$, $H_2 \to H_1$ light-clock styled measurement for the velocity of light, using a fixed instrumentation, yields equal quantities. Model this by (*) $\mathtt{st}({}^*v(t_a)) = \mathtt{st}({}^*v_1(t_b)) = c$ a NSPPM constant quantity. Property (*) yields

$$\int_{t_1}^{t_2} \frac{1}{x}dx = \int_{t_2}^{t_3} \frac{1}{x}dx. \tag{3.20}$$

And solving (3.20) yields

$$\ln\left(\frac{t_2}{t_1}\right) = \ln\left(\frac{t_3}{t_2}\right). \tag{3.21}$$

From this one has

$$t_2 = \sqrt{t_1 t_3}. \tag{3.22}$$

7. Derivation Part 3.

In the appendix to article 2 in Herrmann (1995), within the NSPPM, a four body problem with photon propagation is investigated using the ballistics property applied to photon behavior and two directed motions. It is argued that two NSPPM speeds $u,\ w$ for a photon source are related by hyperbolic geometry. That is, when simple classical physics is applied to a simple Euclidian speed configuration within the substratum, then there is a transformation Φ: NSPPM $\to$ physical-world, which is characterized by hyperbolic velocity-space properties. This is also the case for relative speed and collinear points, which are exponentially related to the Einstein measures in the physical-world. *Einstein measures model the physical-world wave properties.* Next properties of Φ are determined.

Previously, the expression $t_2 = \sqrt{t_1 t_3}$ was obtained. The Einstein measures are defined formally as

$$\begin{cases} t_E = (1/2)(t_3 + t_1) \\ r_E = (1/2)c(t_3 - t_1) \\ v_E = r_E/t_E, \ \text{where defined.} \end{cases} \tag{A1}$$

Notice that when $r_E = 0$, then $v_E = 0$ and $t_E = t_3 = t_1 = t_2$ are infinitesimal light-clock measures or an equivalent. The Einstein time t_E is obtained by considering the "flight-time" that would result from using one and only one wave property not part of the NSPPM but within the physical-world. This property is that globally the c is not altered by the speed of the source. This Einstein approach assumes that the light pulse path-length from F_1 to F_2 equals that from F_2 back to F_1. Thus, the Einstein flight-time used for the distance r_E is $c(t_3 - t_1)/2$. The t_E, the Einstein time corresponding to an infinitesimal light-clock at F_2, satisfies $t_3 - t_E = t_E - t_1$. From $(A1)$, we have that

$$t_3 = (1 + v_E/c)t_E \text{ and } t_1 = (1 - v_E/c)t_E, \tag{A2}$$

and, hence, $t_2 = (\sqrt{1 - v_E^2/c^2})t_E$. Since $e^{\omega/c} = \sqrt{t_3/t_1}$, this yields

$$e^{\omega/c} = \left(\frac{1 + v_E/c}{1 - v_E/c}\right)^{(1/2)}. \qquad (A3)$$

Thus, (A3) is the relation between the NSPPM speed w and the corresponding physical world speed v_E. The Lorentz transformations are the direct result of a three body problem that uses the classical composition of NSPPM speeds and hyperbolic trigonometry. Three physical-world and NSPPM points $F_1,\ F_2,\ P$ and NSPPM relative speeds $w_1,\ w_2,\ w_3$ are used. Directed speeds lead to a speed-triangle with the angles formed by the recession of these three points one-from-another coupled with measures obtain via the photon radar approach. The transformations are obtained by introducing Einstein measures for time and distance and a rectangular coordinate system. After various calculates are made

$$t^{(1)} = \beta_3(t^{(2)} - v_3x^{(2)}/c^2),\ x^{(1)} = \beta_3(x^{(2)} - v_3t^{(2)}),\ y^{(1)} = y^{(2)},\ z^{(1)} = z^{(2)},\ (A15)$$

is obtained, where $\beta_3 = (1 - v_3/c)^{1/2}$.

All measures are Einstein measures, something which is forgotten when these transformation are give in a modern textbooks. The v_3 is the Einstein measure of a relative speed between the physical-word (and NSPPM) points $F_1,\ F_2$. All other NSPPM relative speeds and angles are eliminated and the Lorentz Transformations are established. If $P \neq F_1, P \neq F_2$, then the fact that $x^{(1)},\ x^{(2)}$ are not the measures for a physical ruler but are measures for a distance related to Einstein measures, which are defined by the properties of the propagation of electromagnetic radiation and infinitesimal light-clock counts, shows that the notion of actual natural world "length" contraction is false. For logical consistency, Einstein measures as determined by the light-clock counts are necessary. This analysis is relative to a "second" pulse when light-clock counts are considered. The positions F_1 and F_2 continue to coincide during the first pulse light-clock count determinations.

8. Derivation Part 4.

How should (A15) be applied so as to remove confusing interpretations? For SR, let s denote standard local measurements that are not assumed to be altered by SR processes. For local measurements, these are the ones that would be obtained for the NSPPM at a stationary point and are the physical "standards." Let m be the NSPPM view of the SR alterations, if any, caused by relative speed v_E which corresponds to a NSPPM speed w. Infinitesimal light-clocks are constructed in a specific manner using a positive and constant infinitesimal "arm" and a counter. To analyze nonzero physical-world time intervals, the R-infinite numbers are employed for the "counts." If the counts are nonzero natural numbers, then the infinitesimal light-clock time measures are members of $\mu(0)$.

By considering the Lorentz Transformations (A15) and measurements in terms of infinitesimal light-clock time, in Article 3, section 2, in Herrmann (1995), the infinitesimalized *chronotopic* interval

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

is obtained, where, for SR, $v_E^2 = (dr^s)^2)/(dt^s)^2 = ((dx^s)^2 + (dy^s)^2 + (dz^s)^2)/(dt^s)^2$. Hence, for $(5)_a$, v_E is in an instantaneous form and $(dr^s)^2 = (dx^s)^2 + (dy^s)^2 + (dz^s)^2$. The values in $(5)_a$ are infinitesimal differences in Eisenstein measures using infinitesimal light-clocks. [Following the Robinson suggestion, these processes take the notion of infinitesimal light-clock measures in the NSPPM as a serious possibility. As an approximation consider the QED to-and fro-like behavior of the virtual photons that maintain the average "distance" between electrons and protons in an atom.]

A new infinitesimal method to derive physical metrics is introduced in Herrmann (1995 Article 3, Section 2, 1996, 2009) using the same NSPPM simple Galilean speed-distance law for photons as used to obtain the Lorentz Transformations. This derivation method employs the notion of "potential speed (velocity)." This is the expression $v + d$ in the line-element (metric) that has speed units of measure and the line-element is not, usually, dependent upon how $v + d$ is otherwise defined. For SR, $v + d = v_E$. The derivation yields the *linear effect line-element*

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

where $\lambda = 1 - (v + d)^2/c^2,\ (dr^m)^2 = (dx^m)^2 + (dy^m)^2 + (dz^m)^2$, and $x^m,\ y^m,\ z^m$ are not dependent upon t^m.

It is a general modeling procedure that the moment when a physical alteration occurs it is assumed that the structure is momentarily (infinitesimally) at rest with respect to the observer and its local environment. Hence, comparing (equating) $(5)_a$ and $(14)_a$,

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

is obtained. This is the basic differential expression used to obtain all of the SR alterations in behavior.

The equation (**) is not a mysterious alteration in the general notion of "time." It states that the infinitesimal differences in infinitesimal light-clock counts are altered. By considering the infinitesimal light-clocks as initially being set to zero, then (**) implies that the counts are being altered in our physical-world by corresponding NSPPM behavior and the transformation Φ. The SR moving infinitesimal light-clocks have a fixed never altering arm. Hence, a "simple" reason for alterations in behavior is that, when compared with the constant behavior in the NSPPM, the value for c is altered by v_E which can be considered as an absolute motion when viewed from the NSPPM. That is, there is no difference in NSPPM behavior if the point F_1 from which this radar measure is obtained for F_2 , or F_2 is considered as fixed in the NSPPM.

Let F_1 have NSPPM speed w_1 and let F_2 recede or approach F_1 with NSPPM speed w_2. The NSPPM relative speed metric is $d(w_1, w_2) = |w_1 - w_2| = w$ and this w is directly associated with v_E. By convention, for the approaching case, if w_1 is nonnegative, then w_2 is negative or convesely. One obtains the same w, if one of the points is considered as fixed in the NSPPM. The value of c would be locally measured as the same as that in the NSPPM. This result is the NSPPM comparative result, when viewed from the substratum. This relation between the NSPPM and the physical-world is called the *emis* (electromagnetic interaction with the substratum) effect.

9. Derivation Part 5.

Using (**) only, how are the SR (and even General Relativity) alterations obtained? A new and somewhat complex derivation process is introduced in Herrmann(1995, Article 3, Section3, 1995a). This method uses a generalization of the well know *separation of variables* method used to solve certain partial differential equations.

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 $T(x_1, x_2, \dots, x_n, t) =$

$h(x_1, x_2, \ldots, x_n)f(t)$. 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 in an invariant separated form. The notion of the universal function is introduced. A universal function is one where the derivation holds throughout its domain of definition and any alterations in measured quantities preserves specific functional forms (i. e. the function is form invariant for specific forms.) The universal function requirement yields the general result that for all such operators

$$\sqrt{\lambda}\, dt^m = \gamma\, dt^m = dt^s \qquad (**)$$

is obtained.

For applications, the time dependent Schrödinger equation is a t-separation operator. This yields the expression

$$\gamma \Delta E^s = \Delta E^m, \qquad (18)$$

for the electron energy changes for a radiating atomic-system. From this, the SR transverse Doppler ($\alpha = 2/\pi$) alteration in frequency

$$\gamma \nu^s = \nu^m \qquad (17)_a$$

is predicted. The first laboratory verification of this prediction was made by Ives and Stillwell (1938). The same Schrödinger equation approach can be used to predict other SR alterations in behavior. For the famous alteration in mass, consider one of two colliding objects each with mass M.

For a Hamilton characteristic function S', the classical Hamilton-Jacobi equation becomes $(\partial S'/\partial r)^2 = -2M(\partial S'/\partial t)$. Suppose that $S'(r,t) = h(r)f(t)$. Consider S' universal in character and the solution method holds throughout our universe. This yields that $h(r^s) = H(r^m)$, $f(t^s) = F(t^m)$, $S'(r^s, t^s) = S'(r^m, t^m)$. [Such equalities are often misunderstood. This is the invariant in value statement. That is, when the values of r^s and t^s are known, then the values of $S'(r^s, t^s)$ and $S'(r^m, t^m)$ are obtained where an invertable transformation is used to express r^s [resp. t^s] in terms of r^m or t^m (or both)]. But, the symbol $S'(r^m, t^m)$ means that each r^s and t^s in $S'(r^s, t^s)$ has been replaced by the transformation equations. This is why $S'(r^s, t^s) = S'(r^m, t^m)$. You can also require that after the transformation equations are inserted that the algebraic expression be invariant in form. Invariant in form usually includes both notions; invariant in value and form.]

Let $D = (\partial(\cdot)/\partial r)^2$. The separation method 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 the case of (22) and (23), one can consider the variables $r^s,\ t^s$ [resp. r^n, t^m] as independent and, hence, (22) [resp. (23)] is equal to a constant. But, in general, one applies the invariant notion for universal functions.

The quantities M^s and M^m are obtained by means of identical modes of measurement that characterizes "mass." The invariant in form requirement leads to the SR mass expression $M^m = (1/\gamma)M^s$.

Consider the basic statement for radioactive decay 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. For the alteration in radioactive decay for SR and to have the requirement that $D(T) = k(\partial T/\partial t)$, where D is a (functional) t-separating operator and k is a universal constant, special equations are defined.

Let, in general, $N(t)$ represent the number of active entities at the "time" t, where $t = t^s$ or t^m. 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. Using these functions, the same procedures used to obtain the mass alteration expression and result (**), the alteration $\tau^s = \tau^m/\gamma$ is obtained.

The linear effect line-element is also applicable to General Relativity. One replaces v_E with "escape" velocity $v_p = \sqrt{2GM/r^m}$ does not use Einstein measure and the metric is one that describes a constant gravitational field. This is equation

(26) in Herrmann (1995), which also used there for a Newtonian approximation. Humphreys uses this metric for the constant gravitational field portion of his recently published cosmology (Herrmann, (2009)).

As mentioned, there is an "explanation" for such behavior that is not merely a statement that "this is how nature works." It is that, as viewed from the NSPPM, the speed of light is slowed for motion relative to the substratum as well as for gravitational fields. (For a GR gravitational field, Humphreys also notes that locally and incomparision c would be altered (Hymphreys, 2007, p. 63).) Assuming that there are, at least, two objects within a universe, then each can have a speed relative to the substratum. Although the speed of light may be altered for each of these objects, one can only detect the effects of such a SR alteration if there is a nonzero relative speed between the two objects so that comparisons can be made. In the most general way, c might be altered in order to compensate for the ballistics behavior in the NSPPM, a behavior that does not globally occur within the physical world. This would be a simple explanation as to why the infinitesimal light-clock counts appear to be altered. Of course, there may be more complex fundamental explanations as well.

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