Matter-waves and Discrete-transitional Motion

AN INFOPHYSICS MONOGRAPH

ON

DISCRETE-TRANSITIONAL MECHANICS

BERNARDO SOTOMAYOR VALDIVIA

This monograph is an evolving document and is updated regularly.

You may click on the following link to obtain its newest version, https://gum.co/matter_waves .

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ABSTRACT

A new hypothesis for stellar Discrete-transitional Mechanics (DTM) is presented based on the Infophysical Spacetime Model (ISM). The concept of spatiotemporal scale-constants is explained using familiar computer jargon and later applied to the stellar scope of Reality. The DTM are used to derive the de Broglie matter-wave relativistic relations by means of the stellar spatial density (frequency) spectrum (SDS) in the Fourier spatial density domain. A tentative value for the stellar spatiotemporal scale-constant is also postulated. The energy, mass and momentum de Broglie relativistic relations are derived, by the same means, without resorting to four dimensional Minkowsky spacetime or to the isotropy of the speed of light, resulting in novel implications such as, discrete-transitional motion and its kinematical properties, natural uniform circular motion in the absence of gravity, universal 3-sphere motional geometry, interscopal coupling, wave-particle equivalence, apodization/containment functions, transitional variables, transactional particles, etc., thus resulting in a novel Discrete-transitional Mechanics (DTM) hypothesis which encompasses Quantum Mechanical concepts, de Broglie matter-waves, Special Relativity and Classical Mechanics.

SUGGESTED READING

In order to better understand the content of this monograph, the reader should be familiar with the following monographs written by the author:

Title	Subject
Reality Unveiled (1).	The defining essay of Infrarealism, an immaterial ontology.
Spacetime Unveiled (2).	An infophysics monograph proposing the Infophysical Spacetime Model (ISM).
Mass-Energy Unveiled (3).	An Infophysics Monograph. Relates the mass-and energy properties to the single fundamental property spatial density (spatial frequency).
Special Relativity Unveiled (4).	An Infophysics Monograph. Derives Einstein's Theory of Special Relativity (SR) in terms of the ISM (2).
Fundamental Constants Explored (5).	An infophysics monograph on the criteria that should be considered in order to establish the legitimacy of a *fundamental* constant of Nature.

You can find links to all the available *Reality Unveiled Collection* monographs at the end of this one.

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INTRODUCTION

For many centuries since Newton introduced his corpuscular theory of light, scientists have tried to determine the nature and speed of light suspecting light to be more than the fastest phenomena in our reality, or just our mayor sensory input. In their endeavor to do so, scientists invented measuring scales made to order. As time passed by, they discovered that light was more than some form of source of energy or communication method but that it seemed to have something to do with almost, if not every, physical phenomena.

In the last one hundred years or so, with the discovery of Quantum Mechanics (QM), physicists discovered that all physical phenomena at the atomic level (scope) behaved in discrete intervals, basically because space and time are both discrete in nature. It turns out that, all physical objects regardless of how small or big, move through space and time, not continuously, but in very small intervals. So small, that we were not aware of it until we began to scrutinize the atomic world.

It wasn't until the discovery of QM that we also realized that all physical phenomena and their properties can only be observed in multiples of very small quantities, therefore the name *quantum*. But quantum is really a misnomer, because the concept of quantity in our modern world can be continuous, although the origin of the word means counting.

When we measure (observe with a scale) any property of Reality, it is measured in terms of either time or space, and since time and space are both discrete, our measuring scales need to be discrete also. As a consequence, all properties can only be counted in terms of some scale. Therefore, a more accurate name for QM could be Discrete Mechanics (DM), but that is neither here nor there.

The point I'm trying to make is that Reality is discrete—countable along some integer scale—, that is, enumerable, which brings us to the point of scale-constants.

SPATIOTEMPORAL SCALE-CONSTANTS

Let me explain what a spatiotemporal (ST) scale-constant is in terms of an example, instead of some formal definition. As a convention, all ST scale-constants, in this and other monographs, are represented by the symbol A_l, where the subscript l represents their domain level (scope).

Let's start with a scale-constant most of us are very familiar with; what we call the *resolution* of an image in a computer display. The word *resolution* in the context of a screen image means, how accurately we are going to draw it. Images are presented on a computer screen by lighting a series of dots in each direction, across its extent. Since computers come with screens of many different sizes, their manufactures need to decide how many dots they are going to be able to light within its extent.

In computer jargon, the number of dots capable of being displayed within the extent of a screen is called its *resolution*. Normally, the resolution of a screen is specified in terms of the number of dots displayable in each dimension—computer screens are flat and have only two spatial dimensions—. Here is where the concept of a scale-constant comes in.

The scale-constants of a computer screen

For each degree of motional freedom (dimension) of the screen, there is an extent, which is the number of (countable) dots in each dimension. But screens come in different sizes, so specifying only the extent of computer screens, would tell us nothing of the resolution (quality) of a particular displayable image. As a consequence, manufacturers place a scale on their screens and specify their resolution in displayable dots (pixels) per inch, which tells us a lot about the quality (resolution) of a displayable image but, at the same time, tells us nothing about the extent of the screen. Computer manufacturers want to sell, so they specify both the extent and the scale-constants of their screens.

To summarize about computer screens:

- ✓ Their extent is the number of pixels in each dimension. Notice this is a unitless quantity, pixels or extents are not units; they are just countable items. This number is normally specified by the product of the two dimensional scale-constants (megapixels).
- ✓ Their scale-constants are the number of pixels per unit distance in each dimension. This number is specified in terms of dots per inch (DPI) or pixels per inch (PPI), which are equivalent. Scale-constants tell us a lot about image resolution.
- ✓ Notice, how systems of units begin to creep-in when we talk about resolution. Pixels are not units, but inches are. This is because we are now *measuring* observable image quality.
- ✓ Scale-constants are about measuring (observing with a scale).

With the above concepts in mind let's discuss the scale-constants of Reality.

The ST scale-constants of Reality

Spacetime has three discrete spatial degrees of motional freedom (dimensions) and one codependent temporal property (motion), whose extents are countable in terms of spatial intervals (spixels) and temporal cycles (tixels), respectively.

So far, no one has been able to discover their extent constants. We don't know the extent constants of the dimensions of space—each may be an infinite number—, but physicists have observed that there exists, at least one relationship, that restricts their degrees of motional freedom in terms of a set of ST scale-constants. I will discuss this relationship in a later section, but first let's continue with the concept of spacetime.

Analyzing spacetime using the computer screen metaphor

Using the computer screen metaphor, assuming Reality is the display domain and infraspace is the screen domain, let's see what we can discern about the ST scale-constants of Reality.

- ✓ Infraspace corresponds to the screen domain, but unlike the screen, we don't know what its extent is, because it's unobservable from the display domain.
- ✓ Reality is observable, but we don't know its extent either, because we are part of it and we haven't traversed all of it.
- ✓ Even if we went as far as what appears to be the end of space, we would never be sure, because we can't reference space to infraspace.

- ✓ Even if the mapping of space to infraspace were one to one, we still wouldn't know its extent, because we don't know the extent of infraspace.
- ✓ The extent of space is unobservable, because infraspace is unobservable.

Since infraspace is unobservable, we can't place a scale on it—like we did with the computer screen—to determine its resolution. In other words we can't count how many points there are in any unit of measure of infraspace, because infraspace's units of measure are also infrareal. The same goes for the temporal property of spacetime.

In conclusion, we are left without knowing, or able to know, the extent and scale-constants of space. All we can say is that they exist, but they are infrareal.

The cyclic nature of the manifestation of time

If we assume that spacetime is manifested by cyclic perturbations of infraspace, which is what appears to be, because all of our Reality seems to have a wavelike behavior, we can conclude or assume the following:

- ✓ Spacetime is manifested as a function of infraspace by some cyclic mapping.
- ✓ *There is a one to one mapping between infraspace and space*. This infraspatial/spatial relational scale-constant is unity (please refer to *Spacetime Unveiled* (2)).
- ✓ The cyclic manifestation mapping is what is responsible for the acquisition of motion (time) exhibited by spacetime.
- ✓ Because the mapping is cyclic, the temporal property is cyclic, which implies that time is finite because its process can stop.
- ✓ Because the mapping is cyclic, it must have a mapping constant that relates infraspace to time. This is the ST scale-constant of Reality. We can use the term ST, instead of infraspatial/temporal, because infraspace and space have a one to one mapping.
- ✓ Time could cycle backwards, but probably for one cycle only. If time could cycle backwards for more than one cycle, Reality would run backwards, which I believe has never been observed.
- ✓ Reality's ST scale-constant is what determines spacetime's Special Relativity (SR).

THE INFOPHYSICAL SPACETIME MODEL

The following conventions are adopted from *Spacetime Unveiled* (2):

Infophysical Spacetime conventions

- ✓ We count the extent of the spatial dimensions in spatial intervals, called *spixels*.
- ✓ We count the extent of the motional property in temporal cycles, called *tixels*.
- ✓ The infraspatial/spatial scale-constant is unity.
- ✓ ST scale-constants determine the resolution of spacetime at a particular scope of Reality. These scale-constants are what I refer to as *scopal scale-constants*.
- ✓ Infrareal data is referred to as belonging to the *existence* domain.
- ✓ Real data and objects belong to the *expression* domain.
- ✓ The manifestation cycle of spacetime is referred to as the *existence-expression cycle*. As in, *spacetime is expressed*, alluding to the evolution from gene to individual, through gene expression.

- ✓ Reality **is** spacetime; therefore both words are used interchangeably in this monograph and others.

The Infophysical Spacetime Model (ISM) assumes the following:

- ✓ The existence-expression cycle (EEC) of spacetime is an orthogonal (Hermitian) mapping.
- ✓ The expression-mapping is the Inverse Discrete Fourier Transform (IDFT), and accounts for
    - Special Relativity.
    - The Heisenberg Uncertainty Principle.
    - The Nyquist-Shannon Sampling Theorem.
    - Wave-particle duality.
    - Dynamical properties, etc.

The cyclic mapping used in the expression of Reality—the IDFT, in case of the ISM—require a set of relational ST scale-constants (ST scopal constants) between the spatial and temporal properties of spacetime, as follows.

SCOPAL SCALE-CONSTANTS

Scopal scale-constants are infrareal, because they belong to the infrastructure of the existence-expression process and are therefore not directly observable; nevertheless they should be calculable if the expression process is known. By assuming that the expression process is the IDFT, we can then use its functional characteristics, first to calculate it and then to verify it experimentally.

The stellar scopal scale-constant

The first attempt to calculate the stellar scopal scale-constant, although that was not the purpose, was established by Isaac Newton when he formulated his classical gravitational relation. The problem is that Big G, although we suspect it to contain some form of a classical scale-constant —we suspect this from its relation to the gravitational forces in contrast to the other forces of Reality—, is a pure empirical constant, thus not revealing its composition. The fact that we call Big G a *coupling constant* attests to this suspicion.

The discovery of the stellar scopal constant is the subject of a future monograph; nevertheless we can address a particular feature of scopal constants, in general, here.

Because scopal scale-constants are ST relational constants —they relate space to time—, they appear to have velocity units; thus, they can be confused with velocities. In order to not confuse the stellar scopal constant with a velocity, we will refer to it, from here on, by the symbol A_γ, where the subscript γ alludes to Special Relativity. A_γ, whose value is presently unknown, is the ST scale-constant of the stellar scope and determines its motional extent. As explained above, the ST scale-constant is unitless, consequently, not a velocity or a speed.

Let's take a look at another relational scale-constant that can be confused with a speed.

The SI units ST scale-constant

The SI units ST scale-constant A_{SI} is an empirical ST scale-constant that is obtained by virtually placing a ruler on part of the stellar scope. Remember that, although we don't know the extent of the stellar scope, we don't need its whole extent to measure its spatiotemporal relation.

Without being aware of it, physicists over the last few centuries—since Ole Rømer, in 1676— may have also been measuring the SI units scopal constant ($A_{SI} = c_0$) by measuring the speed of light (c) in a vacuum. I use the word also, because the speed of light can be confused with c_0, which is not a speed but a constant infrareal value. I say may have, because the speed of light (c) and (c_0) may not have the same value. ***The SI units ST scale-constant c_0 is equivalent to the stellar ST scale-constant A_γ in terms of SI units.***

There's no doubt that the values of c and c_0 are very close to each other, because if that weren't the case, Special Relativity would have been proven false already, and it hasn't.

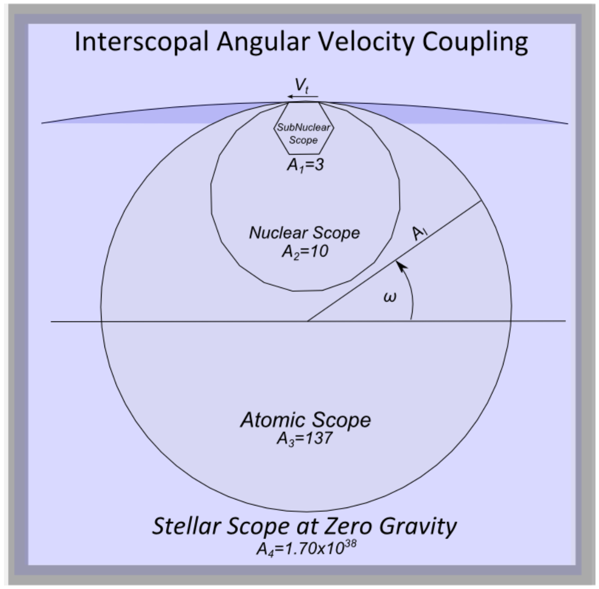

Fig. 1 - The above polygons illustrate the angular velocity coupling between the different scopes of Reality.

The internal angular velocity of a wavicle belonging to a particular scope is incremented as its scope travels within another scope that contains it, for example, an atom travelling within the stellar scope.

Interscopal coupling is responsible for stellar Special Relativity, as well as the stellar matter-wave behavior discovered by de Broglie/Einstein.

MATTER-WAVES

According to *Spacetime Unveiled* (2), an infophysical wavicle (Real object) can be modeled as the trace (the motion) of an oscillating infrareal point that forms a discrete wavefunction in the displacement domain. This model is equivalent to the QM wavefunction, except that the infophysical wavefunction is discrete and describes the wavicle's real displacement, not its probability density.

The discrete wavefunction in the displacement domain is obtained by taking the Inverse Discrete Fourier Transform (IDFT) of the wavefunction's value-frame (Spatial Density Spectrum) in the spatial density domain.

As shown in the sidebar, the total angular velocity (ω) of a wavicle is continuously shifted according to the wavicle's scopal velocity within its upper scope, thus contracting its wavelength in the direction of motion.

INTERSCOPAL COUPLING AND SR

The concept of a moving scope within another scope —also possibly moving—, is a bit confusing at first, that is, if you are not familiar with the nesting of mathematical functions or the concepts of object-oriented programming (OOP[1]) in Software Engineering; nevertheless, Nature appears to be very comfortably implementing it.

Physicists and other scientists have been painfully aware of the rule-changing that Nature imposes on objects depending on their size (scale). Quarks have different behavior rules than nucleons, nucleons also have

[1] Wikipedia, Oct. 2015: *Object-oriented programming (OOP) is a programming paradigm based on the concept of "objects", which are data structures that contain data, in the form of fields, often known as attributes; and code, in the form of procedures, often known as methods.*

different rules, so do atoms and so do the objects that we are used to dealing with (stellar objects). This type of rule-changing appears to me as a haphazard way for Reality to behave knowing its notorious efficiency everywhere else. The nesting of scopes is an Informatics/Software Engineer's attempt to interpret some order into those scale differences.

The following are general concepts and observations relating to the ISM's oscillating points and their scopal behavior:

- ✓ All of Reality's scopes and their objects are modeled by means of the ISM.
- ✓ Wavicles are oscillating points (wave packets) that are expressed, at all scopal levels, in accordance with the ISM, by means of the IDFT of their existence data.
- ✓ Wavicles and their discrete wavefunctions are real and not probability densities as postulated by QM.
- ✓ An abstract point can be an infrareal point or a point-wavicle, depending on the scope.
- ✓ The spatial frequency[2] property —referred to as spatial density property, in this monograph— of an oscillating point or a point-wavicle replaces the concept of physical mass or of a point-mass.
- ✓ The spatial density property (σ) of a wavicle is the number of spatial cycles per unit distance of an oscillating point and it's the same as the inverse of its wavelength $(\sigma = 1/\lambda)$.
- ✓ The temporal density property (f) of a wavicle is the number of temporal cycles per unit time of an oscillating point and it's the same as the inverse of its period $(f = 1/T)$.
- ✓ The temporal frequency property —or temporal density property— of an oscillating point or a point-wavicle is what we observe as physical energy.
- ✓ Special Relativity is the result of the coupling between the atomic and stellar scopes in terms of the angular velocities intrinsic to their Fourier transforms. According to the ISM, SR is not the result of a four dimensional spacetime or of the isotropy of the velocity of light in a vacuum.
- ✓ By the superposition principle, the spatial density of a composite wavicle —no matter how complex its structure— is the sum of the spatial density of its individual components. This property of wavicles facilitates their representation as point-wavicles at all scopal levels.

There is no doubt that matter behaves as SR predicts, but because Reality's objects appear to us to be rigid structures with permanent properties; we can't physically visualize their relativistic behavior. On the other hand, if we assume that all objects are waves, their relativistic properties become easier to rationally accept, but the difficulty arises when we attempt to explain how a conglomerate of wave packets can be as rigid as matter appears to be. There is the conundrum, are objects made out of rigid solid structures or are they malleable waves?

WAVE-PARTICLE DUALITY

From Wikipedia, Sept. 2015, Wave-particle duality:

> *Wave–particle duality is the fact that every elementary particle or quantic entity exhibits the properties of not only particles, but also waves. It*

[2] Wikipedia, Oct. 2015, Spatial Frequency: *In mathematics, physics, and engineering, spatial frequency is a characteristic of any structure that is periodic across position in space. The spatial frequency is a measure of how often sinusoidal components (as determined by the Fourier transform) of the structure repeat per unit of distance.*

addresses the inability of the classical concepts "particle" or "wave" to fully describe the behavior of quantum-scale objects.

It turns out that not only elementary particles exhibit wave properties, recent interference experiments have shown that also atoms and very large molecules can exhibit wave properties.

There have been many explanations and opinions expressed by many leading scientists, such as, Albert Einstein, Erwin Schrödinger, David Bohm, Niels Bohr, Erwin Heisenberg, and so on, for more than a century since Louis de Broglie proposed the hypothesis in his 1924 PhD thesis. In a nutshell, his reasoning was that if light waves exhibit particle properties, as proposed by Einstein, then particles should also exhibit wave properties. Surely enough, his hypothesis has been proven true for many types of particles, including electrons, neutrons, neutral atoms, etc. Also, recent interference experiments have shown the de Broglie relations to hold even for massive molecules such as fullerenes and larger molecules with masses as large as 10,000 amu. Furthermore, it has not been established yet, what the mass limit is for particles to exhibit wave properties, or whether a limit exists at all. Can an object the size of the moon exhibit wave properties? I believe the answer is yes, and could be proven if the right experimental setup is constructed.

Throughout all of the opinions above, one current of thought prevails; wave-particle properties are dual properties —matter behaves like waves— not identical properties —matter is made of waves—. This current of thought stems from the historical conclusion that matter has permanent properties, a fact that has been considered obviously and irrefutably observable, denying on the other hand, the possibility of a transient existence for what we observe as permanent matter.

In this monograph and in others before, I have proposed a discrete-event infophysical spacetime model (ISM) that proposes the transient nature of wavicle objects (wave packets); standing waves that appear to have particle properties. The ISM's wave packets, although basically the same, are not like QM's probability density waves, but observable waves that integrate our Reality. Furthermore, these wavicles have different but similar properties depending on the Reality scope in which they reside, thus providing a single hypothesis that integrates all of Reality and its infrastructure. The ISM, as a matter of fact, is based on a variation of the de Broglie hypothesis explained in the next section.

DE BROGLIE MATTER-WAVES

From Wikipedia, Sept. 2015, [Matter-wave]:

All matter can exhibit wave-like behaviour. For example a beam of electrons can be diffracted just like a beam of light or a water wave. Matter waves are a central part of the theory of quantum mechanics, being an example of wave–particle duality. The concept that matter behaves like a wave is also referred to as the de Broglie hypothesis due to having been proposed by Louis de Broglie in 1924. Matter waves are often referred to as de Broglie waves.

Let's start with the de Broglie non-relativistic wavelength of a wavicle, in terms of the ISM, *(1)* $\lambda = \frac{h}{mv}$, where,

$\lambda = \lambda_\alpha$ is stellar (Compton) wavelength of a wavicle. Notice the use of the γ subscript in order to specify the stellar scope,

h is the Planck constant,

m is stellar mass and

v is stellar speed.

In terms of atomic wavelength, using $\lambda_\alpha = \frac{h}{mc_0}$ from *Mass-Energy Unveiled* (3)*,*

(2) $\lambda = \frac{h}{mv} = \lambda_\alpha \frac{c_0}{v}$, where,

λ_α is the atomic wavicle (Compton) wavelength. Notice the use of the α subscript to specify the atomic scope.

c_0 Is the stellar spatiotemporal [scale] constant in SI units. For short, c_0 is referred to as the stellar ST constant. Notice that the stellar ST constant c_0 is not to be confused with the speed of light in a vacuum c.

Using $\sigma = \frac{1}{\lambda}$, we get the de Broglie relation in terms of atomic spatial density,

(3) $\sigma = \sigma_\alpha \frac{v}{c_0}$, where,

σ_α is atomic (Compton) spatial density and

σ is the stellar spatial density of a wavicle.

Observations on *Eq. (1)* to *Eq. (3)*

The de Broglie matter-wave equation, *Eq. (1)*, gives us the relationship between what we observe as the *kinetic energy* of particles in the stellar (classical) scope, and their wave behavior. By his own words[3], de Broglie's purpose was to find a relationship that would support the corpuscular (photon) theory proposed by Einstein in 1905, as well as, the wave theory of light. Needless to say, ever since then, a multitude of interference experiments have demonstrated his equation to hold true.

In my opinion, de Broglie found much more than theoretical matter-wave compatibility. I believe his matter-wave equations carry a deeper insight into the infrastructure of Reality, namely, the coupling relationship between Reality's different scopes, as follows:

- ✓ We know from (3) that the $\frac{m}{h}$ term in *Eq. (1)* is a conversion factor from angular momentum (in SI units) to normalized spatial density (in SI spatiotemporal units), thus establishing a coupling relationship, by *Eq. (3)*, between the atomic and stellar scopes of Reality. Please refer to *Fig (1)* in the sidebar in the last section.
- ✓ *Eq. (3)* represents the equivalent-mass contribution of a stellar wavicle in terms of spatiotemporal units.
- ✓ Without the coupling relationship established by *Eq. (3)*, it is difficult to rationally accept the relativistic behavior of classical objects. Special Relativity demands too much elasticity from classical structurally rigid objects; while on the other hand, the dilating nature of the spatial density of wavicles is not a difficult behavior to visualize.

[3] Wikipedia, Sept. 2014: Matter wave.

- ✓ The tangential speed v in the above de Broglie equations is normally taken as the linear group velocity in the Cartesian direction of motion of the wavicle because this equation is a non-relativistic equation. If we assume v to be the tangential point speed of the stellar Fourier transform expression process, as shown in the previous section, we can use this transformation to justify the relativistic behavior of discrete wavicle motion.

DISCRETE-TRANSITIONAL MECHANICS

There are various ways of deriving the relativistic de Broglie matter-wave relations and they can be readily found in the literature. Nevertheless, in this section, I will derive the de Broglie relations by means of stellar Discrete-transitional Mechanics (DTM) as implied by the Infophysical Spacetime Model.

We know from *Spacetime Unveiled* (2)[4] that the construction of the bandlimited wavicle wavefunction Ψ_n in the displacement domain is accomplished by using the inverse Discrete Fourier transform (IDFT) of Φ_k, the discrete wavefunction in the spatial density domain, in accordance with the Nyquist-Shannon Sampling Theorem.

THE STELLAR DISCRETE WAVEFUNCTION

Substituting the stellar scale-constant in the generalized discrete scopal wavefunction in the spatial density domain, we get,

(4) $\Psi_n = \frac{1}{\lambda_S A_\gamma} \sum_{k=0}^{A_\gamma - 1} \Phi_k e^{i2\pi\left(\frac{k}{A_\gamma \lambda_S}\right)n}$, where, we show the following scopal wavicle properties in infounits[5],

Ψ_n is the stellar expression discrete wavefunction in the displacement domain,
$\lambda_S = 1$, is the sampling spatial interval,
$\sigma_S = \frac{1}{\lambda_S} = 1$, is the sampling spatial density,
$\lambda_S A_\gamma = A_\gamma$, is the angular resolution,
$\lambda_C = 2\lambda_S = 2$, is the free stellar-wavicle wavelength,
$\sigma_S = 2\sigma_C$ is twice the free stellar-wavicle spatial frequency (density),
$\sigma_S = 2\sigma_N$ is also twice the Nyquist spatial frequency as required by the sampling theorem, that is,
$\sigma_N = \sigma_C = \sigma_\gamma$, the Nyquist, Compton, stellar wavicle spatial densities, respectively, which are all equivalent.
Φ_k is the stellar existence frame in the spatial density domain,
k, is the discrete angular velocity index,
n, is the discrete displacement index,
$\sigma_k = \frac{k}{A_\gamma}\sigma_S$, are Fourier spatial density spectral points,
$S_\gamma = \lambda_S A_\gamma = A_\gamma$, is the EEC stellar frame size and
$\mathcal{S}_\gamma = \lambda_C A_\gamma = 2\lambda_S A_\gamma = 2A_\gamma$, the stellar scale factor $\mathcal{S}_\gamma$.

In terms of spatial density,

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[4] Links to other monographs by the author, where the reader may find more detailed explanations and a derivation of *Eq. (4)*, are available at the end of this monograph.
[5] From *Spacetime Unveiled* (2): A set of special units similar to natural units.

(5) $\Psi_n = \frac{\sigma_e}{2A_\gamma}\sum_{k=0}^{A_\gamma-1}\Phi_k e^{i2\pi\left(\frac{k\sigma_e}{2A_\gamma}\right)n}$, where,

$\sigma_S = \frac{1}{\lambda_S} = 2\sigma_e$ is the stellar spatial density sampling interval, which is assumed to be twice the spatial density of the free electron, as a preliminary assumption. This assumption is justified for now —although not necessarily true—, for generalization purposes.

As a starting point, a stellar wavicle's spatial density spectrum (SDS)[6] —existence value-frame— in its simplest form would be,

(6) $\Phi[k] = \left| \begin{matrix} \sigma_0, k = 0 \\ \frac{k\sigma_0}{A_\gamma}, k = 1\ to\ A_\gamma - 1 \end{matrix} \right|$, which is a one dimensional array of spatial density spectral amplitudes representing the wavicle's discrete wavefunction in the existence domain —the stellar special density spectrum (SDS) of a single isolated wavicle—, where,

$\sigma_0 = \sigma_\alpha$ are the rest spatial density and the atomic spatial density, respectively and

$\Phi[k] = \frac{k\sigma_0}{A_\gamma}$ is the k^{th} spectral density amplitude of the wavicle.

This type of stellar wavefunction, at first sight, seems reasonable because it would account for an increasing spatial density component with an increasing velocity index, but the wave function would be linear, which could not explain Reality's behavior in regards to SR, gravity or de Broglie matter-waves. What appears to be needed here is an apodization[7] function —also known as a tapering window— for the IDFT to yield the contained, non-ambiguous (non-aliasing), spatial behavior that Reality exhibits.

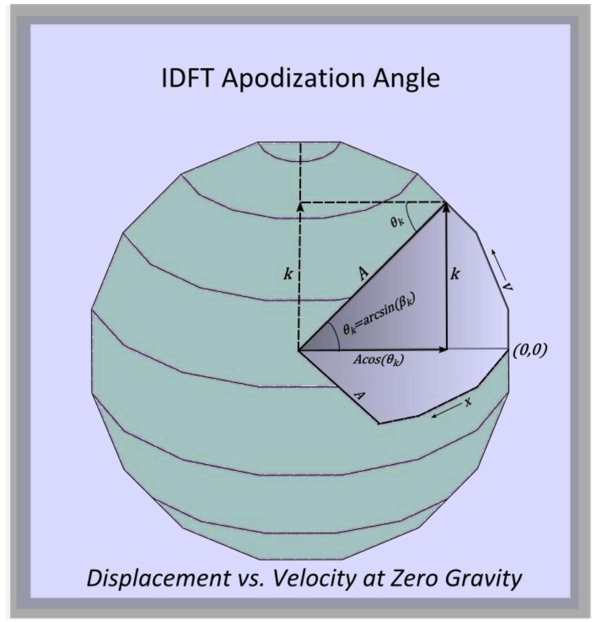

Fig. 2 - The above figure illustrates the IDFT angular frequency and the relativistic apodization angles for a scope of radius A, where:

a) k is the tangential velocity index of the spatial density domain.

b) $\beta_k = \frac{k}{A_\gamma} = \frac{v_k}{c_0}$, is scopal angular frequency and

c) λ_k is the apodized effective wavelength,

d) θ_k is the stellar apodization angle.

The useful trigonometric relations for the apodization angle θ_k are:

e) $sin(\theta_k) = \frac{k}{A_\gamma} = \frac{v_k}{c_0}$,

f) $\theta_k = arcsin\left(\frac{k}{A_\gamma}\right) = arcsin\left(\frac{v_k}{c_0}\right)$ and

g) $\lambda_k = \lambda_0 cos(\theta_k) = \lambda_0\sqrt{1-\left(\frac{k}{A_\gamma}\right)^2}$.

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[6] As in Spectral Analysis, Wikipedia Dec. 2015: Spectral analysis or Spectrum analysis is analysis in terms of a spectrum of frequencies or related quantities such as energies.

[7] Wikipedia, Oct, 2015: Apodization. *Apodization is an optical filtering technique, and its literal translation is "removing the foot". It is the technical term for changing the shape of a mathematical function, an electrical signal, an optical transmission or a mechanical structure.*

In order to account for SR, the first apodization function that came to mind was the cosine apodization function[8] for the wavicle wavelength $\lambda_k = \lambda_0 cos(\theta_k)$, which would yield,

(7) $$\Phi[k] = \left| \begin{matrix} \sigma_0, k = 0 \\ \frac{k\sigma_0}{A_\gamma cos(\theta_k)}, k = 1\ to\ A_\gamma - 1 \end{matrix} \right|,$$

where, for the standard cosine apodization function, the apodization angle θ_k would be, $\theta_k = \frac{\pi}{2}\frac{k}{A_\gamma}$, which would yield the required contained behavior, close to SR, but not the same.

On closer observation (please refer to *Fig (2)* in the sidebar above), choosing,

(8) $\theta_k = arcsin\left(\frac{k}{A_\gamma}\right)$, for the apodization angle, can yield the exact results as SR and de Broglie matter-waves. The apodization window then becomes,

(9) $w(k) = cos(\theta_k) = cos\left(arcsin\left(\frac{k}{A_\gamma}\right)\right) = \sqrt{1 - \left(\frac{k}{A_\gamma}\right)^2}$, which leaves us with,

(10) $$\Phi[k] = \left| \begin{matrix} \sigma_0, k = 0 \\ \frac{k\sigma_0}{A_\gamma \sqrt{1 - \left(\frac{k}{A_\gamma}\right)^2}}, k = 1\ to\ A_\gamma - 1 \end{matrix} \right|,$$ as a special case of the stellar SDS —the stellar existence value-frame— containing a single stellar wavicle.

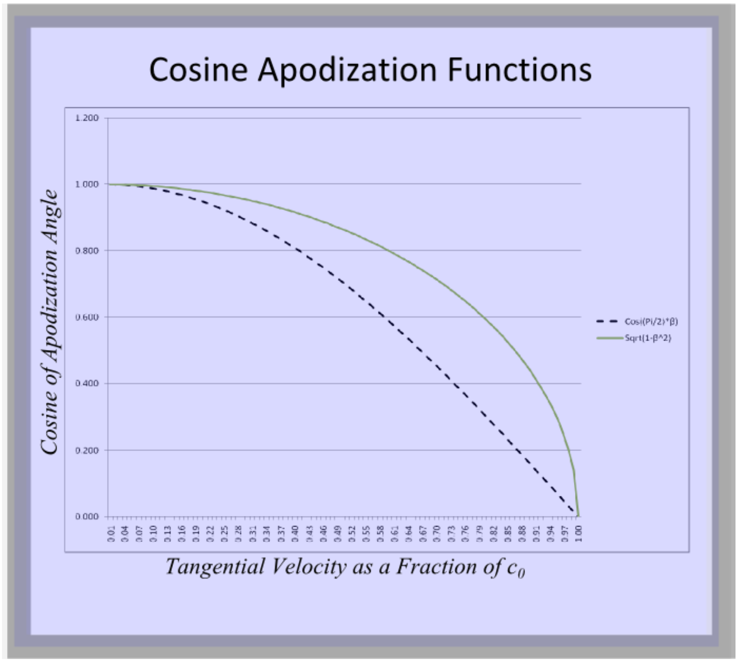

Fig 3. — A plot of two possible (of many) cosine windows that could be considered for the apodization of the existence domain's stellar wavefunction. The dotted curve is the plot of $w(k) = cos\left(\frac{\pi}{2}\beta\right)$, which is a standard cosine apodization function of spectral analysis. The solid curve represents the cosine apodization function required for relativistic effects, which is $w(k) = cos(arcsin(\beta)) = \sqrt{1 - (\beta)^2}$. In both cases $\beta = \frac{k}{A_\gamma} = \frac{v_k}{c_0}$.

Notice that both functions start at unity and approach zero as β approaches unity, which is, of course, a property of the cosine function. Their important difference lies in the shape of the curves at their limits. Notice how the relativistic curve is more linear than the standard cosine curve at low velocities and has a much steeper slope as velocities approach the stellar ST scale-constant. This is a very desirable effect in digital processing because it provides a sharper signal boundary.

Notice also that both functions are valid for negative velocities.

Observations on *Eq. (4)* to *Eq. (10)*

The following are observations on each of the equations presented in this section.

[8] Wolfram MathWorld, Oct, 2015: Cosine Apodization Function.

Eq. (4) is the stellar version of the IDFT of the infophysical discrete wavefunction of the ISM. As you can see, if you have read *Spacetime Unveiled* (2), the stellar ST scopal scale-constant A_γ has been substituted for the scale-constant A_l in the generalized ISM discrete spatial density domain wavefunction of a spacetime wavicle, where A_l represents the scale-constant of the level l scope of Reality, namely the stellar scope. This is done because the de Broglie relations are stellar (classical/relativistic) effects.

The following is my —as much as possible— plain English interpretation of *Eq. (4)*:

- ✓ All variables are in infounits.
- ✓ The equation is a one dimensional discrete wavefunction of the stellar scope containing a single isolated wavicle. Do not be tempted to interpret it as two dimensional, considering time as a dimension; the ISM does not model a four dimensional spacetime in the same way as SR does. What you see in *Fig (2)* is a one dimensional ($k = v_k$) wavefunction, parameterized by its scopal stationary wavelength $\left(\lambda_0 = \frac{1}{\sigma_0}\right)$.
  Because the wavicle's effective wavelength $\left(\lambda_k = \lambda_0 cos(\theta_k)\right)$ is a circular orthogonal function of its tangential scopal velocity, it is represented as a two dimensional point wavicle, whose motion is tiled on a 2-sphere.
- ✓ The three dimensional discrete wavefunction must be modeled by the three dimensional IDFT, which would be the subject of a future monograph.
- ✓ The expression of motion in the ISM is a discrete-event process, and therefore so is time. Time is not a dimension as in Minkowsky spacetime; it is a discrete property of spacetime.
- ✓ The sampling spatial interval ($\lambda_S = \lambda_e/2$), as in the Nyquist-Shannon Sampling Theorem[9], is postulated to be twice the highest sampled spatial density of stellar Reality, which is postulated to be one half the Compton wavelength λ_e of the free-electron.
- ✓ A 3D stellar wavicle is the expression of the discrete wavefunction of a point-mass oscillating at a discrete angular velocity, restricted to a 3-sphere whose radius is the stellar ST scale-constant.
- ✓ The stellar scope is assumed to contain a single isolated wavicle in the absence of gravity.
- ✓ The infophysical discrete wavefunction implies that a wavicle (any Reality object), if set in motion by a spatial density transaction, will remain in a ***discrete uniform circular transitional state of motion*** in the absence of gravity or other spatial density transactions. This of course, is a radical re-statement of Newton's first law of motion.
- ✓ *Eq. (10)* is the stellar SDS —a one dimensional array of spatial density amplitudes— representing the IDFT of the wavefunction of an isolated stellar wavicle.
- ✓ The stellar SDS completely determines the construction principles (laws) of motion of a wavicle, as well as, all its isolated properties, such as energy, mass, momentum, etc.
- ✓ Because of the circular nature of the Fourier transform, the stellar spectrum (SDS) also determines the wave-like properties of matter.
- ✓ As we can see, the wavelength of a wavicle approaches zero as its relative velocity approaches the stellar ST scopal constant (c_0), as expected.
- ✓ The transitional wavelength of a stellar wavicle is undefined for tangential velocity zero, because velocity zero does not contribute any spatial density to the wavicle. In other words, a stationary object does not trace a wave and therefore does not have any de Broglie properties.

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[9] Wikipedia Oct. 2015: Nyquist-Shannon Sampling Theorem. *In the field of digital signal processing, the sampling theorem is a fundamental bridge between continuous-time signals (often called "analog signals") and discrete-time signals (often called "digital signals"). It establishes a sufficient condition for a sample rate that permits a discrete sequence of samples to capture all the information from a continuous-time signal of finite bandwidth.*

- ✓ *Eq. (10)* is the relativistic existence value-frame for the spatial density of an isolated stellar wavicle. As it clearly shows, the spatial density of a stellar wavicle increases exponentially as its tangential velocity approaches c_0, while its wavelength approaches zero. Because the wavicle's transitional spatial density increases with tangential velocity, so does its transitional mass, momentum and energy.

Apodization functions

Apodization functions are commonly used in Digital Signal Processing[10] as an essential function in many engineering applications to record, analyze, manipulate and or reproduce physical processes.

The sidebar illustrates how an apodization function in the existence domain affects the spatial density of a wavicle in the expression domain. *Fig. (3),* above, illustrates what happens to the wavelength of a wavicle when its tangential velocity approaches the ST scale-constant.

One can't help but wonder what other similar apodization function could have been chosen for the expression process of stellar Reality, thus generating a different universe. Additionally, it would also be interesting to investigate which of those functions could generate a stable universe. Obviously the relativistic cosine function has worked fine, so far, to generate a stable and evolving universe, so asking what else could have been chosen is a moot point, unless one wants to experiment with creating one's own simulated reality, in which case it would be a reasonable question.

[10] Wikipedia, Oct. 2015: Digital signal processing. *Digital signal processing (DSP) is the numerical manipulation of signals, usually with the intention to measure, filter, produce or compress continuous analog signals. It is characterized by the use of digital signals to represent these signals as discrete time, discrete frequency, or other discrete domain signals in the form of a sequence of numbers or symbols to permit the digital processing of these signals.*

DE BROGLIE WAVES

As shown in the sidebar, the purpose of the inverse of the apodization function of the stellar wavefunction (*Eq. (10)*), seems to be a containing mechanism for stellar object dynamics. In other words, if the stellar universe is expressed as proposed by the ISM, the relativistic cosine function imposes a boundary for the expression of stellar physical dynamics.

This is not to say necessarily that material objects are waves, but that the stellar wavefunction represents the complete set of properties and containment of an isolated object residing within the stellar scope. In other words, the stellar wavefunction establishes the governing principles by which an object of Reality must abide when observed within the stellar scope, which includes its wave-like properties as well.

Another very important implication of the stellar wavefunction is that all stellar objects must exhibit discrete properties and therefore all object interactions must be discrete-transitional. In other words, all motion and its related properties can only change as discrete-event transitions from one state of the wavefunction to another.

The transitional properties of an isolated stellar wavicle are derived in the following section.

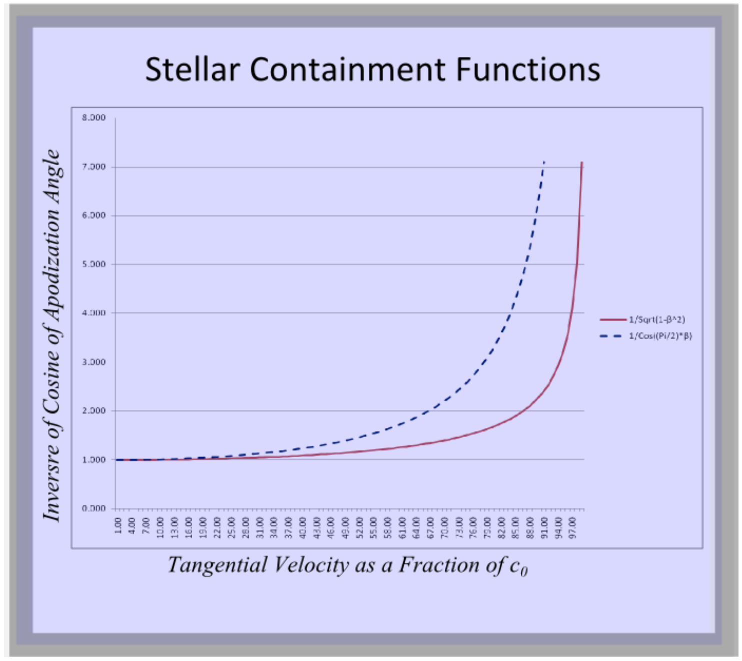

Fig 4. — This is a plot of the inverse of the same apodization cosine functions shown in *Fig. (3)*, in the previous section.

Using the inverse of each apodization function helps us visualize the containment effect that both functions have. The relativistic cosine function has a better containment effect because it remains linear longer than the standard cosine function and provides a steeper boundary. We can speculate on the idea that that's one of the reasons it was chosen, while considering as well that simpler and faster computation can be implemented.

The inverse of the functions are plotted because of the relation $\sigma = 1/\lambda$. We know that energy, mass and momentum are directly proportional to wavicle spatial density (σ_k), thus inversely proportional to wavicle wavelength (λ_k). The plots show a direct relation to the relativistic behavior of mass and energy of a stellar object, as its tangential velocity increases and approaches c_0.

Transitional spatial density

From *Eq. (10)*, the stellar SDS for a single stationary wavicle is,

(11) $$\Phi[k] = \begin{vmatrix} \sigma_\alpha = \sigma_0, k = 0 \\ 0, k = 1 \ to \ A_\gamma - 1 \end{vmatrix}, \text{ where,}$$

σ_α is its atomic spatial density,
σ_0 is its rest spatial density, which is equal to the atomic spatial density σ_α and
A_γ is the stellar ST constant.

From the same equation, the stellar spatial density spectrum for a wavicle in its k^{th} state is,

(12) $\Phi[k] = \left| \begin{matrix} \sigma_0, k = 0 \\ \frac{k\sigma_0}{A_\gamma cos(\theta_k)}, k = 1 \; to \; A_\gamma - 1 \end{matrix} \right|$, where,

k is the tangential velocity index,

θ_k is the k^{th} stellar apodization angle $\theta_k = arcsin(\beta_k)$, where $\beta_k = \frac{k}{A_\gamma} = \frac{v_k}{c_0}$, as shown in *Fig. (2),* above.

The amount of spatial density —the spatial density transaction— required for a wavicle to transition from its ground level $k = 0$ state to a higher spatial density level k^{th}-state (velocity-state) is given by,

(13) $\sigma_k = \frac{k\sigma_0}{A_\gamma cos(\theta_k)} = \frac{v_k\sigma_0}{c_0 cos(\theta_k)} = \frac{\gamma\sigma_0 v_k}{c_0} = \sigma_0 tan(\theta_k)$.

Using the trig identity for $cos(\theta_k)$, substituting $sin(\theta_k) = v_k/c_0$ in *Eq. (13)* and converting to SI units by using $\sigma = \frac{mc_0}{h}$, we get,

(14) $\sigma_k = \frac{v_k m_0}{h\sqrt{1-\left(\frac{v_k}{c_0}\right)^2}} = \frac{p_k}{h}$, which is the relativistic de Broglie spatial density transaction required in order for a stellar isolated wavicle to transition from its ground (rest) state to velocity v_k, where,

v_k is discrete tangential velocity and

p_k is discrete relativistic tangential momentum.

Solving for p_k,

(15) $p_k = h\sigma_k$, which is the unit conversion relation between transitional spatial density and transitional momentum. Obviously, the equivalent of Einstein's equation on the corpuscular theory of light,

(16) $p_k = \frac{h}{\lambda_k}$.

Transitional mass

In terms of mass, using *Eq. (14)*,

(17) $m_k = \frac{v_k m_0}{c_0\sqrt{1-\left(\frac{v_k}{c_0}\right)^2}} = \frac{p_k}{c_0} = \frac{h\sigma_k}{c_0} = m_0 tan(\theta_k)$. This is the transitional mass of the wavicle.

The transitional mass of a wavicle is the mass increase induced by the increase in the transitional velocity of the wavicle.

Transitional energy

In terms of energy, using *Eq. (14)* and $E = hc_0\sigma$,

(18) $E_k = hc_0 \frac{v_k m_0}{h\sqrt{1-\left(\frac{v_k}{c_0}\right)^2}} = \frac{v_k m_0 c_0}{\sqrt{1-\left(\frac{v_k}{c_0}\right)^2}} = p_k c_0$, this is the transitional (kinetic) energy of the wavicle.

The total spatial density of a wavicle is given by, *(19)* $\sigma = \sigma_0 + \sigma_k$, which is the rest (atomic) spatial density plus the transitional spatial density contributed by stellar transitional motion, namely the kinetic spatial density. Converting to SI units by using $\sigma = \frac{mc_0}{h}$ and *Eq. (14)*, we get,

(20) $mc_0 = m_0 c_0 + p_k$. Multiplying both sides by c_0,

(21) $E = E_0 + p_k c_0 = E_0 + E_k$, which is the total energy relation of a stellar wavicle.

Solving for E_k,

(22) $E_k = \frac{E_0}{cos(\theta_k)} - E_0 = E_0\left(\frac{1}{cos(\theta_k)} - 1\right) = E_0(\gamma - 1)$, which is again the relativistic kinetic energy, this time in terms of the rest energy of the wavicle.

Energy-Momentum Relation

Let's start with the Lorentz factor,

(23) $\gamma = \frac{1}{cos(\theta_k)}$. Squaring both sides,

(24) $1 = \gamma^2 cos^2(\theta_k) = \gamma^2 - \gamma^2 sin^2(\theta_k)$, multiplying both sides by ${m_0}^2 {c_0}^4$ and substituting for $sin(\theta_k) = \frac{v_k}{c_0}$,

(25) ${m_0}^2 {c_0}^4 = \gamma^2 {m_0}^2 {c_0}^4 - \gamma^2 {v_k}^2 {m_0}^2 {c_0}^2$, using $E = m{c_0}^2$ on both sides of the equation and solving for E,

(26) $E^2 = {E_0}^2 + (pc_0)^2$, which is the energy-momentum relation

The above relations show that the total stellar energy of a wavicle is the sum of its rest energy plus its transitional (kinetic) energy. As you can see, the Pythagorean nature of this relation is a direct result of the stellar apodization angle. Any other angle would result in totally different, probably unstable mechanics, resulting perhaps in a collapsed or oscillating Universe. This is not to say that the Universe has reached, or will ever reach, a steady-state. All we know is that it has been stable enough for us to exist.

Transitional wavelength

The relativistic de Broglie wavelength of a wavicle with tangential velocity v_k is given, from *Eq. (14)* by,

(27) $\lambda_B = \lambda_k = \frac{h\sqrt{1-\left(\frac{v_k}{c_0}\right)^2}}{v_k m_0} = \frac{h}{p_k}$.

The above equation is the de Broglie relativistic wavelength relation derived from the ISM's discrete wavefunction equation of the stellar scope.

The de Broglie wavelength is the effective wavelength (apodized wavelength) of a transitioning wavicle at a constant transitional velocity. In terms of relativistic mechanics we could say that, the de Broglie wavelength of a stellar object is the one-dimensional effective wavelength of the wave traced by a single point-mass, traversing a spherical great-circle of the Universe.

- ✓ The stellar SDS —a one dimensional array of A_γ spectral spatial density points— is set to $\Phi[k] = \frac{k\sigma_0}{A_\gamma cos(\theta_k)}$ in order to account for what is observed as angular momentum, SR and de Broglie matter-waves by multiplying each spectral amplitude by the inverse of the relativistic cosine apodization function.
- ✓ Notice that the subscript (k) in the tangential velocity index v_k is used to remind us of ***the discrete nature of wavicle motion***.
- ✓ The angular velocity component introduced by discrete stellar motion increases the Compton spatial density (momentum) of a wavicle or conglomerate of wavicles, as a function of the tangent of the stellar apodization angle $\theta_k = arcsin(\beta_k)$, where $\beta_k = \frac{k}{A_\gamma} = \frac{v_k}{c_0}$. Please refer to *Fig. (5)* in the sidebar.
- ✓ There is no need to postulate the isotropy of the speed of light or of a four dimensional spacetime to account and derive all of the SR relationships.

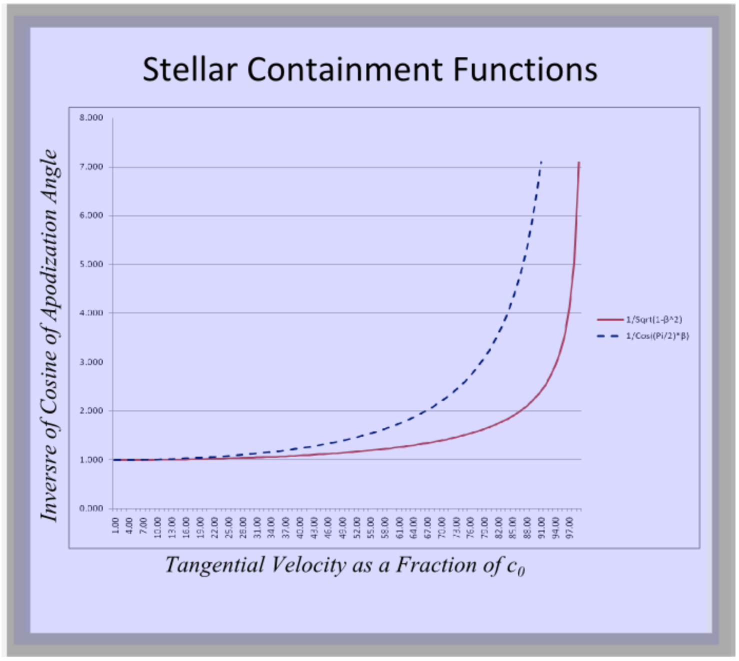

Fig 5. — This is a plot of the relativistic behavior of wavicle transactional spatial density as a function of $tan(\theta_k)$ where, $\theta_k = arcsin(\beta_k)$ and $\beta_k = \frac{k}{A_\gamma} = \frac{v_k}{c_0}$.

Because transitional mass, momentum and energy are directly proportional to spatial density, the plot also shows a direct relation to the relativistic behavior of kinetic mass, momentum and energy of a stellar object as its tangential velocity increases and approaches c_0.

- ✓ There is no mention here of frames of reference, relative or absolute, because ***any spatial coordinate of the stellar scope <u>is</u> a frame of reference, which can be either relative or absolute, without conflict***.
- ✓ As you have probably noticed in all of the equations in this monograph, there is no mention of probability densities, that's because the stellar discrete wavefunction is a real function representing the sinusoidal oscillation of a point mass, not a probability density function as in QM. ***The infophysical wavicle is a real object and its discrete wavefunction is its real representation***.
- ✓ *Eq. (13)* shows very clearly how the stellar scope is coupled to the atomic scope of Reality. The coupling relationship implied by the de Broglie relations, obtained from the ISM, explains how, as a wavicle transitions to a higher angular velocity state, its total spatial density increases, thus accounting for Special Relativity.
- ✓ As shown by *Eq. (13)*, the coupling implied by the de Broglie relationship derived from the ISM, is the cause of Special Relativity and consequently defines the transitional properties of discrete motion within the stellar scope.
- ✓ *Eq. (14),* relates the transitional spatial density of a stellar wavicle to its momentum. As a consequence, momentum is also transitional.

- ✓ *Eq. (15)*, shows very clearly that ***the Planck constant is a conversion factor —not a fundamental constant— from spatiotemporal SI units to SI mass units***. The Planck constant relates wavicle temporal frequency to total classical energy, as well as, wavicle transitional spatial density to momentum.
- ✓ The de Broglie transitional energy E_k, as shown by *Eq. (21)* and *Eq. (22)*, relate the stellar transitional (kinetic) energy of a point-wavicle (point-particle) to its relativistic momentum, as expected, since this was one of de Broglie's original assumptions.
- ✓ *Eq. (17)*, relates the stellar transitional mass of a point-wavicle (point-particle) to its relativistic transitional momentum.
- ✓ It can also be clearly seen from *Eq. (17)*, how a wavicle can gain mass under the action of gravity, thus gaining spatial density and energy.
- ✓ *Eq. (27)* is the relativistic de Broglie wavelength relation. You may notice that Einstein's SR is not explicitly required, because ***relativity is intrinsically implied by the apodization of the discrete wavefunction of the stellar scope***.

STELLAR TRANSITIONAL UNITS

Because all stellar wavicle transitional properties must be countable (enumerable) a value for unity (transitional unit value) for each property must exist.

A stellar transitional unit is the minimum value (quantum) of a stellar wavicle's transitional property. As I will show, the base stellar properties are the transitional displacement unit (spixel) and the transitional time interval unit (tixel), from which all other transitional property units can be derived.

I must emphasize that, none of the equations in this section imply that scopal transitional units have the same value across different scopes; ST scale-constants vary across different scopes, so may their transitional units. The rest of this section discusses the stellar wavicle's transitional property units.

But, before we go on to calculate transitional property units, we first need to estimate the stellar ST scale-constant.

The stellar ST scale-constant

From *Eq. (4)* and the requirement by the sampling theorem that the sampling frequency needs to be twice the highest sampled frequency component, we can postulate for now, as a preliminary value, that $\sigma_S = 2\sigma_e$, where σ_e is the Compton spatial density of the free electron. In other words, we are postulating that σ_S is the transitional spatial density unit and that λ_S is the transitional displacement unit of the stellar scope, where $\lambda_S = \lambda_\gamma = \frac{1}{\sigma_S} = \frac{\lambda_e}{2}$.

Remember that postulating the value for the stellar spixel to be one half the atomic scope's sampling wavelength is just an ad hoc assumption, which takes into consideration that free electrons do not exist within the atomic scope and because the free electron is a stellar wavicle. Also, we use the value here to give us orders of magnitude for the stellar properties transitional units. If it turns out that this postulate is true, which is perfectly possible, that means we got lucky, which I believe to be the case. Keeping that in mind, we can now determine our first estimate for the stellar ST scale-constant A_γ by means of the observed value of the extent of the universe.

The spatial extent of the Universe

The spatial extent of stellar motion —the extent (circumference) of the universe— can be determined from the stellar discrete wavefunction and is given by,

(28) $X_\gamma = 2\pi\lambda_\gamma A_\gamma = \pi\lambda_e A_\gamma$, where λ_e is the Compton wavelength of the free electron and A_γ is the stellar ST scale-constant.

The Cosmic Microwave Background

If we assume 3-sphere motional geometry for the stellar scope, we can appreciate from *Fig. (6)* in the sidebar, how the Cosmic Microwave Background (CMB)[11] can be interpreted in two dimensions to be the radiation that has gone around the antipode of the universe and has reached us as diffused radiation.

You can also appreciate from the motional geometry of the universe that, no matter what the absolute displacement of the earth may be, the earth is always placed at some origin with an antipodal CMB, thus making it appear that the earth is at the center of the universe. Additionally, radiation from the antipodal CMB will reach us diffused from all directions, at all times.

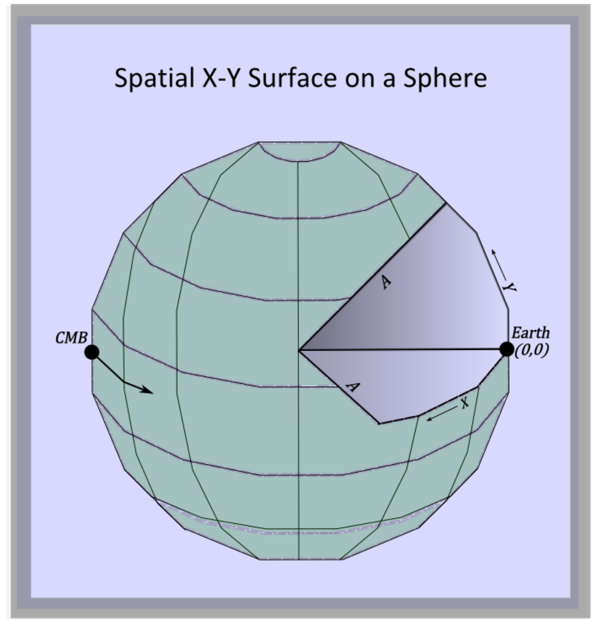

Fig. 6 - The above figure illustrates what we observe as the spatial X-Y plane, tiled on a spherical surface.

This type of tiling is identical to the longitude-latitude tessellation of the surface of the earth.

The spatial 3D mapping of Reality can be mathematically described as a tessellation on the 3D hypersurface of a 4D sphere of radius A_γ. Unfortunately, this type of mapping is impossible to visualize directly because we reside in a 3D surface whose fourth dimension is infrareal and not observable.

There are many ways of indirectly visualizing a 3-sphere —the 3D hypersurface of a 4D sphere—, all of which I found to be more confusing than revealing, therefore I decided to give up and try to understand the relationships of Reality's spatial coordinates, taking them two at a time, as in the figure above.

Once the spatial relationships are expressed and understood in one and two dimensions, they can then be mathematically generalized to three dimensions, without confusion.

If we take the observable size of the universe $X_{0\gamma}$ to be the stellar scopal extent, the stellar ST constant is calculated to be,

[11] Wikipedia, Dec. 2015, Cosmic Microwave Background.

(29) $A_\gamma = \frac{X_{0\gamma}}{\pi\lambda_e} = 1.15\text{x}10^{+38}$, where,

$X_{0\gamma}$ is the extent of the Universe.

The above calculated/observed value of A_γ is smaller than A_4 ($1.70x10^{+38}$) of the Combinatorial Hierarchy (5), but of the same order of magnitude. This is a very minor difference, telling us that we are probably heading in the right direction. The observed value of $X_{0\gamma}$ is calculated according to the Big Bang theory, which takes into account Doppler effects and relativistic corrections, making it questionable under our context.

For our purpose here, which is to obtain the order of magnitude of the stellar transitional units, we can use A_4 to calculate the stellar scopal extent without making significant difference. The value of X_γ becomes,

(30) $X_\gamma = \pi\lambda_e A_4 = 1.30x10^{+27}$ Meters or $1.37x10^{+11}$ light years. This value turns out to be 147% of the observed[12] size of the Universe ($8.8x10^{+26}$ meters or $9.3x10^{+10}$ light years).

The velocity transitional unit

Again from $\beta_k = \frac{k}{A_\gamma} = \frac{v_k}{c_0}$, we can express A_γ in terms of the minimum tangential velocity interval by setting $k = 1$. The velocity transitional unit $v_\gamma = v_{k=1}$ can be obtained from,

(31) $A_\gamma = \frac{c_0}{v_\gamma}$, where v_γ is the stellar velocity transitional unit. Solving for v_γ,

(32) $v_\gamma = \frac{c_0}{A_\gamma} = 1.76x10^{-30}$ Meters/second. A very tiny tangential velocity quantum. An object travelling at this velocity would take $1.80x10^{+22}$ years to travel one meter. A hardly measurable or detectable observable!

The ***transitional velocity*** property of wavicles, according to *Eq. (32)*, ***can only vary in tiny discrete intervals (velocity quanta) of the order of 10^{-30} meters per second***. The stellar velocity quantum is such a small interval, that it's no wonder it has not been —as far I know until mentioned here— neither postulated, noticed nor measured.

If the velocity transitional unit v_γ is measured experimentally, *Eq. (31)* can then be used obtain an experimental value for A_γ, assuming that such an experimental setup is feasible.

The displacement transitional unit

The stellar spixel, i.e., the displacement transitional unit $x_\gamma = \lambda_\gamma = x_{n=1}$ is the minimum stellar discrete displacement interval possible, where n is the displacement index in *Eq. (4)*. The stellar displacement transitional unit is the sample wavelength of the stellar scope; consequently, from *Eq. (4)*, we can postulate that,

(33) $x_\gamma = \lambda_\gamma = \frac{\lambda_e}{2} = 1.21x10^{-12}$ Meters, according to the 2014 CODATA value of λ_e.

The sampling spatial density is postulated to be twice the spatial density of the free electron, because the free electron resides within the stellar scope and the sampling theorem demands the sampling spatial frequency to be twice the value of the highest sampled frequency, to prevent aliasing. In other words, the sampling

[12] Wikipedia Dec. 2015, Observable universe.

frequency of the stellar scope σ_γ is postulated to be four times the sampling spatial frequency of the atomic scope σ_α.

The spatial density transitional unit

Using $\sigma = \frac{1}{\lambda}$ and *Eq. (33)* above,

(34) $\sigma_\gamma = \frac{1}{x_\gamma} = 8.24x10^{+11}$ m^{-1}, where σ_γ, is the stellar scope's spatial density transitional unit.

The momentum transitional unit

Now that we have calculated the spatial density transitional unit, we are ready to calculate the momentum transitional unit p_γ. From *Eq. (34)* and using $p_k = h\sigma_k$,

(35) $p_\gamma = h\sigma_\gamma = \frac{h\sigma_e}{2} = 5.46x10^{-22}$ kg-m/s.

The transitional period (tixel)

From *Eq. (33)*, we can now calculate the tixel to be,

(36) $T_\gamma = \frac{x_\gamma}{c_0} = 4.05x10^{-21}$ Seconds. This is the temporal transitional unit (temporal interval) or stellar tixel.

The temporal frequency transitional unit

Since $f = \frac{1}{T}$, then the frequency transitional unit is,

(37) $f_\gamma = \frac{1}{T_\gamma} = 2.47x10^{+20}$ Hertz.

The energy transitional unit

From *Eq. (37)* and $E = hf$, we can now calculate the energy transitional unit,

(38) $E_\gamma = hf_\gamma = 1.64x10^{-13}$ Joules.

The mass transitional unit

From *Eq. (34)* and $m = \sigma \frac{h}{c_0}$, we can now calculate the mass transitional unit,

(39) $m_\gamma = \sigma_\gamma \frac{h}{c_0} = \frac{E_\gamma}{{c_0}^2} = 1.82x10^{-30}$ Kg.

Results from *Eq. (28)* to *Eq. (39)*

The following table lists the transitional units of the stellar scope and their calculated values.

Table 1 — Table of Stellar Transitional Property Units

Transitional Property	Equation Number	Sym.	Formula	Transitional Unit Value	Units
Displacement	*Eq. (33)*	x_γ	$\lambda_e/2$	$1.21x10^{-12}$	meters
Spatial density	*Eq. (34)*	σ_γ	$2\sigma_e$	$8.24x10^{+11}$	meters^{-1}
Scale-constant	*None*	A_γ	$A_\gamma = A_4$	$1.70x10^{+38}$	none
Spatial extent	*Eq. (30)*	X_γ	$\pi\lambda_e A_4$	$1.30x10^{+27}$	meters
Velocity	*Eq. (32)*	v_γ	c_0/A_γ	$1.76x10^{-30}$	m/s
Momentum	*Eq. (35)*	p_γ	$h\sigma_\gamma$	$5.46x10^{-22}$	Kg-m/s
Period	*Eq. (36)*	T_γ	x_γ/c_0	$4.05x10^{-21}$	seconds
Frequency	*Eq. (37)*	f_γ	$1/T_\gamma$	$2.47x10^{+20}$	Hertz
Energy	*Eq. (38)*	E_γ	hf_γ	$1.64x10^{-13}$	Joules
Mass	*Eq. (39)*	m_γ	$\sigma_\gamma\, h/c_0$	$1.82x10^{-30}$	Kilograms

As a final observation; the relativistic stellar transitional relations resolve the conflicts occurring with massless particles, such as the photon, because of the concept of transitional mass, as follows.

What we refer to as massless particles:

- ✓ Do not have a rest mass.
- ✓ Have stellar transitional mass only, which is their total mass.
- ✓ Have momentum.
- ✓ Have kinetic energy only, which is their total energy.

A better name for massless particles would be *transactional particles*.

IMPLICATIONS

It has been shown in this monograph that the ISM/DTM hypothesis can be applied, so far, to a generalized understanding and integration for de Broglie matter-wave equivalence, Classical Mechanics and Relativistic Stellar Mechanics, all of which are clearly implied and whose mathematics promise to be simply developed from the hypothesis.

I must make clear that all relativistic kinematic relations developed in this monograph assume a single isolated wavicle contained within the stellar scope in the absence of forces. Also, a single isolated wavicle implies that all spatial density transactions must be conducted with wavicles from scopes external to the stellar scope, neither which is a real situation.

Obviously, the discrete stellar wavefunction needs still to be modeled with multiple wavicles in close proximity, in order to consider intra-scopal spatial density transactions (forces), such as gravity. Nonetheless this line of thought leads to the possibility of inter-scopal transactions, in which case the intra-scopal spatial density (mass, energy, momentum) conservation principle wouldn't necessarily hold in the local scope.

The future of the DTM hypothesis in regards to Quantum and Stellar Gravity is very promising and it's to be treated in two forthcoming monographs by the author.

There are at least three very important classes of implications extractable from the DTM, those are, extrapolated concepts on the infrastructure of the stellar Universe (scope), its motional geometry and the understanding of what we observe as kinetic energy.

A clear understanding of what is observable (real) vs. what is non-observable (infrareal) to us is clearly emerging from the ISM/DTM hypothesis.

ON EMPTY SPACE VS. SPACETIME

We hypothesize from the ISM that empty space is quiescent infraspace and spacetime objects are either static or travelling oscillations of infraspace (wave packets). From these two basic postulates and the DTM we can state the following implications:

1] *Empty space is quiescent infraspace*. Empty space is a one to one mapping onto infraspace and what we observe as empty space is the quiescent extent of infraspace. In other words, take your pick, space is: the lack of motion, three dimensions, three degrees of motional freedom, zero properties, nothingness, etc. In simple words, zilch!

2] *Matter/energy is spacetime*. The synthesis of infraspace and motion is what we observe as spacetime.

3] *Space does not have any properties*. If space is emptiness, the absence of spacetime, it cannot have properties of any kind. We can talk about the properties it doesn't have, but only in contrast to the properties of spacetime.

4] *Space does not have extent or geometry*. We can discuss the constraining volume of spacetime motion but not the volume of space. In other words, space itself does not have geometry but spacetime motion has. In contrast, the motional properties of spacetime are constrained to within a given region, thus constraining spacetime to 3-sphere motional geometry. Please refer to *Fig. (7)* in the sidebar.

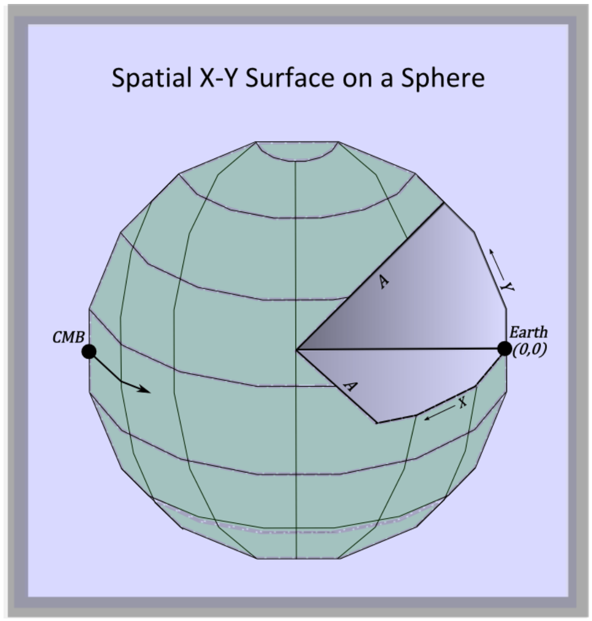

Fig. 7 - The above figure illustrates what we observe as the spatial X-Y plane, tiled onto a 2-spherical surface.

The CMB is shown as the radiation coming around from all the great-circles defined by the earth and its antipode (a CMB).

Think of the CMB as a form of "horizon" as observed through the curvature of the stellar scope. Any radiation coming from a point before the horizon is spherically lensed, while any radiation coming from behind the horizon is diffused.

The CMB is diffused light coming from behind the earth's antipode.

ON ROTATIONAL PROPERTIES AND MATTER-WAVE EQUIVALENCE

From the section on de Broglie matter-waves and the SDS of the stellar discrete wavefunction (*Eq. (11)* to *Eq. (27)*), we can extract the following implications:

5] An infophysical wavicle is a real object and its discrete wavefunction is its real representation.

6] A wavicle is the synthesis of space and motion on a three dimensional hypersurface, in a very similar way that an animation is the synthesis of space and motion on a two dimensional computer screen.

7] The stellar discrete wavefunction is defined by its spatial density spectrum (SDS).

8] *All stellar objects must exhibit discrete properties* and therefore all object interactions must be discrete-transitional. In other words, all motion and its related properties can only change as discrete-event transitions from one state of the stellar wavefunction to another.

9] The tangential velocity property of wavicles can only vary in minute discrete intervals (velocity quanta) of the order of 10^{-30} meters per second. All other wavicle transitional properties follow suit, as shown in the *Results* section of this monograph.

10] If the velocity transitional unit v_γ is measured experimentally, *Eq. (31)* can then be used to obtain an experimental value for A_γ, assuming that such an experimental setup is feasible.

11] *All motion is rotational*; therefore transitional properties such as energy, momentum, mass, etc., are also rotational.

12] All matter (wavicles) will exhibit wave-like de Broglie properties, because of their rotational motion. This is not to say necessarily that material objects are waves, although they very well could be, but that the stellar discrete wavefunction determines the complete set of properties and containment of an isolated object residing within the stellar scope, wave or not.

13] The de Broglie wavelength is the effective wavelength (apodized wavelength) of a transitioning wavicle at a constant transitional velocity. In terms of relativistic mechanics we could say that, the de Broglie wavelength of a stellar object is the one-dimensional effective wavelength of the wave traced by a single point-mass, traversing a 3-spherical great-circle of the Universe.

14] The stellar discrete wavefunction describes the motional (displacement) behavior of all wavicles within the stellar scope.

15] *Wavicles exhibit three degrees of motional freedom only*. The circular nature of each spatial dimension restricts spacetime motion to a three dimensional hypersurface —to a 3-spherical motional geometry—.

ON COSMOLOGY AND MOTIONAL GEOMETRY

As we concluded in a previous section, it is not possible to discuss the properties of empty space, because empty space does not possess any properties. Empty space is represented by the mathematical coordinates (degrees of motional freedom) for allowable spacetime displacement. With this in mind we can extract from the three dimensional stellar wavefunction the following statements on the geometry of stellar discrete-transitional motion:

16] If we define the Universe as *the 3-spherical region encapsulated by an infrareal fourth dimension*, we can include empty space and spacetime as its components. Under this definition the Universe becomes the region of possible spacetime motion —the observable Universe—, thus making it possible to refer to its properties. Properties, such as extent, motional geometry, total energy, total mass, etc.

17] *The containing region of stellar motion is defined by the 3D stellar discrete wavefunction.* In other words, *the possible extent of spacetime motion* is defined and expressed by the discrete wavefunction of the stellar scope.

18] *Two-dimensional stellar motion (please refer to Fig (7) above) is discrete-transitional and adheres to the surface of a sphere (a 2-sphere) of radius $\lambda_\gamma A_\gamma$, in the absence of gravity or other spatial density transactions.* This of course is a radical re-statement of Newton's first law of motion.

19] We can generalize *[18]* to conclude that the stellar scope's motional geometry —that which we call our observable universe—, is a 3-sphere (the hypersurface of a 4-dimensional sphere of radius $\lambda_\gamma A_\gamma$).

20] *The geometry of the region of stellar motion is a 3-sphere*. This means that, the constraining volume of spacetime motion is the three dimensional hypersurface —a 3-sphere— of a four dimensional spherical manifold whose fourth dimension is infrareal. By the way, except for the infrareal part, this was originally proposed by Albert Einstein in 1917.

21] The stellar scope is a 3-sphere that allows a frame of reference to be either relative or preferred, without conflict. This is because the origin and any other point are indistinguishable on a 3-sphere, in other words, any point on the hypersurface can be considered to be the scopal origin.
22] A static or absolute frame of reference is possible, but cannot be distinguished with certainty, because infraspace is not observable.
23] Under 3-sphere motional geometry the CMB cannot be used as an absolute frame of reference, because the earth's antipode moves with the earth.
24] *The CMB could be used to estimate the circumference (extent) of a great-circle of the Universe*. This needs to be done assuming a 3-spherical lensing motional geometry.
25] There is no need to postulate the constancy of the speed of light or of a four dimensional spacetime to account for and derive all of the SR relationships. Special Relativity is a direct result of the codependence between a wavicle's spatial properties and its transitional motion, namely the apodization of the stellar discrete wavefunction.
26] Different apodization functions would result in different stellar mechanics that would therefore evolve into different universes, some of which with unstable mechanics, resulting in collapsed or oscillating universes. Obviously, the stellar apodization function of our Universe has evolved, so far, into what appears to be, a stable steady-state.
27] A diluted Universe is not possible, because of 3-spherical motional geometry, but the same cannot be said about single or multiple Big Crunches under the influence of gravity. This implication still needs to be considered under gravitation at all the different scopes of Reality. Also, an oscillating stable Big Bang/Big Crunch needs to be considered.
28] *Time is not the fourth dimension*. The ISM/DTM do not postulate time —the number of expression cycles between two spacetime displacement events— as a dimension, time is postulated as a codependent property of space and motion. The fourth dimension, that which encapsulates 3-space, is postulated as another spatial dimension that is not observable (infrareal).
29] The Universe is a finite, compact, connected, 3-dimensional manifold without boundary. In other words the universe has the motional geometry of a 3-sphere.
30] A stellar object heading in any direction will close on itself coming back to the same point. That is why the earth seems to be in the center of the Universe. Also why the CMB is observed basically equidistant in any direction.
31] The 3-dimensional hyperarea of the 3-sphere of radius $r = \lambda_\gamma A_\gamma$ is $2\pi^2 r^3$, therefore, the motional volume of the observable Universe can be calculated to be of the order of $9.72x10^{+115}$ cubic meters.

ON THE BIG BANG VS. 3-SPHERICAL MOTION

Obviously I'm treading on very sacred philosophical and cosmological grounds here, but the implications are there and we must follow through. I must confess that I personally dislike the Big Bang theory, because it implies the permanent existence of time. Whatever time is, it is part of Reality and therefore if Reality is transitory, then so is time —it had a beginning and may stop—. Additionally, assuming that time existed before a transitory Reality, is not justifiable.

If Reality was created, then we can safely assume that so was time, therefore it does not make sense to ask if the Creator requires (or required) time in order to exist. Does the Creator require water in order to exist? This is obviously a nonsense question. If Reality was not created, then why the Big Bang? The generally accepted answer seems to be, *to explain the observed cosmological evidence*.

Nonetheless, I leave the reader with the following restlessness. What if all the Big Bang cosmological evidence can be explained by 3-spherical motional geometry?

I now take license to suggest some preliminary explanations:

- ✓ *Redshift of galaxies*. Explained in terms of 3-spherical lensing of motion. The 3-spherical motional geometry lenses incoming light in a similar way to gravitational lensing, thus magnifying (red shifting) the wavelength of light. Needless to say, the <u>Doppler</u> redshift of galaxies is the main evidence for an expanding universe. If the redshift is not a Doppler effect but a 3-spherical motional geometry lensing, then the Big Bang becomes questionable.
- ✓ *Expanding Universe*. The ISM/DTM hypothesis can include the Big Bang as one of our Universe's possible initial conditions. In this case, the Big Bang becomes the Big Break, as in a billiards table. By the way, other initial conditions are also possible, including steady-state conditions, any of which could have evolved into our, so far, apparently universal steady-state.
- ✓ *Mixture of elements*. In terms of a possible Big Break/Big Crunch or of steady state initial conditions.
- ✓ *Looking back in time*. In terms of a possible Big Break/Big Crunch.
- ✓ *The Common Microwave Background (CMB)*. In terms of antipodal light diffusion as explained in this monograph.
- ✓ Etc.

REFERENCES

1. **Sotomayor V., Bernardo.** *Reality Unveiled - A Collection of Monographs on the Infrastructure of Reality.* Jinotepe : s.n., 2011. Essay. RPI No: 000244.

2. —. *Spacetime Unveiled.* Jinotepe : s.n., 2014. Infophysics Monograph. RPI No: 000749.

3. —. *Mass-Energy Unveiled.* Jinotepe : s.n., 2012. Infophysics Monograph. RPI No: 000361.

4. —. *Special Relativity Unveiled.* Jinotepe : s.n., 2014. Infophysics Monograph. RPI No: 000748.

5. —. *Fundamental Constants Explored.* Jinotepe : s.n., 2014. Infophysics Monograph. RPI No: 000944.

6. **Noyes, Pierre.** *The Combinatorial Hierarchy – An Approach to Open Evolution.* Stanford : Stanford Linear Accelerator Center, Stanford University, 1980.

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About the Author

Bernardo Sotomayor Valdivia is an independent scientific researcher born in León, Nicaragua. He has degrees in Physics and Systems Engineering, as well as advanced studies in Information Systems. He participated in the US space program, including the Viking program at Jet Propulsion Laboratory, NASA, in Pasadena CA and was for many years Chief Technology Officer for various start-ups in e-commerce within the US. He now writes on Infrarealism and Infophysics.

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