Transactions of the SDPS:
Journal of Integrated Design and Process Science
25 (3&4), 2021, 65-133
DOI 10.3233/ JID-210033
http://www.sdpsnet.org

THE RELATIVISTIC OBSERVER
Consequences of a Linear Expansion of Spacetime

"One now has to remember that by our knowledge "matter" is not to be perceived as something primitively given or physically plain. There even are those, and not just a few, who hope to reduce matter to purely electrodynamic processes, which of course would have to be done in a theory more completed than Maxwell's electrodynamics." Albert Einstein, to the Prussian Academy of Science, November 15, 1915.

Frank M. Skidmore[a], Murat M. Tanik[b*]

[a] *Vice President for Research and Development, Analytical AI, LLC, Birmingham, Alabama*
[b] *Professor, Department of Electrical and Computer Engineering, Birmingham, Alabama*

Abstract Communication Dynamics Theory, defined in a companion paper, offers a new approach to understanding Spacetime. In Communication Dynamics Theory, physical reality is assumed to arise from an anisotropic expansion of a one-dimensional communication network. In this paper, we perform a first approximation mathematical transformation of the theory into hyperbolic geometry. The resulting model provides a potential basis for developing insight pertaining to previously poorly understood fundamental constants of physics. As a demonstration, we define a proton, neutron, and electron, demonstrate the emergence of observable space and time, and generate heuristic estimates of Euler's number, the fine structure constant, and π, as well as geometric descriptions of fundamental forces of nature, occurring as natural consequences of the linear dynamic expansion of Spacetime.

Keywords: Communication dynamics theory, theory of matter and energy, communication theory, physics, general and special relativity

Introduction

More than 100 years after the emergence of the notion of quantum effects, fundamental challenges remain in understanding and modelling the relationship between particles and waves (particle-wave duality). After the "miracle year" of 1905 (Einstein, 1905a, 1905b, 1905c, 1905d) Einstein focused on expanding electromagnetic theory to incorporate and generate photons (waves to particles). Concentrated efforts between 1908 and 1911 did not generate results to his satisfaction. He subsequently approached the problem from a different direction, expanding the notion of particles on the large scale to wave behaviour (particles to waves). After several years Einstein in arguably a second "miracle year" introduced his general theory of relativity through four submissions presented to the Prussian Academy in 1915 (Einstein, 1915a, 1915b, 1915c, 1915d).

In ensuing years, Einstein continued to strive to extend General Relativity to electromagnetic theory, or alternatively derive the theory of General Relativity from electromagnetic theory, but a statistical-mechanical interpretation of the quantum, powerfully embodied by 1925 by Earnest Schrödinger (Schrödinger, 1925) increasingly became dominant. However, clues supporting the existence of a more

* Corresponding author. Email: mtanik@uab.edu

1092-0617/©2021 - The authors. Published by IOS Press

coherent, unified interpretation of physics that might integrate general relativity and quantum physics have long been available in the works of Max Planck, Hermann Minkowsi, and Werner Heisenberg. First, the absolute linkage between Space and Time was recognized by Minkowsi (Minkowski 1908, 1909, 1915). Minkowskian Spacetime, fully adopted by Albert Einstein in his general theory of relativity, embeds time in 3D space using an imaginary number to generate complex vectors. Minkowski diagrams present points of simultaneous observation in a Spacetime manifold, considering only one dimension of space, and one of time. If we consider each point in a Minkowsi diagram to be an observer, each point in a Minkowski diagram can be considered to show an instance of an observer dependent spacetime location map – a network of location information. Multiple instances of this map (a dynamic Minkowsi diagram) could consequently be represented as an evolving communication network transmitting location information between observers. The Planck postulate, a reluctant innovation presented by Max Planck to the German Physical Society in 1900, provided a potential bound or constraint on the point observers of Minkowski. Planck postulated that energy can only be emitted in certain quanta (Planck, 1900). Einstein, notably, later leveraged the work of Planck for his Nobel-prize winning papers on the photoelectric effect (Einstein 1905a). Heisenberg subsequently formalized the concept of measurement uncertainty in 1925 (Heisenberg 1925), sparking a sparring match between Heisenberg and Schrödinger over disparate but ultimate equivalent formulations of quantum theory and leading to an explosion of innovation, and a dominant interpretation of small scale interactions (quantum physics). As the new field moved forward, Einstein's General Theory of Relativity was left dangling behind almost as a curiosity, an isolated theory representing only the behaviours and properties of large-scale phenomena.

We introduced Communication Dynamics Theory in a companion paper (Pan, 2022). We claim that Communication Dynamics Theory can in a single model bridge quantum theory and General Relativity by representing particles and waves as relativistic, observer dependent manifestations of continuous energy. This continuous energy is observed and experienced in the context of a Universe with four simple, fundamental properties:

1) The existence of momentum
2) The presence of a perturbation of momentum, resulting in the emergence of energy
3) A defined minimum observation distance
4) A defined speed of communication

Applying an axiomatic approach, we can expand on these simple properties to generate a visualization of the Communications Dynamic Model in hyperbolic geometry. We show below that the resulting visualization can replicate and calculate properties of protons, electrons, neutrons, space, the perception of time, and the experience of mass, electromagnetism, and strong and weak interactions. Our geometrical model is set in a coordinate space we will refer to as Planck-Space (units J*s). Anisotropic motion through Planck-Space yields trajectories and rotations with unit J (energy). Thermodynamics implicitly results from Spacetime trajectories within this model.

We accomplish five primary results from this approach. First, changes in the energy state of objects moving through this space can model space, time, frequency, and forces of nature. This establishes a justification for our model while tying this paper to our companion work. Second, general axioms and definitions are introduced. Third, the concept of the "Relativistic Observer" is introduced, whereby we generate a conceptual model of a single neutron, proton, and electron, and describe a hydrogen atom. Fourth, from our models of a neutron, and hydrogen atom, we embed the perspective of the "Relativistic Observer" to estimate, from first principles, Euler's constant e, the fine structure constant α, and the value of the Euclidean rotation constant π as natural consequences of linear expansion of one-dimensional Spacetime. Finally, we will relate our geometrical model formally to the Communication Dynamics Theory and compare with Quantum Theory.

Model Justification

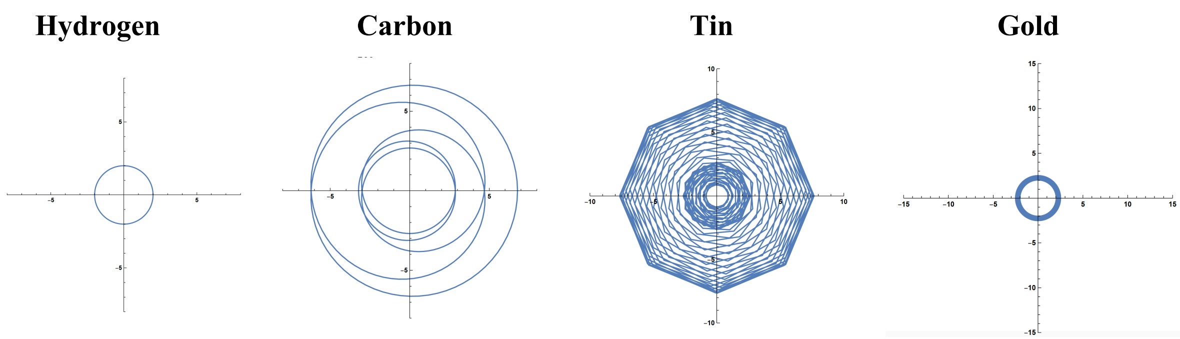
In a prior work, we introduced Communication Dynamics Theory as a general model to describe physical reality (Pan, 2022). We used the Communication Dynamics model to calculate the orbital radius of 118 atoms in the periodic table, using the known radius of Hydrogen to calibrate predicted radii of other elements. Inherent in our approach is the use of the U-Matrix Equation.

$$u_n''(t) = \sum_{\ell=0}^{n-1} \sum_{m_\ell=-\ell}^{\ell} \frac{2yn^2 e^{i(A+\ell m_\ell)t}}{\left(\frac{A}{n} + \ell m_\ell\right)^2} \tag{1}$$

Where n represents the principal quantum number, ℓ the Azimuthal quantum number or angular momentum, m_ℓ the Magnetic quantum number (projection of angular momentum), A the atomic number, and y the period number. Simplifying the equation to only treat the valence shell (e.g. $\ell = n - 1$), we have equation:

$$u_\ell'(t) = \sum_{m_\ell=-\ell}^{\ell} \frac{2yn^2 e^{i(A+\ell m_\ell)t}}{\left(\frac{A}{n} + \ell m_\ell\right)^2} \tag{2}$$

The resultant computations define cross-sectional "slices" of spacetime that illustrate a repetitive theme of object-specific, internal communication. This internal communication structure can be calibrated to provide an estimate of the relative cross-sectional area of the valence shell, allowing an estimate of atomic diameter and volume. Figure 1 shows some examples of structures calculated using U-matrix equation 2.



The outer valence shell for Hydrogen, Carbon, Tin and Gold are calculated using Equation 2.

Figure. 1. Simplified Atomic Structure (as generated by U-Matrix)

The shapes projected by the U-Matrix in Figure 1 use a wave-equation to predict a static, 3-dimensional structure, but what we have not described in this description is the nature of the coordinate space we are working in, and how this space relates to observed space, time, and forces of nature. The current paper describes the underlying structure of Spacetime described by Communication Dynamics Theory.

1. Defining Planck-Space

Defining the Point Trajectory Model (Summary): We propose that Communication Dynamics describes interactions occurring between locations in Spacetime. In this model, interactions, or communication, between spacetime locations are observed as energy. We can therefore visualize Spacetime, as described by Communication Dynamics, as a latent energy space.[1] When communication occurs, it occurs at a specific universal speed "c", over a specific complex vector. The act of communication transforms latent energy embedded in the space to observable energy. We note that this complex vector is specifically not "time" as we observe time. Further, while we use the word "space", we must understand the word is used in a mathematical sense; observable space, observable time, and forces of nature are emergent properties of the Communication Dynamics model. In this paper, we reference Axioms, Definitions, Assertions, and Hypotheses. Each has a specific meaning:

Axiom: A first principle or foundational element of the model

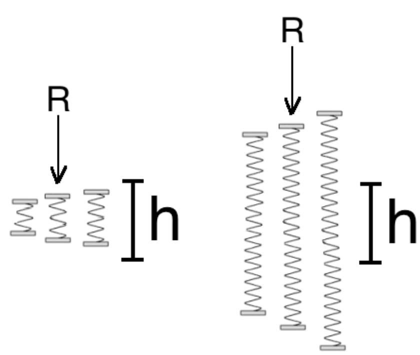
Definition: A description of how Axioms are represented in a spatial form

Assertion: Assertions are assumed to flow logically from Axioms and Definitions

Hypothesis: A hypothesis is presented, initially, as an extra-logical argument, which we will work to support, or refute as the paper progresses. Over the course of the paper, assertions, as well as mathematical modelling, should support hypotheses.

Throughout the paper, we describe objects moving on hyperbolic trajectories. Unless otherwise noted, figures are not designed as mathematically precise illustrations. More specifically, figures and illustrations are often flattened with simplified dimensionality, and are provided either to illustrate projected dynamic Euclidean or Hyperbolic space, or to improve intuition. We will not be able to fully prove our hypotheses in one paper. We propose, rather, to fully support or reject principal hypotheses over a series of papers.

[1] **The concept of a latent energy space:** Latent energy in our model differs in substance from the concept of potential energy. A latent energy space is a space that is assumed to have the capability to carry energy. As a brief analogy of the concept, consider a spring (Figure 1). A spring is an object that be at rest (carry no energy) or can be in a state of vibration. In Figure 2 below we assume a mean (or reference) state, about which a vibration occurs. Fluctuations below a minimal observable distance "h" can exist but cannot be observed. If a process occurs whereby a fluctuation above the measurement threshold "h" occurs, a location can be observed. In this analogy, the spring is the "latent energy space" that can have a series of energy configurations above or below observability.



Latent energy exists and permeates continuous Spacetime, but occurs below the level of observation (e.g., $E_L < h$ (left)). Observed energy occurs at an observable scales ($E_o > h$ (right)). R is placed to locate a measurement reference frame compared to a horizontal Trajectory (eg right to left).

Figure. 2. Latent Energy

1.1. The Point-Trajectory Model (Axioms)

To introduce the model, we can start by considering a solitary, dimensionless point (P) as the most parsimonious communicating object. We now define some Axioms regarding P.

Axiom 1: P exists in the absence of any external space and can only reference and communicate with itself.

Axiom 2: In the absence of motion, P is unique. When P moves to, or through an initial position, a second instance of P is generated. This new point P is also unique. We can model the generation of a P_2 from a unique P_1 as a movement around a circle of circumference h.

Axiom 3: P_1 and P_2 are now a communicating system P_1P_2. In order for a movement to be "observed" by P_1P_2, additional movement can be represented as the generation of additional points P_n , in integer multiples of a minimum distance h.

Axiom 4: While there is a minimal observation distance (Axiom 3), the structure of Spacetime is continuous, including at unobserved and unobservable distances < h.

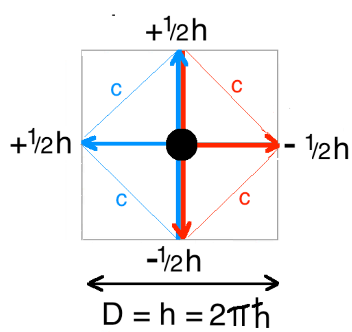
Axiom 5: For systems $P_1P_n > h$, axiom 4 admits the existence of a set of additional communicating systems P_xP_{m+x}, where $x < h$, and m is an integer in multiples of minimum distance h.

Axiom 6: All communication occurs at a universal communication speed c.

Axiom 7: All points P derived from Axioms #1-6 communicate at all scales only with other points P (external, out of set communication is forbidden).

Axiom 8: In the absence of interaction, momentum of any given system $P_{n-1}P_n$ is conserved.

We will term our point P, and its possible observed positions in accordance with Axioms 1-8, as an object which we will call a **Spacetime Moment (Figure 3).** A single Spacetime Moment in the absence of



Flattened illustration of a Virtual Spacetime Moment, the smallest possible instance of spacetime.

Figure. 3. Virtual Spacetime Moment

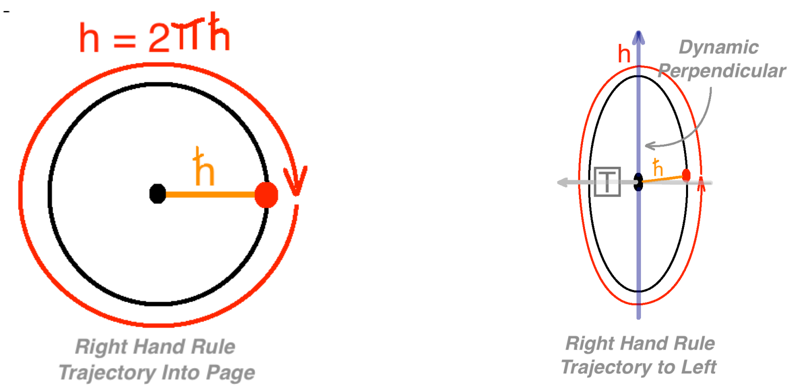
other observable moments is the smallest possible instance of Spacetime. Provided the movement distance is less than h, observed motion has not occurred, and we term this dimensionless entity an **Ideal Virtual Spacetime Moment (M_i)**. We now define the following pertaining to M_i:

Definition 1 (M_i): M_i is self-contained and incorporates all possible positions of P < h.

Definition 2 (M_i): There is no "outside" of the space defined by M_i (i.e. M_i is a causally complete set of locations of P).

Definition 3 (M_i): We define the units of our Virtual Spacetime Moment in "Plancks" (J*s). We can also define a Planck as a unit of Point Momentum (intuitively, we may conceptualize "kg*m/s" or our standard momentum metric) that occupies a specific observation length (intuitively, we may use the metric "m" or meters). Note we use conventional units for intuitive purposes to correlate with current concepts of physical measurement. However, kilograms, meters, seconds, Joules, and all current metrics become emergent properties according to our model. Planck-Space can be defined as a ***latent energy space*** that we have described previously. Note latent energy differs from potential energy.

Definition 4 (M_i): Imprecision in position of a dimensionless point (Figure 4, red point) implies virtual motion, which can be modelled as a virtual acceleration ($A_{\wp}$). The unit of acceleration can be represented in Joules (J).



A Spacetime Locus is a minimum observation distance that obeys conservation of momentum. When a spacetime locus has completed an observable trajectory, it becomes a Spacetime Moment.

Figure. 4. Spacetime Locus

Definition 5 (M_i): The presence of acceleration admits a second (virtual) reference point 0_ρ (Figure 4, black point), representing an average position. Note we add the extra-logical constant π at this point; we will justify this value as an emergent property of the linear expansion of Spacetime later in this paper.

Definition 6 (M_i): In the presence of an acceleration, 0_ρ can be modelled to experience an orthogonal virtual trajectory T (unit, J). To correlate with our observable reference frame, we impute the right-hand rule.

Definition 7 (M_i): According with Special and General Relativity, T is assumed to proceed through hyperbolic space.

1.2. Observed Spacetime

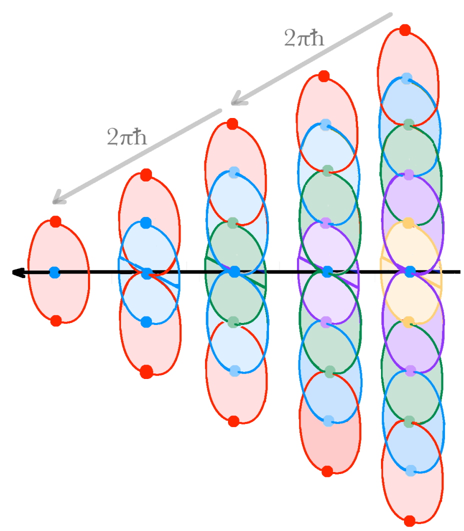
Having defined a virtual Spacetime Moment, we now generate observed Spacetime:

Definition 8 (M_o): Observed Spacetime occurs when point P achieves a movement of h.

We have made precisely one Jump-Step of length h for P and a trajectory step ($< h$, below our observation limit) for virtual point O_p. P accordingly observes itself at two locations, and we must now develop a coordinate system that involves only P and O_p. We define the line connecting these three points as a "dynamic perpendicular".

Definition 9 ($\boldsymbol{M_o}$): A dynamic perpendicular is a line perpendicular to the net trajectory of the Spacetime Moment (Figure 4).

In the absence of interaction with other points, we assume P and O_p expand through hyperbolic Spacetime along a specific trajectory, and observe a uniform, dynamically generated perpendicular to this trajectory. A given Spacetime Moment can further be assumed to observe and receive communications from previous Spacetime Moments allowing it to define its current position (Figure 5). Note the placement of P is arbitrary. Therefore, in the act of acceleration O_p must similarly be defined through internal coordinates of rotation, trajectory, and distance, in the context of a minimum observation distance h. Figure 5 shows conceptually how O_p over 2 jump-steps ($2h$) can dynamically generate new Spacetime Moments.



The number of Spacetime Moments that can be arbitrary defined expands as P makes successive jump-steps. This expansion also expands the number of potential precedent locations of of P and O_p in hyperbolic space. Partial, flattened representation is presented for intuition.

Figure. 5. Expanding Spacetime

1.3. Summary of the Point-Trajectory Model, and Consequent Assertions

An observed Spacetime Moment **($\boldsymbol{M_o}$)** consists of two points and three axes of motion. A first point (P) experiences rotation (curvature +1). A second point (0_ρ) experiences a hyperbolic trajectory (-1). Observation is mediated by P and 0_ρ in quantitative increments of value h. Consequent to our Axioms and Definitions, we now make the following assertions:

Assertion 1: A point in Spacetime making a circuit of precisely h (Figure 4) is the smallest possible observer.

Assertion 2: A Spacetime Moment M_o is the smallest possible unit of Spacetime that can be observed.

Assertion 3: M_o contains the following information:

1. Angular Acceleration (mediated by P, unit J)
2. Trajectory (mediated by 0_ρ, unit J)
3. Position (mediated by prior positions of P and O_p)
4. Instantaneous (Simultaneous) Communications impacting relative Position, Acceleration and Trajectory, which we will call interactions

Assertion 4: Consistent with the Heisenberg Uncertainty Principle, the location of P and 0_ρ cannot be precisely measured; information can therefore be modelled to be "stored" at the average location, 0_ρ.

Assertion 5: The "average observed" trajectory of 0_ρ, merging information from P and 0_ρ, is flat (Euclidean)

Assertion 6: If 0_ρ experiences a rotation, or trajectory $\geq h$, new observable Spacetime Moments (new instances of M_o) are generated (Figure 5).

Assertion 7: Multiple Spacetime Moments have the capability of communication at speed c

The characteristics of the formulated system of Spacetime Moments is a hyperbolic representation of the T-vectors described in our first paper. To fully explore the consequences of the above axioms, definitions, and assertions, we will create a coordinate space, describe three classes of Spacetime Object, and demonstrate model utility by estimating, from first Principles, the inter-related fundamental constants of nature $e, \alpha,$ and π.

1.4. The Planck-Space Coordinate System

We now define a coordinate system for Planck-Space, in accordance with principle axes (trajectory and spin, embedded in hyperbolic space). Trajectory of 0_ρ is labelled as axis T. Spin of P around 0_ρ occurs orthogonally in the $\Delta p \Delta q$ (also referenced as $\boldsymbol{pq}$) axes (Figures 6, Euclidean 3D intuition). Position in pqT space, with respect to a given 0_ρ (Figure 6, orange central ball), can be represented in hyperbolic pqT coordinates.

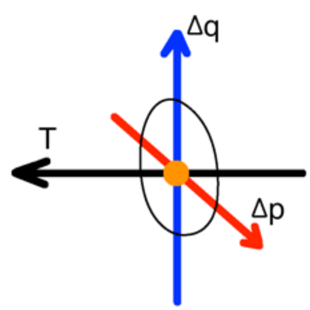
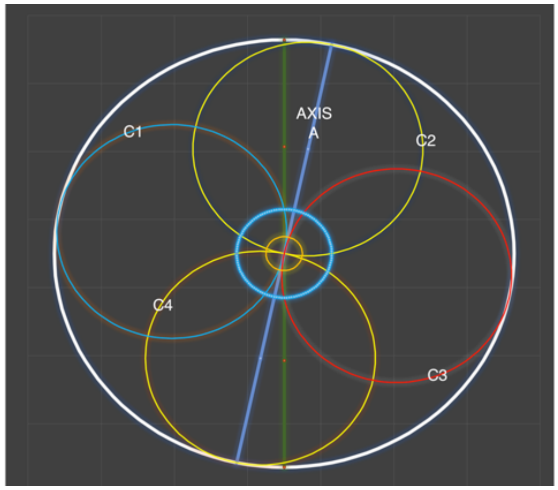


Figure. 6. Planck-Space Coordinates (pqT coordinates)

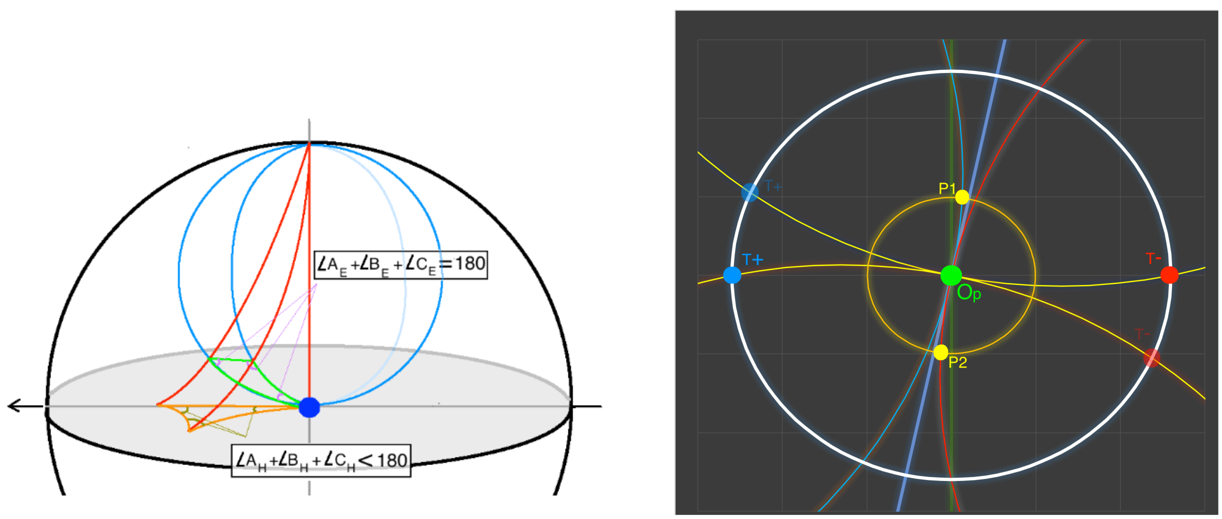
In Figure 7, we represent the pqT coordinate system on a Poincaré plane (Poincaré, 1895). Note Figure 7 represents only 2 dimensions (only q and T are represented). For the purposes of defining the coordinate space we can assume 0_ρ is the center of hyperbolic sphere $\mathbb{S}^1_\infty$ (cross-section in Figure 7, white outer circle represents ∞), in which the radius unit value 1 is given the value h (i.e. $\mathbb{S}^h_\infty$). To embed Euclidean surfaces into our Poincaré space we can generate internal circles C_1 C_2, C_3, and C_4, in this case either tangent, or perpendicular to an arbitrarily selected axis A. We give our hyperbolic space curvature $\kappa_h = -1$. Circles C_1 C_2, C_3, and C_4, contacting 0_ρ and h (∞), can be extended into spheres S_1 S_2, S_3, and S_4 in a full Poincaré spherical model, with apparent curvature in the 3D Poincaré projection of $\kappa_h = +1$.



Horizontal axis: T axis. Vertical Axis (green): q axis. An arbitrary Axis A can be defined that may or may not be perpendicular to axis T (trajectory axis).

Figure. 7. Poincaré Representation of qT Axes

Note that surface of spheres S_1 S_2, S_3, and S_4 are perpendicular to all asymptotic parallels (Figure 8, left) and therefore projected orange triangle ABC_H (with $\angle A_H + \angle B_H + \angle C_H < 180$) forms a Euclidean 2D surface on a given defined sphere S_n passing through the origin which we can label ABC_E (with $\angle A_E + \angle B_E + \angle C_E = 180$). We have now constructed a basic element that will allow us to model the impact of Assertion 5. We further detail the Euclidean projected observer frame later, but as a first intuition, see Figure 8, right. In this (right) image we represent a virtual trajectory T. 0_ρ is located centrally in a Poincaré sphere. For illustration we also turn the $\Delta p \Delta q$ rotation (yellow internal circle), 90 degrees; let us assume



Left: Poincaré disk (gray) embedded in Poincaré sphere $\mathbb{S}_\infty^h$. A triangle in the disk can be projected on the surface of a sphere of radius $h/2$ contacting the observer point (blue) and infinity, generating a projected Euclidean plane. **Right:** A point placed at the origin can observe dynamically generated Euclidean surfaces. Specifically, when point 0_ρ experiences a trajectory, point P perceives a rotational acceleration; both experiences exist along the respective Euclidean projected surface.

Figure. 8. Projecting Dynamically Euclidean Surfaces in Poincaré Space

that for a right to left trajectory T^+ our "thumb" extends out of the page, yielding a counter- clockwise rotation for $\Delta p \Delta q$. For T^- rotation is clockwise. In Figure 8 image right, we assume:

$$T^+ = T^- = {}^1/_2\, h = \pi\hbar$$

Observed space is assumed to be generated through the rotation of the Euclidean 3-Ball. We can see that a full trajectory ($T^- \rightarrow T^+ = h = 2\pi\hbar$) is associated with a rotation from the yellow sphere position (red point T^- in Figure 7) to the orange sphere position (blue point T^+) as well as an associated rotation from the green 3-sphere position P_1 to the red 3-sphere position P_2. Note that the 3rd dimension is implied in Figure 8; for a jump-step of $\leq 2\pi\hbar$ information can be encoded in a rotating projected Euclidean plane, which becomes a 3D structure. Note further that for a point O_p computing or observing a transition from a past point T^- to a future point T^+ two possible trajectories are possible (fainter red/blue trajectory in Figure 8). We will relate this in later in our paper to observed spin states.

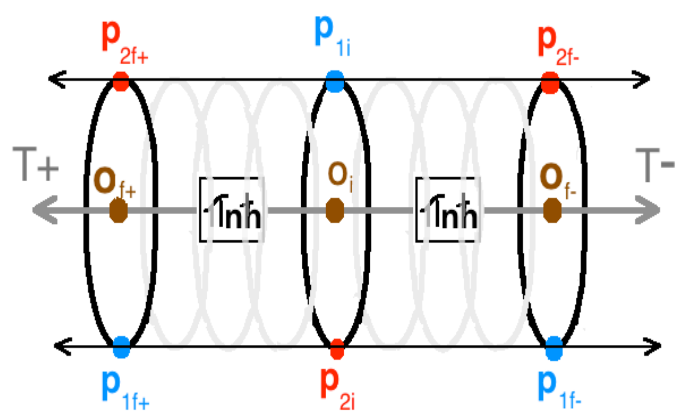
1.5. Imputing Motion to a Spacetime Moment

Before defining observation, it is now productive to impute degrees of motion and acceleration greater than h to $\boldsymbol{M_i}$, and describe the consequences. We will define three classes of object, based on two possible motion characteristics, $n_\emptyset$ and $n_{2\pi}$, as defined below:

$$\{\mathbb{R}\}\backslash\{\mathbb{Z}\} = \{n_\emptyset : n_\emptyset \in \{\mathbb{R}\}, \sim(n_\emptyset \in \{\mathbb{Z}\})\} \quad (3)$$

$$\{\mathbb{Z}\} = \{n_{2\pi} : n_{2\pi} \in \{\mathbb{Z}\}\} \quad (4)$$

Where $\mathbb{R}$ is the set of all real numbers, and $\mathbb{Z}$ is the set of integers. To briefly demystify these equations for those not familiar with mathematical encoding of language, we are saying, simply, that $n_{2\pi}$ is the set of all integers (ie 1, 2, 3, …) and that $n_\emptyset$ is the set of all other numbers (not including integers). Note, however, in our space integers are defined as multiples of 2π.



Communication. Two diagonal points P1, and P2 (representing the furthest distance traversed) are selected, showing a maximal distance between points at $(n_\emptyset * h)/2$.

Figure. 9. A Communication

<u>Object Class 1, Communication (M_B – Figure 9):</u>

Definition 10: We define a communication as the set of all objects such that the rotation of 0_ρ is

$$T_\emptyset = n_\emptyset * h \quad (5)$$

Since $n_\emptyset$ excludes integers, we see that

$$T_\emptyset \neq n_{2\pi} * h \quad (6)$$

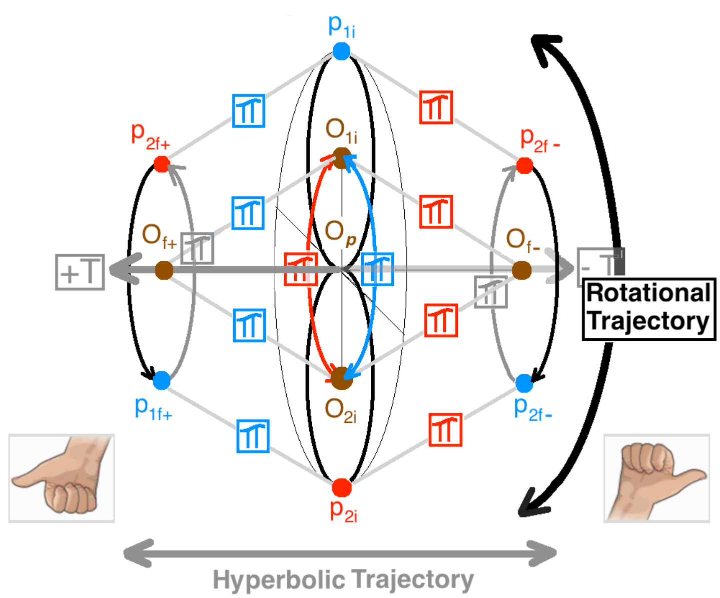
The movement of O_ρ from O_i to any defined O_f does not satisfy Axiom 3, and therefore O_ρ does not observe its trajectory as motion. Object class 1 propagates at speed "c" and T progresses along a single (hyperbolic) dimension.

Object Class 2, Stationary Observer (M_S – Fig 10, also Fig 8):

Definition 11: Here, we define a Special Case of $T_\emptyset$, where we define:

$$T_\emptyset = T_\pi = h/2 \tag{7}$$

The movement of O_{f+} to O_{f-} now satisfies Axiom 3. In accordance with $\mathbf{M}_V$ definition #5, we now define a rotation associated with O_ρ, and can select (Figure 10) diagonal points O_{1i} and O_{2i}, in addition to trajectory points O_{f+} and O_{f-}. We now assume this "stationary" object is receiving communication from one or more adjacent, diverging, converging, or co-traveling spacetime moments.



We can select two diagonal points P1, and P2 that can be modelled to propogate over time. Note a rotation around O_ρ is now embedded.

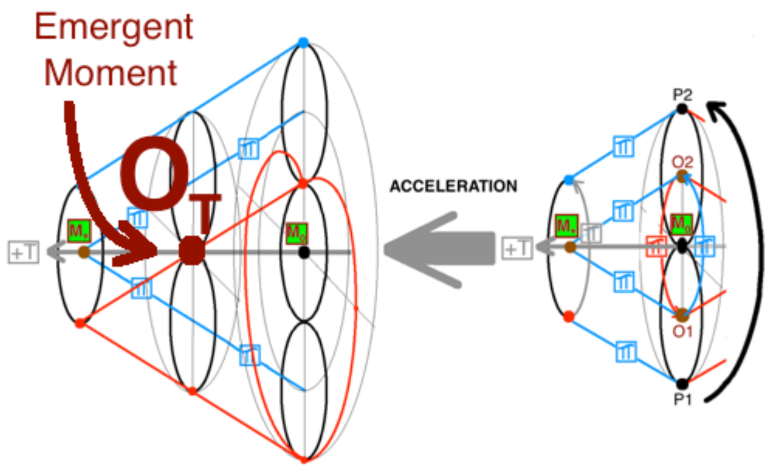
Figure. 10. A Stationary Observer

Object Class 3, Accelerated Moment (M_p – Figure 11):

Definition 12: An accelerated Spacetime Moment has a defined trajectory with respect to a given frame of reference, such that:

$$T_{2\pi} = n_{2\pi} * h \tag{8}$$

Note the conic shape of the accelerated Moment; we describe the reason for this representation shortly (e.g. see Figure 12 and related discussion). In the Point-Trajectory Model, the entire moment is assumed to move in a coherent fashion along a hyperbolic trajectory, following the leading element. A "central", dynamically generated average location point O_T exists for every Accelerated Spacetime Moment, representing the formation point for a new, embedded, emerging Spacetime Moment. The impact of dynamically generating O_T is most notable when $n_{2\pi} = \{1, or\ 2\}$, and we will largely focus on this level of precision in this paper.



An accelerated moment generates an observable pocket of spacetime that can communicate location, trajectory, and acceleration to adjacent loci. Additional Spacetime Moments can be implicitly generated that become manifest over 2 jump-steps.

Figure. 11. An Accelerated Moment

2. Principle Hypotheses

After defining our model, we now present three principle hypotheses:

Hypothesis 1: Object class 1, Communications, can mathematically represent bosons.

Hypothesis 2: Object class 3, Accelerated Moments, can mathematically represent fermions.

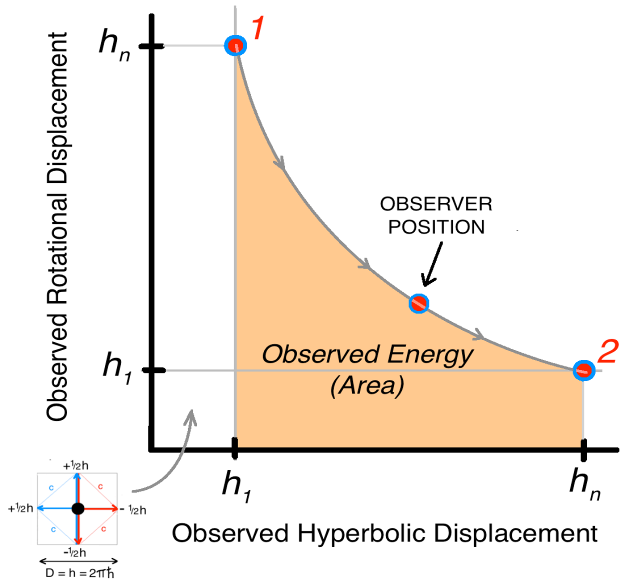
Hypothesis 3: Object class 2, Stationary Observers located at average moment computational positions, can account for properties of fermions, including spin, apparent perspectives of motion and rotation, and relativistic effects that differentiate leptons from hadrons.

In the remainder of this paper, we will both describe the implications of the model and provide initial support for these hypotheses. Specifically, we will first extend our model to define a reference frame (Section 3), discuss the role of stationary observers in our model (section 4.1), and then build an (initially simplified) model of neutrons, protons, electrons, and a proton-electron pair (Sections 4.2). We will then estimate and relate Euler's number (e) the fine structure constant (α) and π (Sections 4.3-4.5). Calculating α provides provides a model-based approach to electromagnetism. As we describe the relationships between $e, \alpha,$ and π we will also describe geometric approaches to understanding the weak force, neutrinos, and quarks, allowing us to build more complex models of a hydrogen atom (Section 5). In Section 6, we review our hypotheses, and we conclude our paper with relevance and connections of our model to Quantum Physics in Section 7.

3. Defining a Reference Frame and Relativistic Observers

3.1. First Principles: Placing an Observer in a Representative Planck-Space

Above, we have defined a model based on the 1-dimensional expansion of a point into a latent energy space under the assumption of a minimum observation distance h. In 3.1, we discuss general principles of observation consistent with our Axioms. First, let us reconsider our object in Figure 4, and place this object in an expanding hyperbolic frame (Figure 12). We can assume a progression from a first state "1" (maximal point potential rotational displacement) to a second state "2" (maximal point trajectory displacement), and



A representative Planck-Space with an observer placed. We assume in this figure (and in this paper) that at least on the scale immediately consecutive "jump steps" of length J, where $J_T^{1h} = R_R^{1h} = h$, that h can be assumed to remain constant. Units are Plancks ($J \cdot s$). Motion through the space can be described in terms of Joules.

Figure. 12. A Simplified Planck-Space Universe

place an observer experiencing (positioned along) a hyperbolic trajectory. We make the following assertions:

Assertion 8: System energy S_E is observed in increments of h from the perspective of a given observer position along rotational and hyperbolic axes (Axiom 3)

Assertion 9: The smallest possible observer is a single stationary observer of total length h (Definition 11).

Assertion 10: The relationship between the maximum hyperbolic displacement (or trajectory) and maximum observed rotational displacement for a closed system S_E can be described as:

$$\frac{R_1 T_1}{L_1} = \frac{R_2 T_2}{L_2}; \tag{9}$$

In which any R_n represents rotational displacement, any T_n represents hyperbolic trajectory, and L_n represents a location/energy relationship generated from properties of h_n. Under the condition $h_n = Constant$ equation 10 follows:

$$R_1 T_1 = R_2 T_2 = C\ (Constant) \tag{10}$$

Note here, we assume "momentum in the system" (number of available Plancks or h_n) remain constant. It should be clear that in this context, our system behaves similarly to the ideal gas law. Energy expressed as rotations is analogous to pressure. Displacement expressed as trajectory is analogous to volume. Available momentum (Plancks) is analogous to temperature. In our system, there is no "outside"; available Plancks are constant. Energy E_S expressed in this (closed) system can therefore be represented according to the following logical progression:

$$
\begin{gathered}
E_S = \int_1^2 R dT \\
\therefore E_s = R_1 T_1 \int_1^2 \frac{dT}{T} \\
\therefore E_s = R_1 T_1 ln[T]_1^2 \\
\therefore E_s = R_1 T_1 (ln[T_1] - ln[T_2]) \\
\therefore E_S = R_1 T_1 \ln \left({}^{T_1}/_{T_2} \right)
\end{gathered}
\tag{11}
$$

We have described, above, a simplified Planck-Space. In this simplified representation we see some important features. First, we observe the relationship between rotation and trajectory is a hyperbolic process, similar to heated gas expanding in an enclosed piston. Second, we note the system is causally complete, and energy is conserved. Observed hyperbolic trajectory and observed rotational movements are all perceived manifestations of a 1-D expansion of energy. In this context, any perception of space, mass, gravity, charge, or other forces (including weak and strong forces of nature) are hypothesized to represent manifestations of system energy as observed by a given Spacetime Moment, at a specific Spacetime location, along a trajectory T. At the commencement of our system, an observer sees all available Plancks as a point of expanding energy (high rotational state, a "bang"). In this simplified model,[2] at the end of the system, an observer can infer all available energy would now be visualized as trajectory/displacement, with no additional available rotations available – a "heat death" at the end of observable expansion.

3.2. An Accelerated Spacetime Moment Forms an Expanding Pocket of Observable Spacetime

To assess our hypotheses, we now focus on the details of the nature of Planck-Scale observations within a Spacetime Moment. We can start by visualizing an isolated Spacetime object moving through a single "jump step" J of length h. Spacetime in this object consists of one point, P with angular acceleration $A_{\wp}$ generating observer point 0_ρ moving along a Euclidean trajectory T at speed c, mapped in hyperbolic sphere $\mathbb{S}_\infty^h$, such that:

$$T_{2\pi} = n * h; n = 1 \tag{12}$$

Axiomatically, we must now address a perspective distortion in our illustrations; our Planck-Space is self-referential, but we have constructed figures with spatial dimensions from our external experience. In Planck- Space, there is no right, left, up or down, no "into" or "out of" the page. The space is defined solely by rotation, simultaneous distance metrics, and trajectory. To allow us to continue to represent the space using geometric principles, an arbitrary axis, rotating over our trajectory, must be defined by internal metrics. We model the axis rotation as a rotation of the Euclidean "3-ball" surface displayed in Figure 7 from position C_2 to C_4 (Figure 13). Turning to Figure 13, we continue the convention of using the right-hand-rule by extending a thumb to the left, with index finger pointing in the direction of the axis. Focusing on an average location (middle of sphere in Figure 7), Figure 13 now represents an observed trajectory from the perspective of 0_ρ along Euclidean arcs ($0_\rho T^+, 0_\rho T^-$). We can define 2 distances. The arc distance R_A is the distance along the 3-ball arc connecting 0_ρ, T^+, and T^-; more formally R_A is the arc distance from an observer 0_ρ to a second point located along the surface of a defined 3-ball sphere C_N located in a hyperbolic sphere $\mathbb{S}_\infty^h$. R_L is defined as the chord distance from 0_ρ on map $\mathbb{S}_\infty^h$ to the second point. Under

[2] Note an aggregative principle allowing storage of energy in State 2 could admit the existence of "Black Holes"; our Planck-space becomes more like a spring (e.g. see Figure 2) in this case. Since Spacetime is simply an expression of energy generated by observer perspectives, in State 2 no further energy is stored as "observable space" in the absence of observers; a new "Bang" could, theoretically, occur at this point based on energy stored in "trajectory".

the condition of 1 jump step of length h, $R_A = {}^{h}/_{2}$. In all cases the chord distance (linear hyperbolic distance) is less than the distance traversed along the Euclidean 3-Ball Arc (e.g. $\mathrm{R_L} < \mathrm{R_A}$). Location 0_ρ in Figure 13 is located in the "average instantaneous location" of the accelerated moment we have defined. Note, however, we can place an observer at any observer point; here intrinsic properties of hyperbolic space help us now define the structure of an object of defined length (length h in this case) moving in Spacetime along a hyperbolic trajectory. In Figure 14, we choose to examine the destination point for the Spacetime Moment (green) with respect to O_T (purple/lavender). Note the relationship between a destination point and O_T generates the dynamic perpendicular (Definition 9). We can appreciate in the Poincaré representation that the Spacetime Moment destination can be approached by two potential displayed trajectories (red dots or blue dots), with two distinct rotational characteristics (into and out of the page). In Figures 13 and 14, we showed C_2 rotating on to C_4, but we now also define a second unique pathway to, defined by a rotation of points from C_3 to C_1.

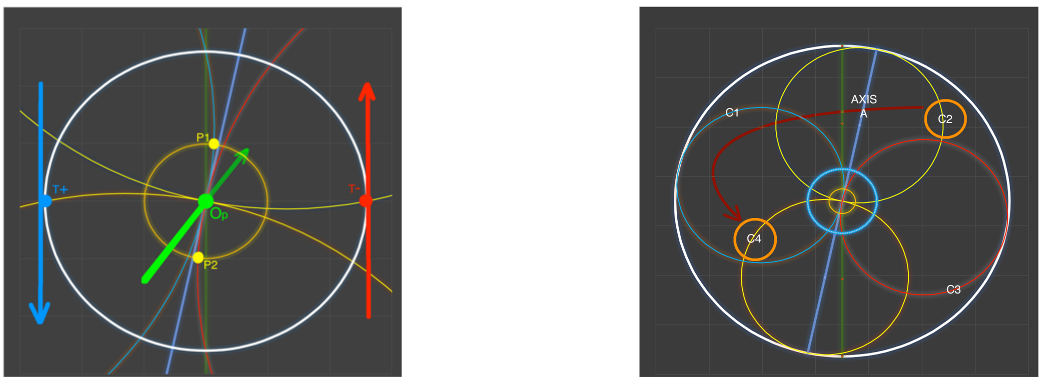
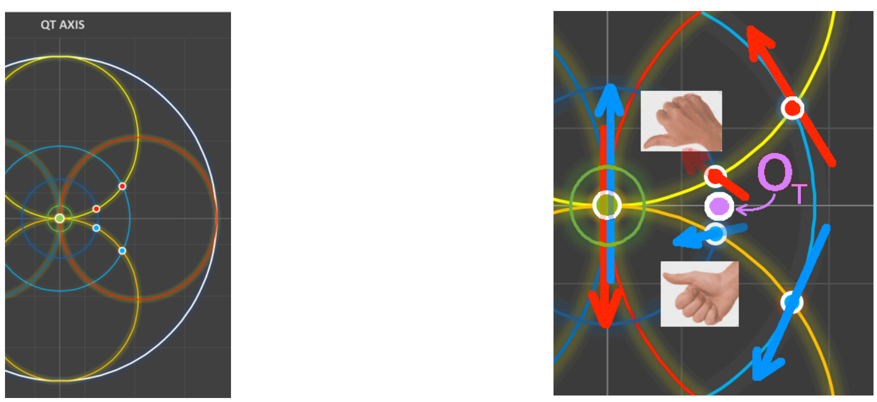


Figure. 13. Average observer point 0_ρ, & Observed Axis Rotation



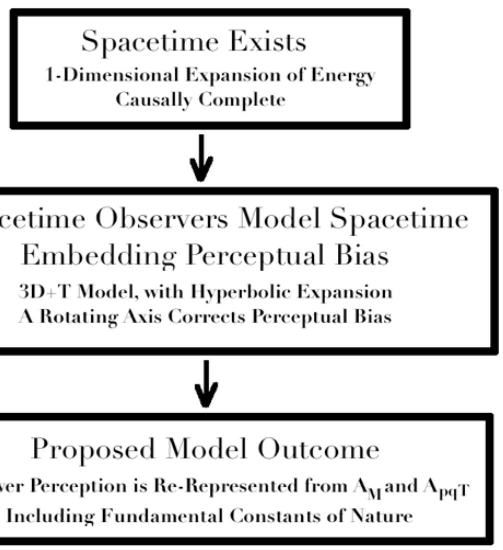
An Accelerated Moment from the perspective of the leading edge of the Spacetime Moment. Note 0_ρ (green locus, centered) observes that it could arrive to its position from either of two hyperbolic trajectories. *Note this figure is to assist in developing model intuition. The dynamic "3-ball" rotation through $\mathbb{S}^h_\infty$ is not represented, and it should also be noted that perpendiculars in Poincaré space are curved, not linear. Further, note the properties of the "dynamic perpendicular" we have defined differ from the hyperbolic static perpendicular (for introduction to Poincaré space, see reference: Poincaré, 1895).*

Figure. 14. An Accelerated Spacetime Moment (Poincaré Representation)

3.3. The Relationship between the pqT Frame, Axis Rotation, and Observable Spacetime

It is now productive to define three distinct reference axis definitions. **First**, we define model axis, A_M. A model axis A_M makes use of our cognitive and perceptual frame, which inherently fractures Spacetime into dimensions of space and time. Our visuospatial system is finely tuned for computation and insight, and it is efficient, from a cognitive perspective, to construct our models in this frame. Multiple projections can be defined (i.e. there many possible A_M projections). **Second**, we define the Spacetime observer axis, A_O. A_O is our experienced axis of Spacetime. We propose A_O can be computed from various A_M projections (Figure 15). **Third,** we have just defined axis as it pertains to Planck-Space (and the pqT frame). Planck-Space assumes a point can give rise to a one-dimensional space, and further dimensionality develops as a natural consequence of perceived motion as defined by Axiom 3. Axis A_{pqT} is defined from the perspective of unique observer points (O_ρ) placed centrally in a sphere $\mathbb{S}^h_\infty$, and is defined by the rotational movement (in accordance with Axiom 3) of a point P_{n-1} to a point P_n around a central observer point O_p moving through hyperbolic space. Relationships below the observation threshold h both exist, and can be ***experienced***, but are not ***observed*** as space or time as they occur at scales < h related to any given observer system $P_{n-1}P_n$. We propose that these interactions are experienced as fundamental constants and forces of nature. Specifically, we make a new assertion:

Assertion 11: When a stationary observer M_v is observed to undergo hyperbolic motion to become an accelerated moment M_p, directionality can be represented as an angle $\angle_{pqT}$ in reference to an axis of rotation A_{pqT} perpendicular to the hyperbolic trajectory T.



The Planck-Space Point Trajectory model generates rotating axis A_{pqT} embedded in a 3D+T hyperbolic Poincaré space (Axis A_M) to represent Spacetime as a 1-Dimensional Expansion of Energy. We propose our stable 3-D Euclidean experience of space and fundamental forces of nature is fractured from a 1-dimensional expansion of energy.

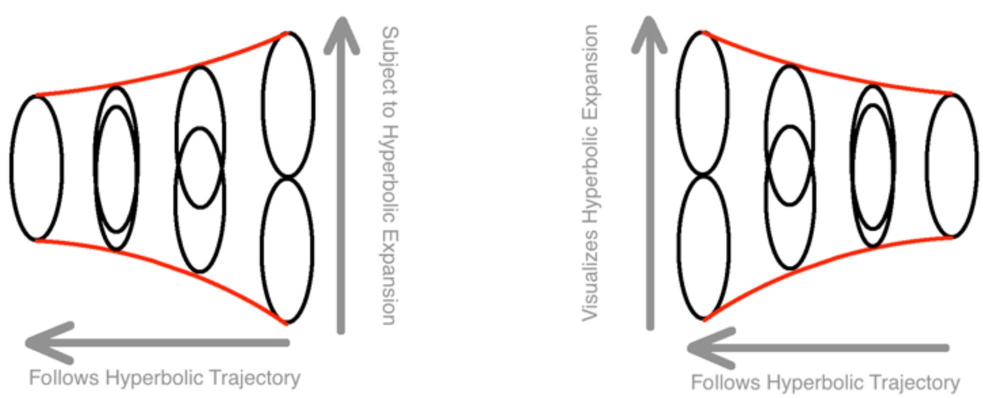
Figure. 15. Proposed Model Outcome

Note that A_{pqT} is generated by the dynamic movement of P and O_ρ through hyperbolic space, and A_{pqT} can be mathematically modelled to rotate over a trajectory with respect to the Euclidean axes describing the one-dimensional accelerated framework. In summary, we propose a model based on recursive assumptions.

1) We have defined Spacetime as a 1-D hyperbolic expansion of energy from a point.

2) We assume, as model builders, that we observe this 1-D hyperbolic expansion of energy as 4 spacetime dimensions (3 of space, 1 of time) and fundamental forces such as gravity, the strong and weak force, and electromagnetism.
3) We have generated 8 axioms to translate a 1-D expansion of energy into a model that accords with our assumed frame of observation.
4) Projections, represented in our observer frame (A_M), requires all elements be self-referential (including requiring a rotating axis A_{pqT}).
5) We propose that we can now use this dynamic model to re-create our observed and experienced, stable axes of Space and Time (A_O).

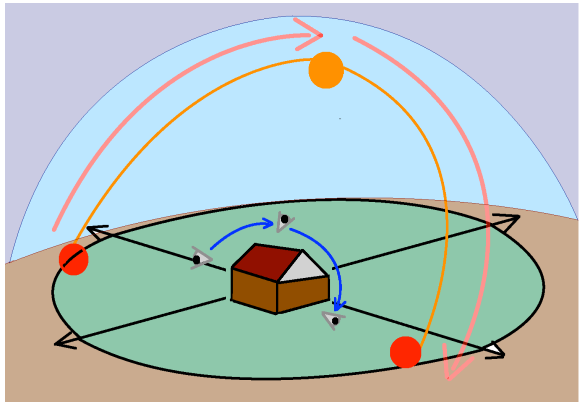
A central feature of the model is the importance, on Planck scale, of the relative position of a given observer. All Planck-scale observers experience a central location in $\mathbb{S}^h_\infty$, but visualize Space and Time only along Euclidean axes. Figure 16 presents a visual intuition of an observer embedding a 3D+T visualization of Spacetime into hyperbolic space. On the left we displays the "leading edge" of a Euclidean observer observing that its "tail" to the right is subject to hyperbolic expansion. Note that the experience is symmetric. When we place O_p in a "tail" location, it becomes the center of hyperbolic sphere $\mathbb{S}^h_\infty$, and the hyperbolic expansion appears to occur to the left (Figure 16). To this observer at the "tail", it appears that the leading edge moves as the observer remains stationary.



The substance of 1D Spacetime is continuous. The nature of 3D+T observation is discrete. The "leading edge" of an accelerated moment notes an expansion of its "tail". The "tail" similarly will observe itself as a unitary object of circumference h, and observe a hyperbolic expansion of the leading element.

Figure. 16. Observer Perspective is Relative

The notion of relative observation frames may seem counter-intuitive, but recall we experience this perspective on a large scale. As an observer I perceive the sun rotating around my personal relatively stationary location (Figure 17). If the sun were truly to be rotating around my position, I would experience the rotation as occurring at a significant fraction of the speed of light (I will leave it to others to do the calculations). However, as I am progressing in Spacetime dynamically towards the Spacetime location of the sun, my observed relationship with the sun is largely (although not completely) defined by Euclidean perspectives. We propose that this experience also occurs at Planck Scale. An "electron" coupled with a "proton", in the absence of interaction can be assumed to experience, from its observer point, that the proton, and in fact all of Spacetime, rotates around its position as the electron "falls" through Spacetime towards the associated proton. In the remainder of section 3, we will describe the reformulation of Planck-Space, in accordance with this principle, into observable space and time.

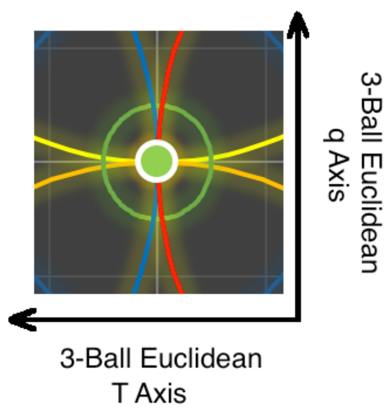


Observers at all scales observe conservation of energy states. The 1D Spacetime destination of an observer is perceived as an orbit.

Figure. 17. Orbits Encode Spacetime Destinations

3.4. Defining motion in Planck-Space for an accelerated moment

In section 3.4, we focus specifically on observations made by P and 0_ρ in the Euclidean (3-Ball) frame during a single hyperbolic movement of length h. Formally, we will call this movement a Jump Step $J_{2\pi} = h$. Jump Steps are measured in integers; e.g. $2J_{2\pi} = 2h = 4\pi\hbar$. The selected observer (0_ρ in this case, central, green) measures space along axes defined by the Euclideans (3-Ball – Figure 18). We display q and T axes only.



Spacetime is observed along Euclidean 3D+T axes embedded in hyperbolic space. Axis transitions (e.g. Red/Blue, Yellow/Orange) are energetic.

Figure. 18. Observed Spacetime Axes

We can now re-represent only the visualized Euclidean parameters of the jump-step, neglecting the hyperbolic (Figure 19). Figure 19 provides a general conceptual overview of potential 3D+T positions observed by P and 0_ρ over a single Jump Step. We label the following points for Figure 19:

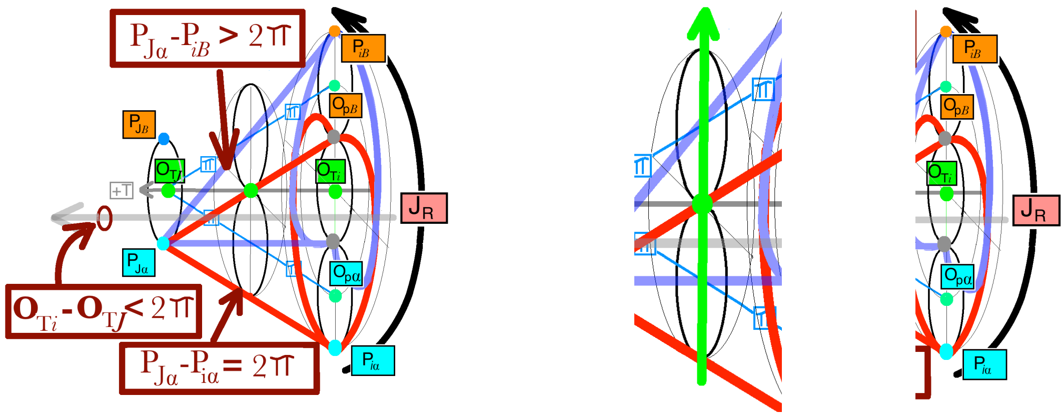
$\boldsymbol{P_{i\alpha}} \rightarrow \boldsymbol{P_{i\beta}}$**:** Observed prior location of "trailing P", related to trajectory observed by $P_{J\alpha}, P_{J\beta}$

$\boldsymbol{O_{Ti}} \rightarrow \boldsymbol{O_{TJ}}$**:** The Spacetime emergent trajectory (and newly generated Spacetime Moment) generated by the observed hyperbolic jump $J_{2\pi}$ of O_p.

$\boldsymbol{O_{p\alpha}} \rightarrow \boldsymbol{O_{p\beta}}$**:** The observed rotational jump $J_{2\pi}$ of O_p.

$\boldsymbol{P_{J\alpha} \rightarrow P_{J\beta}}$: Location of "leading P", depending on trajectory/state

Note, in Figure 19, all relationships are dynamic. A location is always in transition "emerging" from one location and "arriving" at a second location.



Left: A 3D+T representation of a Single Jump Step. From the perspective of O_{TJ}, due to axis rotation, $P_{iB} \rightarrow P_{J\alpha} > h$ (and $P_{i\alpha} \rightarrow P_{JB} > h$), while trajectory ($O_{Ti} \rightarrow O_{TJ}$) has advanced $< h$.
Middle: A dynamic perpendicular is generated by the movement $O_{Ti} \rightarrow O_{TJ}$ (green).
Right: A jump J_E (red) along the hyper-trochoid would represent the simple, Euclidean jump; P , however, makes jump J_R due to axis rotation A_{pqT}.

Figure. 19. Potential Locations of P and 0_ρ from the perspective of 0_{TJ}

We can make a related assertion:

Assertion 12: There exist a set of points $O_{Ti}, O_{TJ}, O_{p\alpha}, O_{p\beta}, P_{J\alpha}, P_{J\beta}, P_{i\alpha}, P_{i\beta}$, within an accelerated Spacetime Moment M_p, that can be selected that describe the relationships between P, 0_ρ, and a dynamic perpendicular defined by O_{Ti} and O_{TJ}.

Explicitly in this representation,

- O_T makes a hyperbolic jump of distance $< h$ from O_{Ti} to O_{TJ},
- A correlated rotational jump (h) is observed from $O_{p\alpha}$ to $O_{p\beta}$.
- $O_{p\alpha}$ and $O_{p\beta}$ are the central loci along T for points P_n.
- $P_{J\alpha}$ can be modelled to experience a half rotation to $P_{J\beta}$ due to the combined effect of a rotation around $O_{p\alpha}$ and an axis rotation around axis $O_{Ti} \rightarrow O_{TJ}$
- The distance from $P_{J\alpha}$ to $P_{i\beta}$ is greater than the distance from from $P_{J\alpha}$ to $P_{i\alpha}$

The differences between the varying relationships (Table 1) are examples of ***relativistic relationships***, which will have important impacts as we discuss first principles-based estimations of the Fine Structure Constant α, Euler's Number e, and the Euclidean rotation constant π we calculate in section 4. We now must account for our model requirement that our axis A_M representation must accord with Axioms #1-8. To accomplish this, we embed rotations that "bring all points back to the 1D". To visualize the "return to line", we present Figure 20, which flattens the perspective to only observe the $\Delta p \Delta q$ frame. We can use the heuristic approach we demonstrated first in figure 4 (replicated right in figure 20 for ease of reference). We make the following assertion:

Assertion 13: In order for movement to be observed by any point P, the point must return to an initial location a trajectory distance T away, measured in multiples of h from its initial location.

Table. 1. Examples of Relativistic Relationships

Observed/Experienced Movement	Type of Movement	Distance
$O_{Ti} \to O_{TJ}$	Trajectory	$< h$
$O_{p\alpha} \to O_{Tj}, O_{p\beta} \to O_{Tj}$	Trajectory	$= h$
$O_{p\alpha} \to O_{p\beta}$	Rotation	$= h$
$P_{i\alpha} \to P_{J\beta},\ P_{iB} \to P_{J\alpha}$	Trajectory	$> h$
$P_{i\alpha} \to P_{i\beta}$	Rotation	$> h$

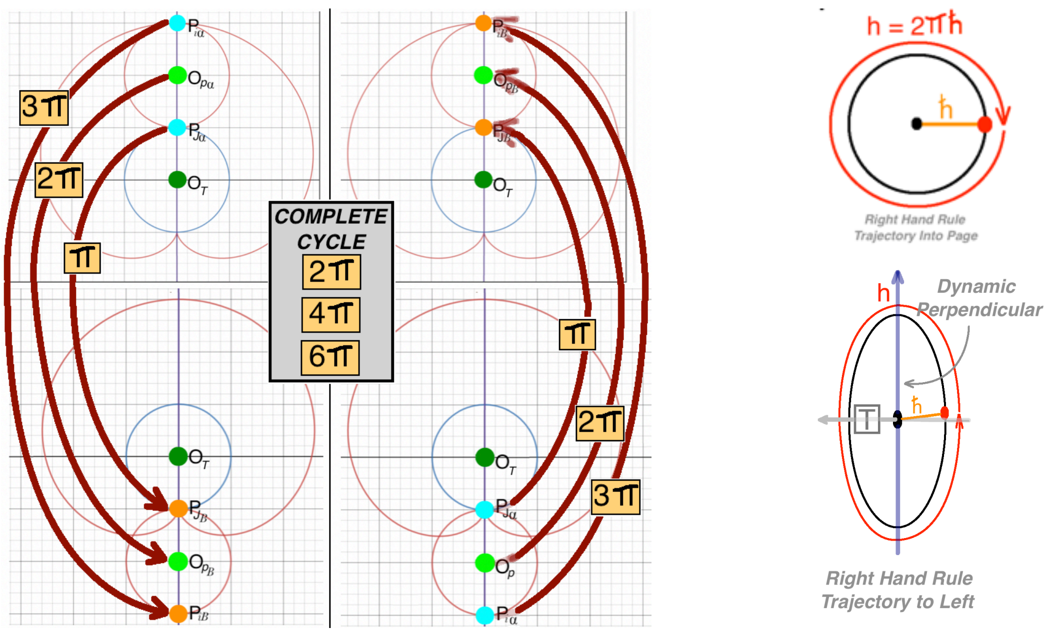


Figure 20 is on right; Elements of Figure 4 reproduced on right for review.

Figure. 20. 2D+T $\Delta p \Delta q$ A_M Visualization

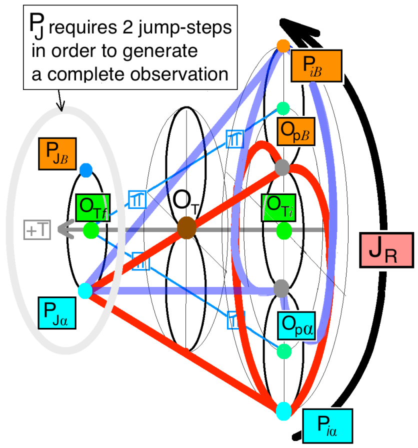
Presented in an A_M frame, we represent this perspective in Figure 20, but also below in Figure 21. Turning to these figures, we see that in our model, constructed respecting Euclidean lines of observation within a Poincaré sphere, an accelerated moment P "orbiting" axis $\{O_{Ti} \to O_{TJ}\}$ experiences a complete observation of its location(s) in 1D, Hyperbolic, Spacetime not over ***one*** jump-step, but rather over ***two***. In Figure 20, we observe the $\Delta p \Delta q$ frame only and note P and O_p appear to "orbit" O_T. Over one jump step ($\Delta T = h$), rotational distance observed is $\{{}^1\!/_2\, h, h, {}^3\!/_2\, h\}$. Figure 21 expands the view of Figure 20 into a 3D+T frame, for better intuition, to make use of our innate visualization capabilities in this frame. We can see that over 2 jump steps ($2h$), Euclidean orbital circumferences of $\{h, 2h, 3h\}$ are observed.

The following assertion flows:

Assertion 14: An accelerated Spacetime Moment observes a complete return to its starting location over 2 jump-steps.

Moving to hyperbolic space, we can also project a version of A_M, placed in a Poincaré sphere model (Figure 22). In Figure 22, we show P_J moving on a trajectory through hyperbolic Spacetime. The Euclidean 3D+T "sight-lines" we expressed as straight lines in Figure 20 and 21 are here expressed as hyperbolic surfaces along the "3-Ball", in red and blue. Embedded in hyperbolic space we note:

1) Space and time can be mapped along the Euclidean trajectories (red/blue curves in a Poincaré representation).
2) Non-Euclidean motion is also present but is observed as vectors of force or interaction projected on the 3-Ball surface.

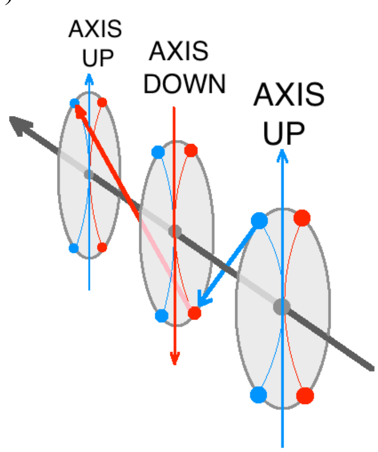


Due to axis rotation P_J completes ½ of a full $\Delta p \Delta q$ rotation in a single jump step.

Figure. 21. 3D+T pqT Visualization

We will demonstrate in the next sections evidence that these non-Euclidean movements, along with relativistic adjustments, can model observation of fundamental forces of nature. The Euclidean projections in Figures 20 and 21, and the Hyperbolic projection in Figure 22 are equally valid projections, serving distinct purposes. Specifically:

1) A Euclidean projection provides intuition on how the object is represented in 3D+T space.
2) A hyperbolic projection provides intuition on how we can relate 3D+T coordinates with additional experiences (forces of nature).



Hyperbolic trajectory is represented in gray. Euclidean 3D+T Observations are shown in red, and blue.

Figure. 22. Point P_i Observing Trajectory $T_{2\pi} = 2J_{2\pi}$ (Hyperbolic Visualization)

To tie these projections into an intuitive whole, we now must discuss the act of observation, the process of communication, and relativistic considerations. Describing observation will allow us to define three fermions: a neutron, a proton, and an electron, as well as a more complex Spacetime object (a proton-electron pair, as well as deuterium and tritium – see Section 5), and provide a conceptual framework for describing the process of Beta Decay, as well as modelling Quarks.

4. Observers in 1D Spacetime

Summary of Section: In prior sections, we have presented Axioms, Definitions, some Assertions, and General Hypotheses. We then presented a coordinate space, and placed observers in this coordinate space. We presented a variety of perspectives, including illustrations touching on an intuitive "view from outside" (based on an Axis A_M representation generated in our 3D+T space), with a hyperbolic visualization in A_M making use of the Poincaré convention. We finally described a rotating axis A_{pqT} that connects our model to the base substrate of the 1-Dimensional, dynamic, hyperbolic expansion of energy that is Spacetime. In this section, we will bring these introduced concepts together, describing the impact of Spacetime location on perspective, and relativistic considerations that influence observation of position and energy state.

4.1. The Stationary Observer

After defining the geometry and behaviour of points in Planck-Space we can now describe the fundamental process of observation. We start with four new, derived, but important, assertions:

Assertion 15: In accordance with Axiom 8 (conservation of momentum), in the absence of a defined interaction, all points in Spacetime can be modelled to experience and observe their progress through Spacetime as a linear trajectory. Other communicating points and objects from the perspective of the selected point display dynamically generated hyperbolic trajectories and/or rotations.

Assertion 16: Correlating with Assertion 15, all points in Planck-Space can also be modelled, in the absence of interaction or communication, as Stationary Observers.

Assertion 17: A communication, or interaction, can change the rotation, or trajectory of a Planck-Space point. This change is observed as a change in trajectory or rotational characteristics of the Moment (and a change in the observed/experienced dynamic perpendicular).

Assertion 18: All observed communications for all points O_p (in which O_p here refers to an "average point" for a coherent Spacetime Moment or set of Moments), at any given trajectory, can be modelled to be observed (received) in a 3D+T coordinate system simultaneously at a given distance. Space and time locations are observed at defined integers of the minimum observation distance, i.e. $\{1h, 2h, 3h, \ldots\ nh\}$.

Assertion 19: From the perspective of an observer, Spacetime occurrences transpiring at non-integer distances $< h$ can be modelled as computations, which we will call *experiences*. These experiences manifest as non-space, non-time energy characteristics located at the 3D+T coordinates.

Observed distances, rotations, and trajectories are point dependent. In this fashion, we can model discrete and continuous features of Spacetime. Specifically:

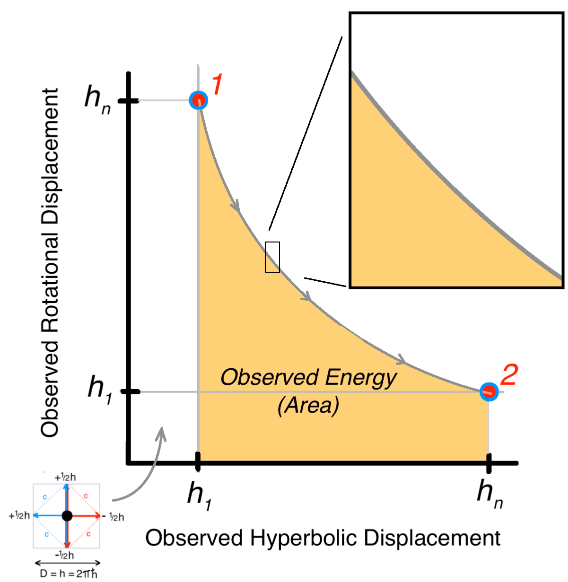
In Assertion 15, we return to the base assumption of our model; Spacetime is the result of a continuous 1-Dimensional expansion of energy that occurs in the context of a minimum observation distance h. Space, Time, and Fundamental Forces of Nature are observed as consequences of h and a uniform communication speed c. The Planck-Space Point Trajectory Model is a description of the rules and characteristics of observation that generate the observer perception.

Assertion 16, in particular, may seem difficult to accord with the previous discussion of objects moving, accelerating, jumping, and rotating, but we must recall now a simple but important feature of our cognitive processes and how we are communicating these ideas. Our model describes behaviours with respect to a reader – an observer. Consider your position, seated, or standing while reading this paper. From your perspective, in the past 24 hours the moon, the sun, and the Andromeda galaxy have all rotated around your position, while you, the reader, has remained largely motionless (review Figure 17). We propose that this is a scale-free phenomenon, that occurs not only on large scale, but also on Planck-Scale. Recall that while a "proton" observes that the electron rotates around it, the "electron" observes the proton orbiting. Any change in the steady process of a trajectory requires a communication or interaction (*Assertion 17*).

Regarding *Assertion 18*, prior to an observer interpretation fracturing the model into discrete observations and experiences, recall there is no space, or time in Planck-Space – only trajectory, spin, and observation distance. The relative location of a communication must therefore be described either as a hyperbolic trajectory, or rotational characteristic with respect to any given observer point placed centrally in a Poincaré sphere, in relation to scalar integer representations of our only distance measure, h. Note points will always disagree on relative coordinate locations of events; observation is relative.

Assertion 19 follows Axiom #4; while observation is discrete, Spacetime is continuous. We now can apply Axiom #8 ("conservation of momentum") to our model. In Figure 23 we observe a full Spacetime trajectory in a Universe projected to start at a point position (Planck trajectory circumference h, maximum potential rotations/energy h_n, progressing to maximum emergent trajectory energy h_n). While a "ringdown" or gradual shift in global system energy transfer is assumed to occur on large scale, at Planck-Scale, we make an important assumption that now needs to be made explicit (Assertion 20).

Assertion 20: The rate of energy transfer between rotational and trajectory energy (the slope of the relationship between rotation and trajectory) can be modelled to be negligible on Planck Scale in our Universe.



We assume observed relationship between hyperbolic and rotational measurement is negligibly small on Planck-scale.

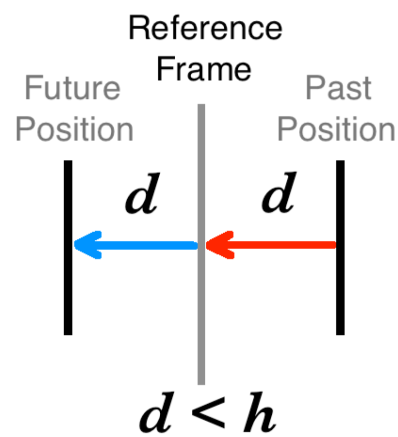
Figure. 23. A Simplified Spacetime pqT Universe

This assumption is important to allow us to use symmetry to approximate the relationship between objects "in front of", and "behind" a given O_T. While on Cosmic scales Assertion 20 does not hold, in this paper, we focus only on a single Spacetime Object, which we now define:

Definition 13 (M_O): A Spacetime Object is a coherent series of Spacetime Moments traversing a uniform Trajectory T, such that all elements maintain a uniform distance from a central point O_T.

Clarifying the implications of Definition 13, note that points in hyperbolic space inherently diverge. A series of points that maintain a constant distance from a central point must invariably observe a transfer of energy with their hyperbolic environment to maintain this coherence. When a series of points do not maintain a constant coherent distance, either a new single object is created (a fusion) or a single object gives rise to one or more new objects (a decay). A group of Spacetime Objects can further communicate relative position and trajectory, per definition 14:

Definition 14 (M_O): We define a ***Reference Frame*** as an instance of communication among a group of Spacetime Objects regarding relative position and trajectory to a particular Spacetime Object with centre O_T. All reference frames are observer-point specific (Figure 24).



Selecting any given O_T, we can locate future, and past positions.

Figure. 24. Reference Frames

Turning to Figure 24, we now explicitly reinforce a feature of Spacetime Objects:

$$\{(R_n * T_n = Constant) \& (T_{2\pi} = n * h)\} \Longrightarrow n * d < n * h \tag{13}$$

Wherein d is defined as the trajectory distance a Spacetime Object is observed to move in a single jump-step, and n is an integer. Communications traverse hyperbolic trajectories at the speed of communication. Spacetime Objects traverse hyperbolic trajectories in all cases at less than the speed of communication. We now make four assertions, relating Spacetime Points, Spacetime Loci, and Stationary Observers to Accelerated Observers.

Assertion 21: In the absence of an instantaneous interaction, all Spacetime Points and Spacetime Loci identify themselves as Stationary Observers. Other objects, including interactions and communications, are observed and experienced as Accelerated Spacetime Moments.

Assertion 22: Euclidean Space and Time (3D+T) provides discrete spatial information for all Spacetime Experiences.

Assertion 23: Strong and Weak interactions are generated by relativistic interactions within Spacetime Moments.

Assertion 24: Electromagnetism and Gravity are generated by relativistic interactions between Spacetime Moments.

Table. 2. Proposed Discrete and Continuous Relativistic Interactions

Type of Interaction	Location of Observation/Experience	Proposed Examples
Discrete (Observation)	Integer Increments of h (Between Moments)	The generation of 3D+T Spacetime Coordinates
Continuous (Experience)	$E < h$ (Within Moments)	Strong and Weak Interactions
Continuous (Experience)	$E > h; E \neq n * h$ (Between Moments)	Electromagnetism and Gravity

Note, it can be intuitively useful visualize our Spacetime Objects in "A Space", but it is important to recall that objects do not approach and recede from each other in 3D space. Rather, we recognize the following due to 1D expansion of Spacetime in the context of measurement imprecision:

1) Space and Time are dynamically generated discrete energy relationships between Spacetime Objects
2) Forces of nature are continuous experiences for observers locate at discrete 3D+T locations related to the 1D expansion of Spacetime.

Only in a silent Universe at the end of expansion could objects conceivably traverse Spacetime in the absence of interaction. We have now sufficiently explored the implications of our definition of Spacetime (a 1-D expansion of energy) and Axioms #1-8 to describe a Neutron, Proton, Electron, and Proton-Electron Pair in our model. We will not prove assertions 21-24 fully in this paper, but we will, in the following three sections, provide proof of the general merits of our approach by approximating, from our definitions of fermionic matter and first principles, Euler's Number e, the related fine structure constant α, and the Euclidean Rotation Constant π.

4.2. Defining a Neutron, Proton, Electron, a Proton-Electron Pair

We have hypothesized that Accelerated Moments can represent fermions (Hypothesis 2). In this section, we will explore this hypothesis by making an assumption, and generating some consequent definitions. Specifically, we assume that a single Spacetime Moment, moving through hyperbolic space, is the fundamental substrate for Spacetime Objects we identify as Fermions (Figure 25, Definitions 15-18).

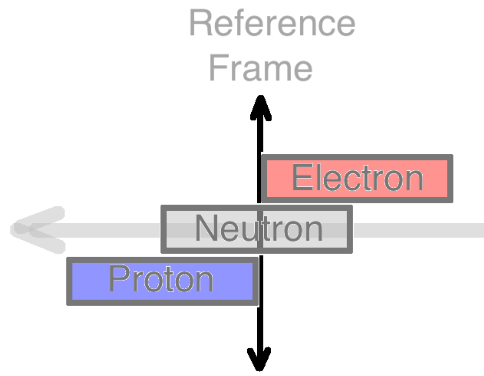
Definition 15: A Planck-Space Neutron is a single Spacetime Moment of length $J_{2\pi} = h$, with center O_p that is observed by other Spacetime Moments to be centered on a dynamically generated reference frame R.

Definition 16: A Planck-Space Proton is a single Spacetime Moment of length $J_{2\pi} = h$, with center $O_{p+\pi}$ that is observed by other Spacetime Moments to be centered a half jump-step ($\frac{1}{2}h = \pi\hbar$) ahead of a dynamically generated reference frame R.

Definition 17: A Planck-Space Electron is a single Spacetime Moment of length $J_{2\pi} = h$, with center $O_{p-\pi}$ that is observed by other Spacetime Moments to be centered a half jump-step ($\frac{1}{2}h = \pi\hbar$) behind a dynamically generated reference frame R.

Definition 18: A Proton-Electron Pair is a Spacetime Object of length $J = 2h$, consisting of a Proton and Electron following the same Hyperbolic Spacetime Trajectory.

In Section 4.3, we will describe a Neutron as a Spacetime Object that observes (and dynamically generates) 2-D+T Spacetime and provide an initial first principles-based estimate of Euler's Number (e_0) as a term describing an expanding Spacetime Trajectory. In Section 4.4, we will discuss neutron decay and describe decay products of the Neutrino, the Proton, and the Electron, focusing most specifically on generation of a Proton-Electron Pair as one possible decay product. We will further describe the generation of 3D+T Spacetime by Protons, Electrons, and Proton-Electron Pairs, and provide an initial first principle-based estimate of the Fine Structure Constant (α_0). In section 4.5, we will focus on the natural emergence of the rotation constant π from the linear expansion of Spacetime. In section 4.6, we will end Section 4 by discussing how an object of initial trajectory dimension $2h$ can be modelled to expand, and be observable, as an object the size of a visible atom due to the relativistic impact of Spacetime Expansion.



Relative placement of Spacetime Moments for Proton, Neutron, and Electron in 1D position compared to Reference Frame ("Observed Now").

Figure. 25. Fermions and Reference Frames

4.3. Properties of a Neutron, and the emergence of an expansion term "e_0" as a natural consequence of accelerated spacetime

We have defined a Neutron as a Spacetime Moment straddling a reference frame. We can reflect on the following Axiom, assertions, and definitions (replicated below): In accordance with Axiom 4, Spacetime is continuous. We now review related assertions regarding this Spacetime Moment:

Axiom 4 (restated): Spacetime is continuous. Observation is discrete.

Definition 6 (restated): In the presence of acceleration, 0_ρ experiences an orthogonal (linear) trajectory T.

Assertion 15 (partial restatement): In accordance with Axiom 8 (conservation of momentum), in the absence of a defined interaction, all points in Spacetime experience and observe a linear trajectory.

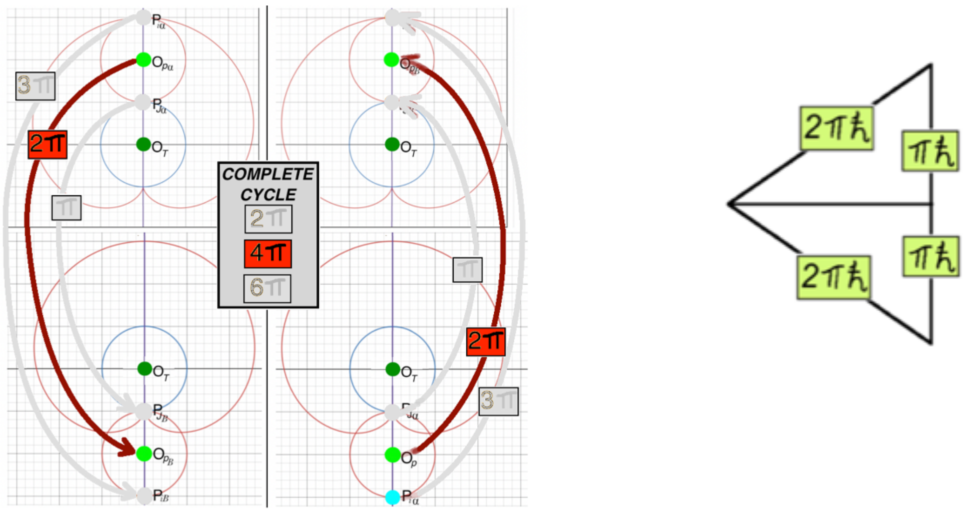
Assertion 23 (restated): Strong and Weak interactions (scale $< h$) are generated by relativistic interactions within Spacetime Objects.

Equation 13 (partial restatement): Trajectory distance $O_{Ti} \rightarrow O_{TJ} < h$; also see Table 1.

We now make a related assertion:

Assertion 25: Expansion of Spacetime can be modelled as a Sub-Planck experience, occurring within a Spacetime Moment.

We can model the implications of assertion 25, pertaining to a Neutron straddling the reference frame. We can *first* note that the expansion of Spacetime is related specifically to the motion of Spacetime generating the dynamic perpendicular to trajectory $O_{Ti} \rightarrow O_{TJ}$. To calculate the expansion constant for a single jump-step, which we will term e_0, we focus on all points O, neglecting for the moment P (Figure 26). We *second* note that a Spacetime Object is a coherent series of Spacetime Moments traversing a uniform Trajectory T, such that all elements maintain a uniform distance from a central O_T (Definition 13). A static intuitive representation can generate for us an isosceles triangle (Figure 26, right image).



O_p and O_T dynamically generate internal location characteristics (space) over 2 jump-steps. This internal space can also be computationally represented as 2-dimensional.

Figure. 26. A Dynamic $\Delta p \Delta q$ Projection of 2-D Euclidean Space+Time

In figure 27, we represent, from the perspective of O_T (central red dot) a point O_p with a particular arbitrary spin state returning to its original position over 2 jump-steps. Note that an alternative spin state (due to axis rotation) can also be observed; more about alternative spin states is discussed in Section 5. We

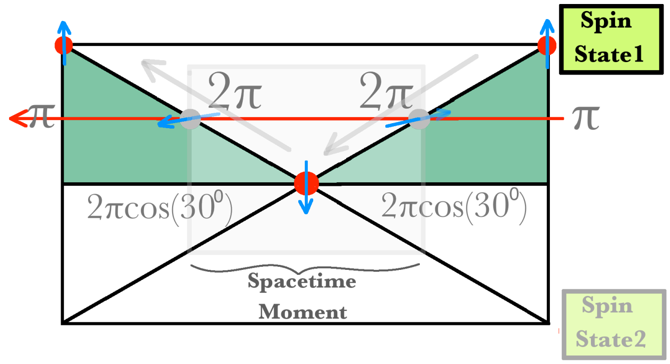


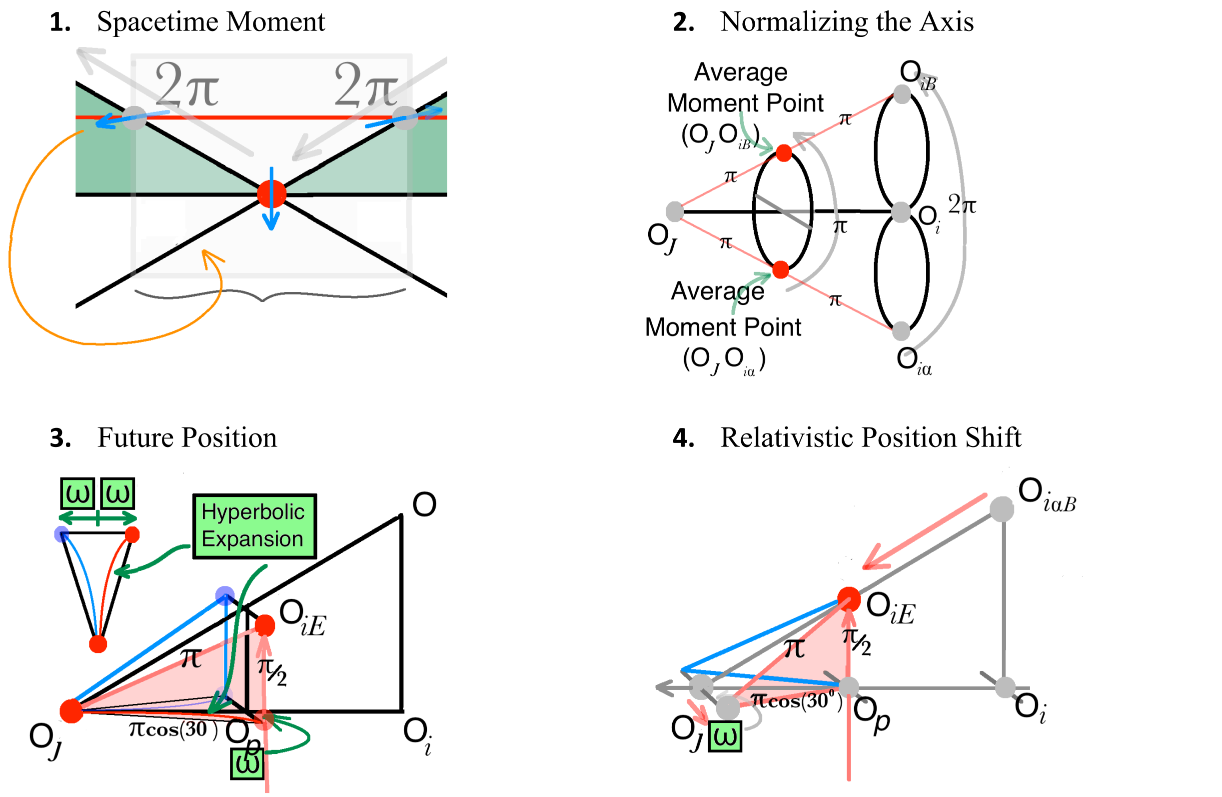
Figure. 27. A Dynamic qT Projection of 2-D Euclidean+Time

note that (in a 2D projection) from the perspective of T, there is precisely one perpendicular line to the internally derived trajectory at point O_p, and the posterior and anterior trajectories of O_p are related to this dynamic perpendicular. We now make two assertions, which we will support in part by visual intuition (Figure 28):

Assertion 26: The trajectory of a single jump-step in the context of a single dynamic perpendicular can be modelled as occurring on a plane.

Assertion 27: A second jump-step along the same linear trajectory, in the absence of interaction, can be modelled as an equilateral triangle, with sides of equal length h ($= 2\pi\hbar$).

In summary, we have stated that space is an emergent property, constructed by the observer from a 1-dimensional expansion of energy. It follows that the experience of Space, like other experiences pertaining to expansion of energy, is observer and scale dependent. On the smallest possible observation scales, Spacetime is observed by points O in the moment as a 2+T-dimensional expansion of energy that can be modelled as an isosceles triangle. Related *experiences* below the level of observation are computed as forces of nature occurring "within the moment". Figure 28 provides several, equivalent or "translating" images representing differing visualizations of the 2D fracture of Space and Time from a 1D Spacetime expansion.



Various perspectives of a dynamic Spacetime Moment. Bottom right and bottom left formulations place an observer variously at a destination point (Bottom Left) or average position (Bottom Right).

Figure. 28. Projection of Spacetime Moment Point Positions
(See Descriptive Statements, Next Page)

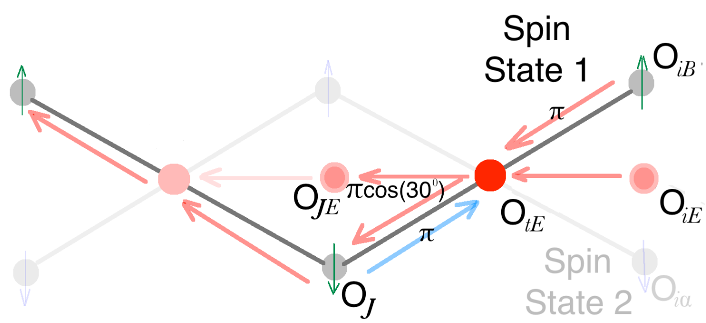
We provide explanation and context for each image in Figure 28 below:

1. Top Left Image: we present a Spacetime Moment as a flat linear expansion with a rotating frame (blue arrows).
2. Top Right Image: The axis is normalized to the A_{pqT} frame; a dynamic axis rotation is not shown but should be presumed to be present. We present (for best intuition) a Euclidean rotation. It is productive here to return to a fundamental principle: all Spacetime points have equivalent quintessence. The movement $O_{i\alpha} \rightarrow O_{iB}$ should not be conceptualized as a ball spinning on a string, rather the system $O_{i\alpha}O_JO_{iB}$ should be conceived more accurately as a precisely equally weighted baton, pivoting around axis O_JO_i as it moves through Spacetime. Analogous to calculation of a center of mass of a baton pivoting precisely around point O_J, the "Average Moment Point" can be considered to be the average moment location for a given jump $O_{i\alpha B} \rightarrow O_J$.
3. Bottom Right Image: The Moment is perpetually moving towards a future point O_J through hyperbolic space. O_J can be modelled to observe a point O_{iE} located along the 3-ball (or 3D)

coordinate frame, with position dependent on a spin state $O_{i\alpha} \rightarrow O_J$ or $O_{iB} \rightarrow O_J$. A hyperbolic expansion term ω can be used to account for the "extra rotation" required to account for rotation of the 3-Ball.

4. Bottom Left Image: Recall that momentum is conserved; any given point O_{iE}, in the absence of an interaction, experiences itself as in "free fall" towards its defined future; all other points appear to rotate, precess, or vibrate around its location. While O_J, the destination for the moment, views O_{iE} as displaced by the factor ω from the simple Euclidean rotation due to hyperbolic expansion, O_{iE} experiences that it is O_J that has accelerated.

An alternative visualization, to assist in generating intuition as to the predicted value for ω, is provided in Figure 29. Turning to Figure 29, we now place a Euclidean point observer in plane, observing the dynamic generation of (2-D) Euclidean Space, and experiencing the impact of its hyperbolic trajectory through Spacetime. Specifically, note that transitional point O_{tE}, the selected Euclidean point observer experiences communication from past points O_{iB} and future points $O_{J\beta}$ at a distance of $1/_2\, h$ as it progresses through transition point O_{tE}. (An identical reasoning can be used pertaining to the alternate spin approach $O_{i\alpha}$; we can represent both – equivalent for this purpose – points efficiently as $O_{i\alpha B}$). Recall we



From the perspective of computational point O_{iE}, the axis of past and future positions can be modelled to spin. As a given point O_{iE} is in the process of jumping to O_{JE} we note the transitional point O_{tE}, receives a communication (blue) from O_J and O_{iB} (red), from distance $1/_2\, h$. Note here we revert to an illustration in which the Spacetime axis ("up" /"down") shifts (in sub-Planck terms these are Moment spin states); O_E (the Euclidean Observer) on large scales will observe these movements as orbits.

Figure. 29. Past and Future Merge and Are Computed Within the Moment with a Communication Distance $\pi\hbar$

have defined our hyperbolic system as having unit dimension $\mathbb{S}_{\infty}^{h}$ where $h = 2\pi\hbar$. We can now approximate our expansion term e_0 based on these principles. We define, and will support further below, that:

$$(2e_0)^2 = (hcos(30^0))^2 - (\omega_0)^2$$
$$2e_0 = \sqrt[2]{(hcos(30^0))^2 - (\omega_0)^2} = \sqrt[2]{\left(\left(2\pi cos(30^0)\right)^2\right) - ((\omega_0)^2)} \qquad (14)$$

The trajectory $O_{i\alpha B} \rightarrow O_J$ is the hyperbolic distance $h = 2\pi\hbar$. O_{tE} receives and computes information from $O_{i\alpha B}$ and O_J at a simultaneous distance of $\pi\hbar = 1/_2\, h$. We have presented Euclidean positions in Figures 26 - 28, but we recognize that, in hyperbolic space, the circumference of a circle of a given radius r is greater than $2\pi r$ (see equations (15,16) below). Restated, our Euclidean dynamic point observer, existing along the Euclidean 3-Ball, expects – and observes spatially – a Euclidean jump of distance of $2\pi\hbar$, but in transitioning through hyperbolic space it also experiences an unobserved additional experience – an "extra amount of rotation". Specifically:

$$R_H = {}^{\pi\hbar}/_{2\pi\hbar} = {}^{0.5h}/_{h}$$
$$C_H = h * \sinh\left({}^{0.5h}/_{h}\right) \tag{15}$$
$$C_H = \pi\hbar * 1.042190610987495$$

Where R_H is the hyperbolic radius and C_H is our hyperbolic circumference. From the perspective of the Euclidean observer, we define ω as the "extra experienced hyperbolic rotation". It follows that our Euclidean observer within the moment experiences a motion of $2\pi cos(30^0)$, but its trajectory through Spacetime is for-shortened, or ***accelerated*** compared to Euclidean expectation; we define this factor of acceleration ω_π.

$$\omega_\pi = \pi\hbar * (1.042190610987495 - 1) \tag{16}$$

To calibrate the impact on our Spacetime Trajectory, we must project this factor, using the dynamic perpendicular for our estimate (See figure 30 for intuition).

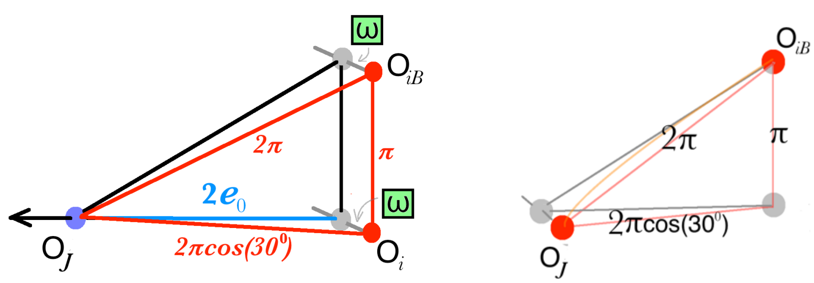
$$\omega_0 = w_\pi * cos(30^0)$$
$$\omega_0 = 0.229575910157313 \tag{17}$$

We now calculate e_0:

$$(2e_0)^2 = 29.60881320326808 - 0.052705098524559$$
$$2e_0 = 5.43655296164247$$
$$e_0 = 2.718276480821235 \tag{18}$$

Note the relationship between our expansion term estimate and Euler's Number e:

$${}^{e_0}/_{e} \approx 0.999998032713991$$



A Euclidean observer experiences a foreshortened Spacetime trajectory, "accelerated" towards O_J. Within a single Moment, we can define an acceleration term e_0. Note if we shift our observer point, we can define a reciprocal view, from O_{iB} (right).

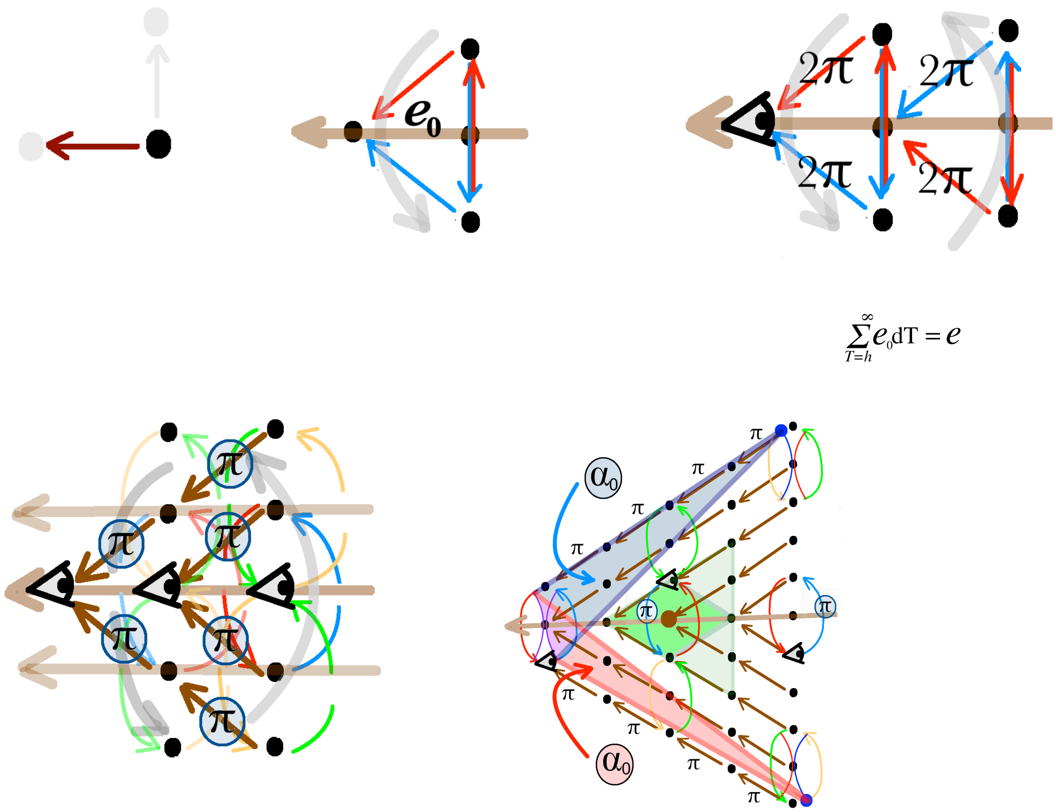
Figure. 30. A 2D Euclidean Observer in Hyperbolic Spacetime

Our estimate of e is derived from a projection, rather than a full parameter space. We will need to address the discrepancy between e_0 and Euler's Number e in later work, but we offer one, additional, insight before moving to the next section. We have defined in this section a 2D structure, involving one orthogonal dimension of Space and a Trajectory dimension, similar in nature to a Minkowsi space. In our next section, we will discuss the emergence of 3-dimensional Space+Time. It is common to think of our Spacetime as 4-dimensional, but our experience tells us that time is different from other dimensions. All dimensions of space, in our experience, move in only one dimension of time. Our geometric model must account for this property of Spacetime. In part, the distinct geometry of 3D+T Spacetime, compared to

1D+T Spacetime, is the underpinning for the distinct mathematics of the geometric projection leading to our estimate of the Fine Structure Constant.

4.4. The emergence of the Protons and Electron, and the Fine Structure Constant as a Natural Consequence of the Energy State of a Neutron

Overview (and Figure): In 4.3 we focused on estimation of a trajectory expansion constant. We now turn our attention to the impact of the rotation of P around O_p. In Figure 31, we provide a conceptual framework for describing how this can result in the development of 3 dimensions of space from a 3-Ball rotating and progressing through hyperbolic space. Turning to Figure 31, the energy inherent in a



From the perspective of a Euclidean Observer, all other Hyperbolic Spacetime Trajectories are curved. We present flattened Euclidean projections.

Figure. 31. Connecting Euler's Number and the Fine Structure Constant

dimensionless point is proposed in our model to be zero. Spacetime is hypothesized to contain *latent energy*, which results in trajectory (brown), and acceleration (gray – ***top left***). Once a trajectory > h occurs, our point now has developed dimensionality. Recall, our system must be self-referential, and respect 3 metrics – trajectory, rotation, and continuous distance (with spatially observed distance occurring in increments of h, and experiences comprising the balance (***top middle***). A trajectory constant e_0 is generated by the expansion of Spacetime. We now place an observer at the anterior point of our Spacetime Object, "looking back" over the expanse of the hyperbolic trajectory. We will state, without proof at this point, that a projection exists such that the sum of observed expansion steps (or trajectory steps) approximates Euler's Number e (***top right***). In the image ***bottom left***, we take a closer look at a single jump-step for our accelerating object. While observation is discrete, Spacetime is continuous. To model this continuous movement, we allow our observer to move half-steps as it observes surrounding Spacetime. Note our point occupies an observable locale of scale h which we have modelled as a circle involving two dynamically interacting points P and O_p. The object in row 3, defined solely by the trajectory of O_p, observes itself move. The object's associated points P move in parallel, their presence noted "in the moment" as they are below the threshold of observation ($< h$) but communications from prior moments arrive, since this object travels at a trajectory speed of $T < c$. In the image ***bottom right*** we flatten the hyperbolic trajectory plane to propose a structure for a Proton-Electron pair. Spacetime fractures into observable Space+Time, as an observer point O_p (gray observer "eyes") rotates around and generates a new trajectory perspective. A central Stationary Observer (green diamond/triangle) flows with Spacetime and observes and experiences the rotation and trajectory of surrounding moments following the same trajectory. Just as e_0 is generated by an "extra experienced trajectory" mediated by hyperbolic expansion, the Fine Structure Constant is mediated by an "extra rotation" experienced by P as it rotates farther (in pqT space) than its observed Euclidean rotation.

Beta Decay: A transition between the objects presented in row 2 in Figure 31, in energy space, implies an energy transition, or transmission, within the object. We propose this transition is the basis for the observed Spacetime Occurrence referred to as Beta Decay (Figure 32). In Beta Decay, a Neutron is observed to decay into a proton, and electron, and a Neutrino. Related to Beta Decay, we make an important assertion:

Assertion 28: Beta Decay marks the emergence of observed three-dimensional space.

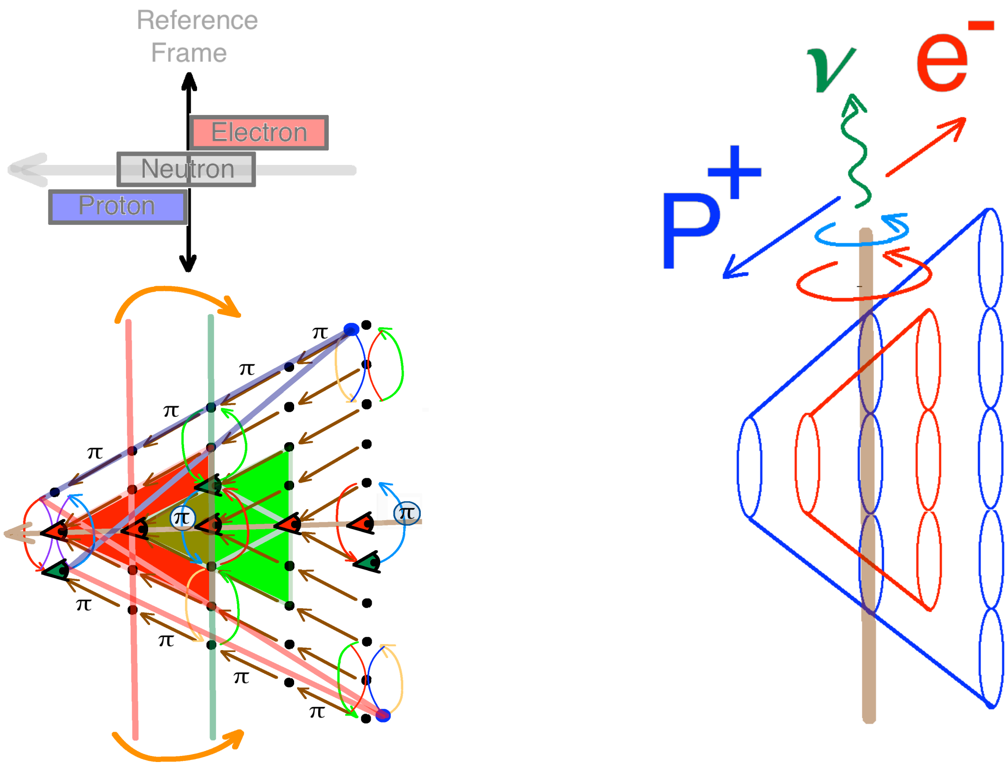
We provide some preliminary, limited mathematical modelling of the generation of 3-dimensional Spacetime in Section 5. While an important process, we need not understand this process in full to estimate the fine structure constant. Before moving on to the next section, however, Figure 32 provides a limited, brief intuition of Beta Decay. As we will show in Section 5, Beta Decay results in a reduction in the amount of energy stored by a Spacetime Moment at the reference frame. A neutrino, in this context, represents a communication transmitting information about the amount of energy in a particular Spacetime Location tied up in the reference frame. Neutrinos are hypothesized to exist on a Sub-Planck level but would be modelled to be transmitted in large numbers and continuously in regions of Spacetime in which Protons, Electrons, and Neutrons are actively undergoing Beta Positive and Beta Negative interactions. Neutrinos would be modelled to interact with distant objects in Spacetime only when their resonant state coincides with that of an intersecting Spacetime Moment.

The Emergence of Electromagnetism: In Figure 33, we can visualize the underlying geometry giving rise to Beta Decay, Weak interactions, and the connection between the Weak Force and Electromagnetism. In the left image, we see a full Spacetime progression for an individual Spacetime Moment (such as a solitary Neutron located at the frame). We note:

$$\begin{gathered}\text{Given } M_{2\pi} \\ O_{iB}O_{J\alpha} = 2\pi\hbar = h \\ O_{iB}O_T = O_T O_{J\alpha} = {}^{h}/_{2} = \pi\hbar \\ \pi\hbar < P_{iB}O_T = O_T P_{J\alpha} < 2\pi\hbar\end{gathered} \tag{19}$$

Where we define $M_{2\pi}$ as a Spacetime Moment existing at an arbitrary reference frame. For this Moment, O_T is in process of making a trajectory jump-step from O_{iB} to $O_{J\alpha}$. An additional "force" is experienced by the additional hyperbolic interaction with P, experienced as two components:

1) Bosonic and fermionic communication from P_{iB} as it "falls towards" O_T at speed c
2) Bosonic communication from $P_{J\alpha}$, "from a future position" communicating at speed c as $P_{J\alpha}$ rotates into its next jump-step

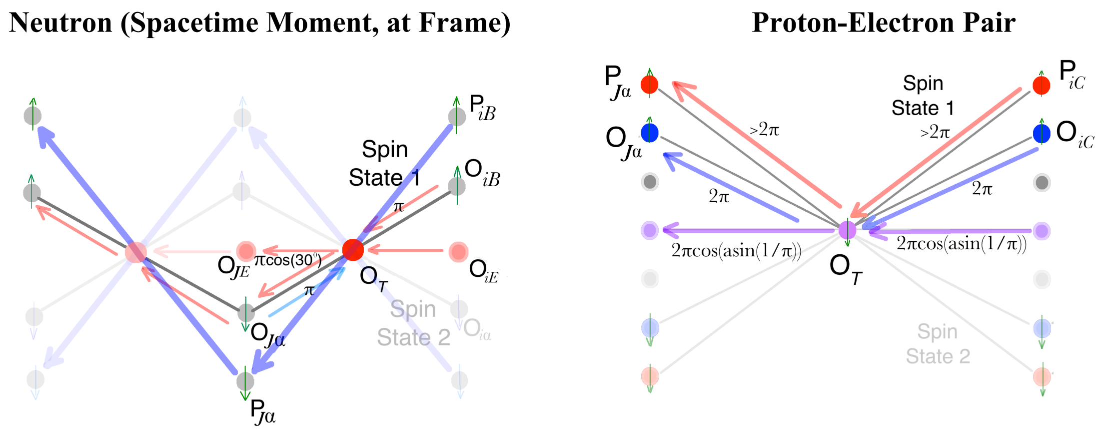


Top Left: A Neutron straddles the reference frame. Beta Decay occurs when Spacetime fractures to Space+Time, charge, and the experience of electromagnetism.
Bottom Left: From the perspective of a Spacetime Moment, the Neutron's observer point can be modelled to be placed along the trajectory (red "eyes"); the generation of a proton-electron pair results in a "relaxation" of energy embedded at the reference frame; this energy can be projected here to orbit the trajectory (blue/green "eyes").
Image Right: From the perspective of an external observer, during Beta Decay energy embedded in the reference frame is reduced, radiating a Neutrino (green) at a significant fraction of c (also see Section 5). In the Beta-Negative Process, energy is injected into the reference frame, lending insight to energetic processes involving many such interactions (such as Supernovae).

Figure. 32. Differing Perspectives of Neutron, Proton, and Electron, and the Process of Beta Decay

Both of these components from P are located at a distance $< h$ and are therefore not observed but are instead experienced as a force. This nascent emergence of an additional dimensionality may be experienced, we propose, as a Weak Interaction. After Beta Decay, a Spacetime Object of minimum observable length $2h = 4\pi\hbar$ exists straddling the reference frame. We can project for this object:

$$\begin{gathered} \text{Given } M_{4\pi\hbar} \\ O_{iB}O_{J\alpha} = 4\pi\hbar = 2h \\ O_{iB}O_T = O_TO_{J\alpha} = h = 2\pi\hbar \\ P_{iB}O_T = O_TP_{J\alpha} > 2\pi\hbar \end{gathered} \tag{20}$$



$\boldsymbol{A_{pqT}}$ or "return to line" projection of Spacetime for an Individual Moment (Left) and a Proton-Electron pair (Right) straddling a reference frame. An Spacetime Moment observing itself at frame is a Neutron.

Figure. 33. Comparing a Neutron and a Proton-Electron Pair

Where we define $M_{4\pi}$ as two Spacetime Moments in front of, and behind an arbitrary reference frame that share the same Spacetime trajectory. The new dimension of energy expansion is now observed as Space, separate from trajectory T (observed "linear" time). Further information on the properties of this 3D+T frame, including why we perceive 3 Euclidean spatial dimensions, is located in Section 5. We can now "unroll" our A_{paT} rotating axis to an A_M (point-trajectory) representation of Spacetime (Figure 34). Turning to Figure 34, we first illustrate a Proton-Electron Pair as an object dynamically in the process of making a trajectory from O_{Ti} to O_{TJ}. Dynamic perpendiculars define relative positions of Pi at various trajectory steps. We specifically examine P_{iC} rotating around O_{iC} , with the two points making a trajectory to O_{TJ} and P_{TJ}. The characteristics of this Spacetime trajectory are computed at a central Spacetime Moment (Blue Box), and these characteristics can be modelled to be "computed" or "held" at average moment point O_p (Fig 34, Top Image). Communication occurs via bosonic communications at speed "c". We can look at the communications within this Spacetime Moment in more detail (Bottom Image).

We identify the Moment communications along the following trajectories:

1) $O_{Ti^1} \rightarrow O_T \rightarrow O_{Tf^1}$ represents the average computed Spacetime Trajectory of the Proton-Electron Pair as observed by the proton, the leading element of the Spacetime Object, with respect to the perspective of O_T.
2) $O_{Pi^1} \rightarrow O_P \rightarrow O_{Pf^1}$ represents a virtual experienced trajectory of the Spacetime Moment with respect to the perspective of O_P (Blue Box).
3) O_P also experiences and observes the trajectories:
    a. $O_{iC^1} \rightarrow O_P \rightarrow O_{J\alpha^1}$
    b. $P_{iC^1} \rightarrow O_P \rightarrow P_{J\alpha^1}$
4) We ignore at present a relationship between O_P and $O_{Ti} \rightarrow O_T \rightarrow O_{Tf}$

Note, from the perspective of O_P, which experiences itself at rest in the absence of interactions, instantaneous velocities, and angular accelerations, the "past" and "future" appear to rotate in opposing directions. This opposing relationship, we propose, is the basis for the experience of charge. We can now define the rotational relationship in terms of angular acceleration, between positive and negative charged objects. We first note, referencing the concept of dynamic parallels, that within our object:

$$O_{Ti}O_TO_{Tf} = O_{Pi}O_PO_{Pf} = 2\pi\cos\left(\operatorname{asin}\left({}^{1}/_{\pi}\right)\right) \cong 5.95637621413871 \qquad (21)$$

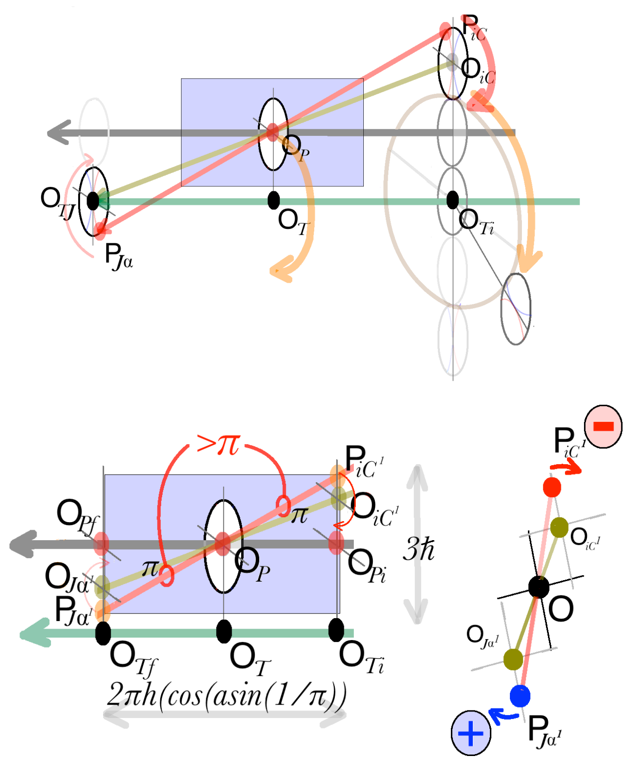


Figure. 34. Generating the Observation of Charge

We can now take the perspective of $O_{J\alpha^1}P_{J\alpha^1}$, the projected communication (on to the computing moment) of the relationship between O_{Tf} and $P_{J\alpha}$. The observed Euclidean distance from O_{iC^1} to $O_{J\alpha^1}$ is:

$$O_{iC^1}O_{J\alpha^1} = 2\pi\hbar = h \tag{22}$$

The expected Euclidean distance from P_{iC^1} to $P_{J\alpha^1}$ is:

$$\begin{gathered} P_{EiC^1}P_{EJ\alpha^1} \cong \sqrt[2]{\left(2\pi\cos\left(\operatorname{asin}\left({}^1/_\pi\right)\right)\right)^2 + (3)^2} \\ P_{EC^1}P_{EJ\alpha^1} \cong 6.66921416692832\hbar = 1.06143840120514h \end{gathered} \tag{23}$$

The Δpq step change along the dynamic perpendicular from points $\{O_{iC^1}, O_{J\alpha^1}\}$ to correlated points along the respective dynamic perpendiculars $\{P_{iC^1}, P_{J\alpha^1}\}$ is $\hbar$. Across a single jump-step of length $h = 2\pi\hbar$, we have demonstrated that, as visualized by the A_M formulation, a half rotation occurs. The expected radius and circumference of a Euclidean circle with radius $\hbar$ is:

$$\begin{gathered} r_E = \hbar = {}^1/_{2\pi}\,h \\ C_E = 2\pi r_E = h \end{gathered} \tag{24}$$

In order to maintain its location on the dynamic perpendicular, P must make an additional increment of rotation. This is related to the hyperbolic circumference:

(25)

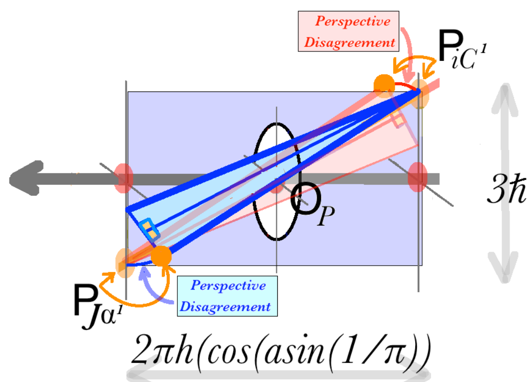
$$C_H = 2\pi\sinh(r_E) \cong 1.004227066076697h$$

We showed previously that over a single jump step, in the A_M model, a half-rotation occurs. We can therefore approximate this extra rotation ϕ_H as:

$$\phi_H \cong {(1.004227066076697h - h)}/{2} \cong 0.0021146599929 \tag{26}$$

Recall (for intuition, see Figure 35, also see Section 5) that O_P only experiences simultaneous distances. Therefore, if O_P observes O_{iC^1} and O_{Tf} at a distance of $\pi\hbar$, it observes P_{iC^1} and $P_{J\alpha^1}$ at the same distance. This is possible by recognizing that O_P observes these points at different trajectory points; further, O_P can be modelled to "average" or "summate" the perspective of these two points. The difference between the two perspectives can be modelled as a ***rotational energy:***

$$\omega_{Em} \cong (1.0021146599929) * (1.06143840120514 - 1) * 2\pi\hbar \cong 0.386845179534552 \tag{27}$$



Perspective is relative. Due to the dynamic generation of Spacetime, P_{iC^1} observes a future location of $P_{J\alpha^1}$, while $P_{J\alpha^1}$ observes a past location of P_{iC^1}. These observations occur at scale $< h$, and a computation of the average of these observations are modelled to occur at location O_P.

Figure. 35. Perspective Disagreement Generates Charge

The increased rotation results in the generation of two overlapping isosceles triangles, representing a disagreement in Spacetime location between P_{iC^1} and $P_{J\alpha^1}$. The base of this isosceles triangle is > 1, related to the relative respective relativistic displacements, estimated as:

$$b_{rOE} \cong \sqrt[2]{(1)^2 + (0.386845179534552)^2} \cong 1.07221679540352\hbar \tag{28}$$

The height of this isosceles triangle, with equal leg/distances of $h = 2\pi\hbar$, is:

$$h_{rOE} \cong \sqrt[2]{(2\pi\hbar)^2 - \frac{(1.07221679540352)^2}{4}} \cong 6.26027199011921\hbar \tag{29}$$

The associated angle observed and experienced by θ_α is:

(30)

$$\theta_\alpha \cong 2 * arcCos(h_{rOE})$$
$$\theta_\alpha \cong 0.170856344723473$$

Rotational energy in our system follows a standard physics form and is proportional to the square of the angular displacement, giving us a constant:

$$\alpha_0 \cong {}^{1}/_{2} * C_R * (\theta_\alpha)^2 \cong C_R * 0.0145959452661332 \quad (31)$$

If we set $C_R = 1/2$, then:

$$\alpha_0 \cong 0.0072979726330666 \quad (32)$$

We can now relate our predicted fine structure constant to the observed fine structure constant, defined as having a value of: $\alpha = 0.00729797352569311$:

NOTE:
$$\begin{gathered} {}^{\alpha_0}/_{\alpha} \cong 0.999999877688442 \ (\sigma{\sim}10^{-6}) \\ {}^{e_0}/_{e} \approx 0.999998032713991 \ (\sigma{\sim}10^{-5}) \end{gathered} \quad (33)$$

It won't have escaped even a cursory read that our coordinate system for calculating α_0 and e_0 differ. As we mentioned earlier, our shift in perspective occurs due to the distinct cognitive process that must occur, informed by the relativistic relationship of our observer frame, in order to expand our observation frame from 1D+T Spacetime to observed 3D+T Spacetime. To understand this difference, and provide convergence between these estimates, we must now define the nature of π.

4.5. The Emergence of π from Hyperbolic Linear Expansion of Spacetime

Introduction: In sections 4.3 and 4.4, we modelled the emergence of Euler's number, and the Fine Structure Constant, under the assumption of a single, or two jump-steps. In this section, we now embed these concepts in a relativistic model, in which an observer integrates information over multiple jump-steps. One preliminary model for eventually rectifying e_0 and α_0 to e and α can be represented, generally, as a summation (Equation 34):

$$\begin{gathered} e = \sum_{n=0}^{m} e_0 \Delta T \\ \alpha = \sum_{n=0}^{m} \alpha_0 \Delta T \end{gathered} \quad (34)$$

In which m represents the number of trajectory steps, or rotations, that have occurred since the original jump-step of the system. Heretofore, we have brought in the extra-logical number of π as a descriptor of our rotational parameter (Definition 5). We now introduce Equation 35 as a corollary to Equation(s) 34:

$$\pi = \sum_{n=0}^{m} \pi_0 \Delta R \quad (35)$$

As we will see, this approach unifies the apparent observer discrepancies we presented earlier between our calculation of e , which we modelled based on the right triangle with side lengths of $\{2\pi\hbar, \pi\hbar, 2\pi\cos\,(30^0\}$, and our calculation of the fine structure constant, which we model based on a family of right triangles with side lengths $\{2\pi\hbar, n\hbar, 2\pi\hbar\cos(arcsin(^1/_\pi))\}$. Specifically, we propose that the observation of the value π is an emergent property of linear hyperbolic expansion of Spacetime. More generally, we propose that the observed Euler's number, the Euclidean rotation constant π, and the fine structure constant α, can be modelled to emerge as a Universe evolves. In the first two jump-steps, ($m = 2$) Euler's number would theoretically become for the first time measurable/observable. We propose that the relationships π_0 and the fine structure constant α_0 may become observable shortly thereafter, if the system energy is such to allow space (protons and electrons) to emerge. As observable trajectory and rotational steps proliferate, we hypothesize that these constants can be projected to normalize to the precise observable values we calculate. Note we estimate values from angles derived from a 3D+T projection of a higher dimensional parameter space, additional precision would also be obtained from better identifying and approximating higher dimensional characteristics impacting our projections.

Estimating a value for π_0: We can start our exploration of the relationship between π, e, and α by observing a projection of the progress of a proton-electron pair through Spacetime (Figure 36), Turning to Figure 36, we present a simplified visualization of a Proton-Electron Pair (also see Section 5). To visualize the movement of our Proton-Electron pair through Spacetime, we must now approach, and attempt to understand some properties of projective spaces. We can start with a simple visualization (Figure 37).

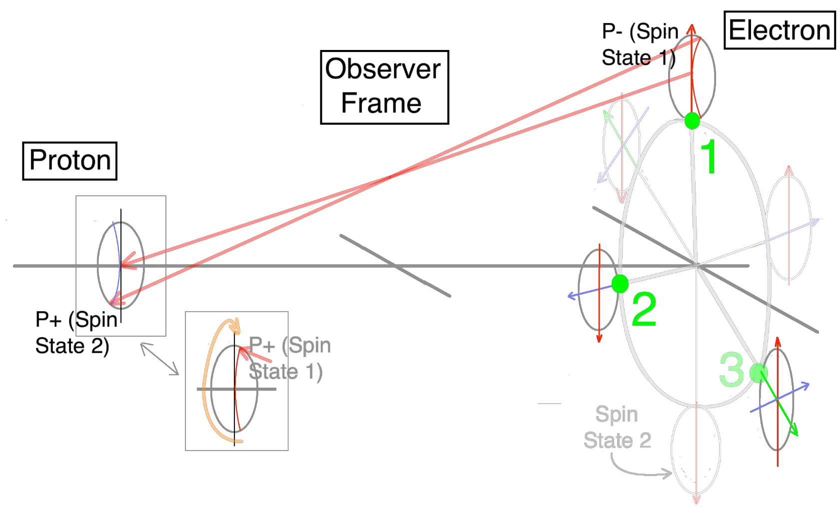


Figure. 36. Visualizing a Proton-Electron Pair (Hydrogen)

In Figure 37, we demonstrate an object existing in 2-dimenstional space. Focusing on the blue right angle, we can see a *projection* of the object on to the vertical line (labelled). Note that we only see an aspect of the whole; the green "projection" is not visible. We propose that, similar to this example, that π is best understood as a projection that occurs from a complex process. **First,** Spacetime exists as a linear expansion in the context of a minimum observation distance. **Second,** observers are formed from Spacetime, and generate multi-parameter translations of this expansion to account for observations and experiences. **Some observers,** formed from charged matter (protons and electrons), project a location from a (at least) 6 parameter set of observations and experiences into a 3D+T observed frame of reference, measured out in increments of Planck scale minimum observable distances. In our model, we attempt to decode this complex projection. Specifically, in Figure 38, we introduce the steps taken to project a hydrogen atom in 3D+T. The purpose of the progression is to display, on a conceptual level, the emergence of rotation from linear expansion, in the context of a minimum observable distance. Note, we present a perspective from outside the system, focusing specifically on the front element (the proton), the location towards which the paired Spacetime Moments are progressing. We model our Spacetime Object making a complete circuit over a distance of $2h$, with an axis shift (defining that we have moved to a new dynamic perpendicular). In a step wise fashion, we can now study how our axioms and assertions impact our 3D+T visualization.

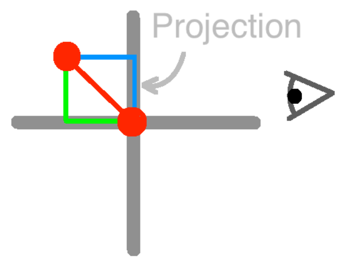
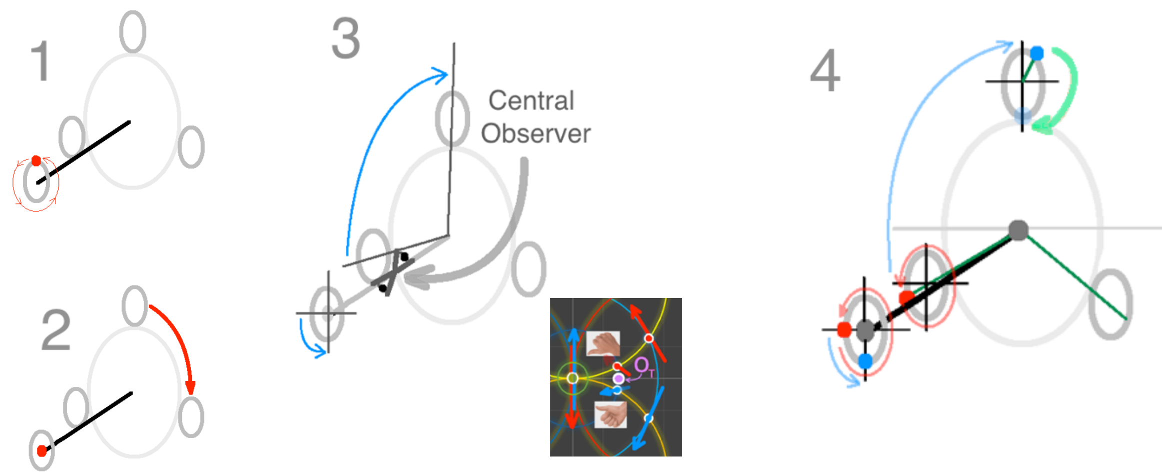


Figure. 37. Projective Space



Fixing different observer points results in different dynamic model (A_M) projections. A final rotation step (pale green arrow) is also occurring within the moment.

Figure. 38. Stepwise Generation of Observed Spin and Trajectory

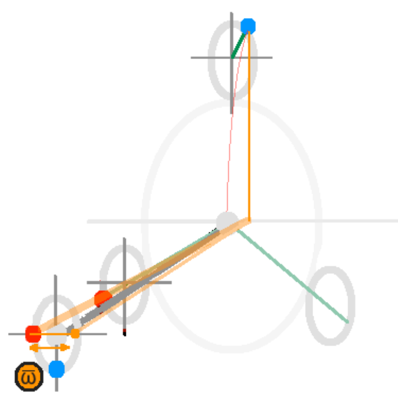
It is important to recognize, by visualizing these relationships from "outside the system", we are performing a complex projection indeed, as in essence we propose to "step outside the Universe" of the model to model what is occurring within. While we place the projection in a Euclidean space, we must remember the points are dimensionless, the lines have no "width", and there is no true "space" that our "circles" occupy. As observers constructed from Spacetime, we have generated a heuristic geometry, with underlying number systems and relational systems, to explain our observations and relate ourselves to an environment of similar observers. It is only natural that to fully understand Spacetime, we may make use of this heuristic geometry to return to the simple principles from which Spacetime is generated. Image-by-image discussion of Figure 38 is presented below:

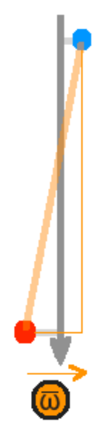
- IMAGE 1: Point P perceives a linear trajectory through hyperbolic space, with a minimum observable distance h. To accommodate to our preferred 4D (3D+T) perspective, we model this linear trajectory as a circle, in hyperbolic space, around an un-seen axis.
- IMAGE 2: In accordance with Axiom 8, momentum is conserved. Our point P perceives neither trajectory, nor rotation. We can model instead that it observes itself at the "average position", with other related objects rotating around its perspective. The posterior element (the "electron")

accordingly appears to rotate. If the wave-front or tip of our "proton" is modelled by the right-hand rule to rotate in Counter-Clockwise direction, we can assert that it perceives the tail or back end of our "electron" to rotate in a Clockwise direction. Note if we placed our observer point at another location, the direction of observed rotation may change.

- IMAGE 3: We can now model the perspective of an observer in the mid-point of our Spacetime Object, located a distance of h from the tip and posterior end of the object of length $2h$. Recall from Figure 14 (inset) that the central observer is itself in a state of relative rotation with respect to P. From the perspective of this object, the axis of our object is in a state of rotation; the "tail" has rotated to a new position perpendicular to its prior position. The "tip" to be consistent must also occupy a new dynamic perpendicular. Importantly, the "mean computational point" describing the motion of our Spacetime Object is this central point – our "frame of reference".
- IMAGE 4: We combine these differing perspectives as a single geometric figure, describing trajectory, spin, and axis rotation.

It is important to understand that in the series of images in Figure 38, we are merely "casting a shadow", from a higher dimensional object on a 4D manifold (incorporating a 3D perspective and arrows to generate a concept of time). Similar to the process of projecting the shadow of a 3D object on a 2D surface, we invariably lose information in the transform. Nevertheless, we can use this operational visualization as a geometrical projection or "shortcut" to estimate π_0, a rotational constant arising as a natural consequence of our model. Specifically, we propose to introduce a spin term ϖ to relate trajectory to observed spin (Figure 39). Note in our Euclidean visualization, the 3 positions of the electron spin-state displayed are separated by 120^0. We therefore, as a first approximation, assign a spin-state value of $\varpi_E = 1.5\hbar$. Incorporating ϖ_E, trajectory, and the speed of communication we can now characterize a "rotation" parameter, π_0. Together, $e_o, \alpha_0, \& \pi_0$ characterize trajectory, rotation, and (in objects of size $> 2h$) a dynamic angular relationship between trajectory and rotation. To calculate our rotation parameter, it is instructive to first return to a 2D projection of our hyperbolic space (Figure 40). To determine the relationship between rotation and trajectory of our object of length = $2h$, we can relate the average rotational

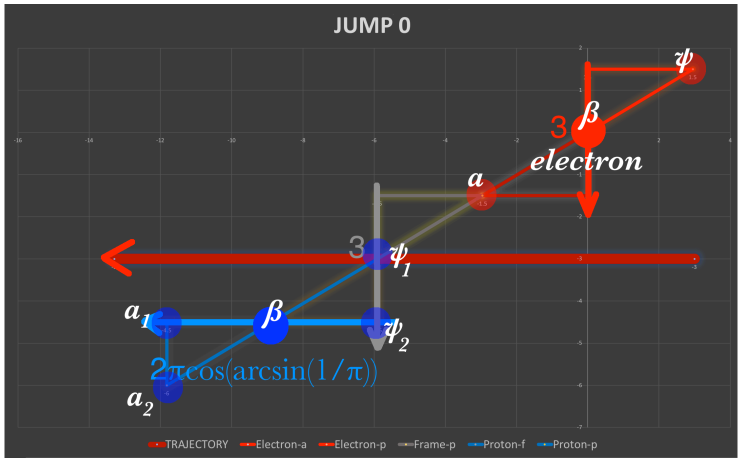




Trajectory of a Spacetime Object of length $2h$ is foreshortened by a spin constant ϖ.

Figure. 39. The Impact of Spin on Observed and Experienced Trajectory

location of the posterior element (red dot) to the average trajectory location of the forward element (blue dot – Figure 39 right, replicated as blue dot β in Figure 40). In Figure 40, we now limit ourselves to 2 dimensions, to assist us in accounting for the fact that the "front end" of our object has 2 orthogonal axes (one spatial and 1 trajectory axis), while the "tail" has 3 independent orthogonal spatial axes, each with an orthogonal trajectory axis, visualized by an observer point that (in Figure 40) is approximated by the dynamic/emerging location between red point α and blue point ψ_1. For the purposes of this visualization, in essence it is productive to conceive of ourselves as flatlanders (Abbot, 1926). Any dimension into, or out of the page, is "imaginary" for us. In this context, we "see" only the projection of one plane, derived from trajectory and a flat dynamic perpendicular, and we only "observe" a full projection in our flat



Initial position (Observed Flat Dimension), Spacetime. We will determine at what point the communication for α,β, and ψ from our posterior element (electron, red) reach the approximate location of our anterior element (blue). We wish to define at what point our posterior element (rotational element, average position red dot β) "returns to the line" (trajectory element, average position blue dot β).

Figure. 40. Base Position of a Proton-Electron Pair in Flatland

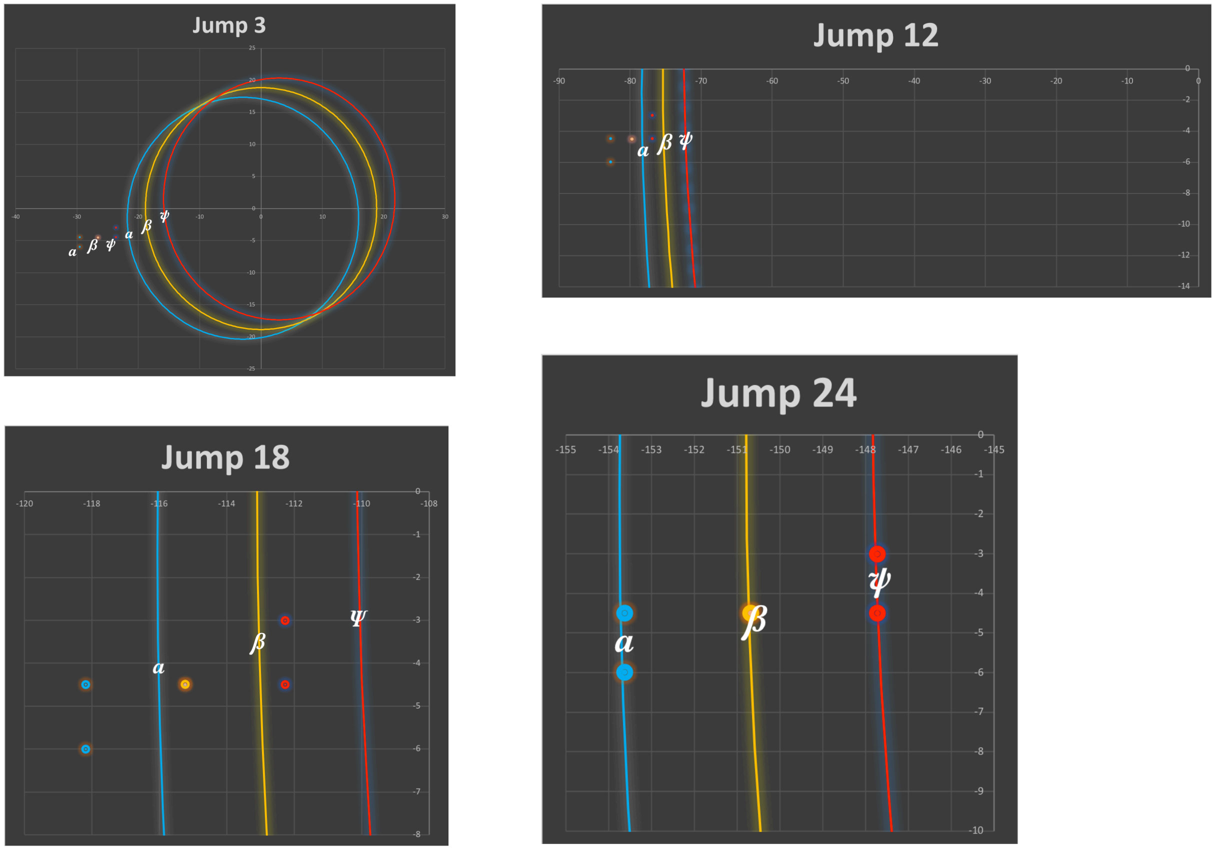
dimensional projection every third jump-step. In Figure 41 (next page), we map out the approximate number of jump-steps required for the communication from the posterior element to reach our anterior element. Turning to Figure 41, we can see at the 3rd jump step, our communication still lags far behind our trajectory. In succeeding steps, we can see the communication gradually "catch up" with the anterior element of the Spacetime Object. The communication from the electron communicates with the proton at approximately Jump-Step 24. Examining the intuitions offered in figure 41, and considering the related implications, we will be able to approach the initial estimate of π that would be generated by observers in the model we describe. We now present equations associated with Figure 41, and the related implications. We start with a revised calculation of T, accounting for the dynamic property (pertaining to the energy of rotation) we visualize in Figure 39 (also see Figure 42). In equation 36, we estimate T_h.

$$2T_h = \sqrt[2]{(2T_o)^2 - (\varpi)^2}$$

$$2T_h = \sqrt[2]{\left(4\pi\hbar\cos\left(\arcsin\left({}^{\hbar}/_{\pi\hbar}\right)\right)\right)^2 - (1.5\hbar)^2} \quad (36)$$

$$2T_h = 11.81793850116973\hbar$$

$$T_h = 5.908969250584863\hbar$$



The Electron communicates with the Proton at ~Jump-Step 24 (Image Bottom Right).

Figure. 41. Point of Interception of Electron Communication with Proton Jump-Step Location

In these projections, we note:

1) T_o is an observed Euclidean trajectory progressing (rotation/trajectory) through Spacetime
2) T_h is a relative foreshortening *experienced* by the observer, impacting trajectory step at which communication between the $\Delta p \Delta q$ linear displacement ("rotation") of the electron, and the proton, occurs.
3) To maximize intuition, rather than present a pure Poincaré representation, we present a hybrid "observed location" presentation where we project the Poincaré progression onto a Euclidean plane. We justify this presentation based on the following principles, which we have either supported or implied earlier:
    1. The observed location of a dynamic object within a Spacetime Moment is defined by the dynamic perpendicular.
    2. Observed locations in Spacetime can be observed as points occupying a 3-ball passing through the origin. Euclidean space arises as a dynamic rotation of this 3-ball progressing through hyperbolic Spacetime.
    3. Circles and spheres in hyperbolic space, from the perspective of a central point in Poincaré space, follow the same geometric principle (equal distances can be presented as an undistorted circle centred at the origin).

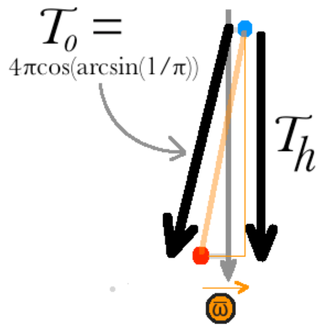


Figure. 42. Generating T_h

Importantly, our Euclidean projection should be recognized not as a static plane passing through Poincaré space (such as we present in Figures 7, 8, 13, 14); the projection in Figures 40, 41, 43, and 45 occurs when we "unroll" and flatten a dynamically generated Spacetime Observer perspective. This distinction is important enough to comprehending the generation of observed π that we also highlight this distinction in Table 3.

Table. 3. Distinct Projective Representations

Static Hyperbolic Perspective Examples: Figures 7,8,13,14	**Dynamic Hyperbolic Perspective** Examples: Figures 40, 41, 43, 45
• A static plane is passed through a Poincaré sphere. • We demonstrate a cross-sectional location of a 3-sphere upon which observable Spacetime points can be arrayed.	• A 3-sphere is rotated dynamically through hyperbolic space over a series of trajectory distances. • An object of length $2h$ is arrayed along the surface of the 3-sphere. • A trajectory direction is defined by a Spacetime Locus of dimension h, located in a $\Delta p\Delta q$ frame orthogonal to T, in which h is represented as an equidistant (circular) shape of distance 2*(constant)*(radius), and the trajectory direction is defined by the virtual center. • The perspective of the dynamic perpendicular at all points along the trajectory is respected • An observed plane is formed by "unrolling" the resultant surface. • A hybrid projection respects Euclidean conventions for trajectory (for intuition), but hyperbolic circumferences are calculated.
Throughout this work, we have presented differing perspectives of Spacetime. Each perspective can be considered a shadow of a whole (see reference: Plato, 514b-518a, about 380 BCE). When we project a higher dimensional "shadow" into 4D space, we lose precision, but can gain substantial insight. In this paper, we pursue first insight. Insight can allow us to then pursue precision in later work.	

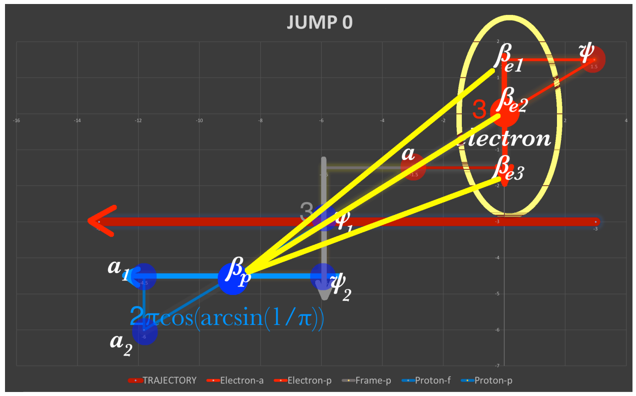
Turning again to Figure 41, we display an estimate of how the trajectory and rotation correlate within the Spacetime Object we have defined. We displayed earlier how communication from the posterior element "catches up" with our anterior element at ~Jump-Step 24. In equation/calculation 37, we present calculations representing the varying relationships between trajectory parameters T_{o-24}, T_{h-24}, and communication step C_{24}. For our estimate of π_0 we will focus exclusively on the average (β) location of the trajectory moment and rotational moments displayed in figure 40.

$$
\begin{gathered}
T_{o-\beta 24} = 24 * \left(2\pi\hbar\cos\left(\arcsin\left({}^{\hbar}/_{\pi\hbar}\right)\right)\right) = 142.9530291393291\hbar \\
T_{h-\beta 24} = 24 * \left({}^{1}/_{2}\right)\left(\sqrt[2]{(2T_o)^2 - (\varpi)^2}\right) = 141.8152620140367\hbar \\
P_{e-o\beta 0} = \{0,0\}; P_{e\beta 0x} = 0, P_{e\beta 0y} = 0 \\
P_{p-\beta o0} = \left\{-\frac{3}{2}\left(\sqrt[2]{(2T_o)^2 - (\varpi)^2}\right), -0.5 * (3\hbar) + 3\hbar\right\} \\
P_{p-\beta o0} = \{-8.86345387587729\hbar, -4.5\hbar\}; \\
P_{p\beta 0x} = -8.86345387587729\hbar, P_{p\beta 0y} = -4.5\hbar \\
P_{p-\beta o24} = \{P_{p\beta ox} - T_{h-\beta 24}, P_{p\beta 0y}\}; \\
P_{p\beta o24x} = 150.7498263352448\hbar, P_{p\beta o24y} = -4.5\hbar \\
D_{H-pe24} = P_{p-\beta o24} \to P_{e-o\beta 0} = -\sqrt[2]{(150.7498263352448\hbar)^2 + (-4.5\hbar)^2} \\
D_{H-pe24} = -150.7458968669908\hbar \\
C_{r\beta -24} = 24 * 2\pi\hbar = 150.7964473723101\hbar \\
|D_{H-pe24}| \approx C_{r\beta -24}
\end{gathered} \tag{37}
$$

In which $P_{e-o\beta 0}$ is the mean location of the posterior rotational point (our "electron"), $P_{p-\beta o0}$ is the initial average trajectory location of our anterior trajectory point (our "proton"), $P_{p-\beta o24}$ is the predicted trajectory location of $P_{p-\beta o0}$ after 24 jump-steps, and $C_{r\beta -24}$ is the radius of the communication of location $P_{e-o\beta 0}$, assuming a constant speed of communication (for historical reasons, we label this constant speed "c"), and D_{H-pe24} is the calculated, dynamically generated, Euclidean distance between the proton and electron at the jump-step as the Communication-step arrives from the electron. Note, the co-location above is not precise, and as we demonstrate later precision will be important for calculating π. We can now take the perspective of $P_{p-\beta o24}$, setting the coordinate space such that $P_{p-\beta o24} = \{0,0\}$ (Figure 43).

Recall that from the perspective of $P_{p-\beta o24}$, embedded in our dynamically generated "flatland" plane, $P_{e-o\beta 0}$ dynamically emerging from one of two perpendicular (let us call them "imaginary") dimensions. The plane is defined by a constant dynamic perpendicular that is emerging on our unrolled plane. We can estimate the hyperbolic expansion, as visualized by $P_{p-\beta}$ related to the set of points $\{P_{e-\beta 1}, P_{e-\beta 2}, P_{e-\beta 3}\}$, as shown in Figure 43. In figure 43, note that we have placed our "observer point $\{0,0\}$ at the mean location of the electron. We can define the dynamically generated "observed linear distances" projected in Figure 43 according to relationships:

$$
\begin{gathered}
GIVEN\ THAT\colon\ T_h = 5.908969250584863\hbar\ (see\ Equation\ 36), \\
WE\ DEFINE\ THAT\colon\ T_{h/2} = 2.954\,484\,625\,292\,423\hbar \\
D_{H-pe0-1} = P_{p-\beta 0} \to P_{e-\beta 1} = \sqrt[2]{\left(3T_{h/2}\right)^2 + (6)^2} \\
D_{H-pe0-2} = P_{p-\beta 0} \to P_{e-\beta 2} = \sqrt[2]{\left(3T_{h/2}\right)^2 + (4.5)^2} \\
D_{H-pe0-3} = P_{p-\beta 0} \to P_{e-\beta 3} = \sqrt[2]{\left(3T_{h/2}\right)^2 + (3)^2} \\
ALSO \\
D_{H-pe0-1} = -3\hbar * 1.135\,656\,312\,216\,57;\ D_{H-pe0-1} > -\pi\hbar \\
D_{H-pe0-2} = -3\hbar * 1.054\,705\,261\,247\,539;\ D_{H-pe0-2} > -\pi\hbar \\
D_{H-pe0-3} = -2.978\,550\,885\,405\,966\hbar;\ D_{H-pe0-3} < -\pi\hbar
\end{gathered} \tag{38}
$$



"Proton Mean Point" $P_{p-\beta}$: Blue Circle labelled β_p ."Electron Dynamic Perpendicular Points": $\{P_{e-\beta_1}, P_{e-\beta_2}, P_{e-\beta_3}\}$: Red Circles, yellow highlight.

Figure. 43. Observed Proton-Electron Distances

Pertaining to the last point ($D_{H-pe0-3} < \pi\hbar$), it is appropriate to note that even at Jump Step 0, a potential position of P_e is "within the moment" for P_p, while the average and maximal position are "outside of the moment" of the system defined by $\{P_P, P_e\}$. We can define the observed dynamically generated Euclidean relationships at jump-step 24:

$$
\begin{gathered}
GIVEN\ THAT\colon\ T_{h/2} = 2.954484625292423\hbar \\
D_{H-pe24-1} = P_{p-\beta 24} \rightarrow P_{e-\beta 1} = \sqrt[2]{\left(51T_{h/2}\right)^2 + (6)^2} \\
D_{H-pe24-2} = P_{p-\beta 24} \rightarrow P_{e-\beta 2} = \sqrt[2]{\left(51T_{h/2}\right)^2 + (4.5)^2} \\
D_{H-pe24-3} = P_{p-\beta 24} \rightarrow P_{e-\beta 3} = \sqrt[2]{\left(51T_{h/2}\right)^2 + (3)^2}
\end{gathered}
\tag{39}
$$

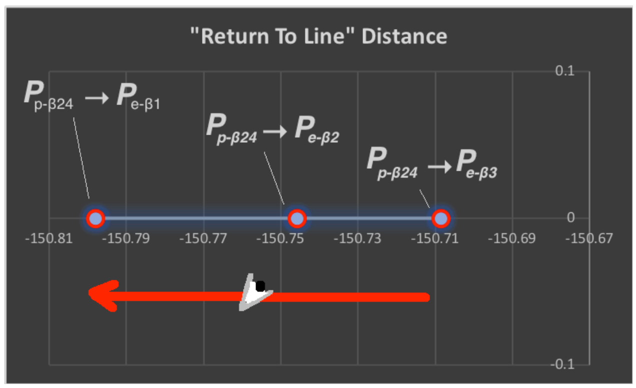
Recall, there is only one point P in our model, and various instances of Spacetime are generated through various communications of relative positions and past positions of this point P with future instances of P . We can therefore transform the distances above to communication step κ between relative positions of the "electron" and mean trajectory position of our "proton":

$$
\begin{gathered}
\kappa_{e\beta 24-1} = \left(\frac{D_{H-pe24-1}}{2\pi}\right) = 24.000\,267\,487\,554\,82 \\
\kappa_{e\beta 24-2} = \left(\frac{D_{H-pe24-2}}{2\pi}\right) = 23.991\,954\,637\,202\,64 \\
\kappa_{e\beta 24-3} = \left(\frac{D_{H-pe24-3}}{2\pi}\right) = 23.986\,015\,123\,079\,44
\end{gathered}
\tag{40}
$$

To restate equation 40 verbally, we can state that when the mean proton position arrives by jump-step 24 as follows:

- The average and closest positions of the "electron signal" have already arrived, and
- The furthest possible projected position of the "electron signal" is arriving

At this point it is productive to also invert our perspective, defining the "return to line distances" – a 1D projection of the model (Figure 44). Note, this "return to line" communication is perceived by an observer that is also moving through Spacetime and is computed (we have proposed) as an interplay between a rotation metric, a dynamically generated perpendicular, a trajectory metric, and the generation (for a Proton-Electron Pair) of 3 Euclidean dimensional axes, progressing through hyperbolic space. The purpose of the perspective shift displayed in 44 is to remind the reader that our projections collapse high parameter computations into lower dimensionality, but our original parameter space was originally 1D. Provided the parameters and rules of observation are fully accounted for, the "return to line" formulation will ultimately be the most precise in our model. By generating Hyperbolic and Euclidean projections, in other words, we are fracturing Spacetime in a manner similar to our experience to compute approximate solutions, gaining intuition, but often at the expense of precision.



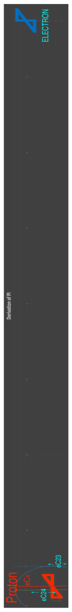
A 1-D projection of Spacetime has low "geometric precision" compared to our experienced Spacetime. A matter observer, moving in trajectory steps < c, observes a communication of "where P was" – defined by a relativistic transform of increments of minimum observable distances at specific points in the past. Points arranged along a 1D projection can also be projected as geometrically existing on along a Euclidean dynamic perpendicular. From the observer's perspective, principles of Euclidean Geometry apply.

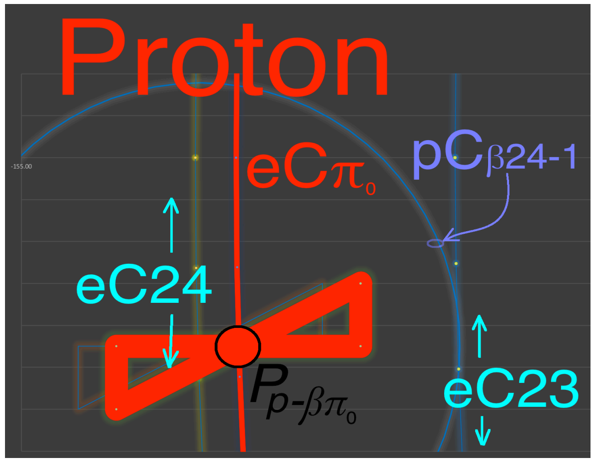
Figure. 44. A One Dimensional Spacetime Projection

In Figure 45, we examine now at an "unrolled" planar structure, based on an object of length $2h$ progressing through Spacetime. This object is the expansion of the object displayed in Figure 43. As we have referred to earlier, our plane "unrolls" dynamically. In every 3rd Jump-step, we can represent the progress along our unrolled planar structure (we can consider jump-steps out of plane as "imaginary" from our flatland perspective). For perspective, the elongated strip on the right side of Figure 45 presents the approximate Euclidean distance between the proton and electron when the average signal from the electron "catches up" with the proton. In equations 36 through 40, we showed that the signal "catches up" around jump-step 24 – a point "visible on the unrolled plane".

In Figure 46, we examine a flattened perspective of the precise point at which the "average signal" from the electron "catches up" with the proton. We label the average "moment point" for the proton $P_{p-\beta_{\pi_0}}$, and the signal from the average point of the electron at eC_{π_0}. We can now define the following relationships:

$$\begin{gathered} P_{p-\beta\pi_0} = \{(P_{p\beta ox} - T_{h-\beta\pi_0}), (P_{p\beta 0y})\} \\ eC_{\pi_0} = N_{\pi_0} * h \\ T_{h-\beta\pi_0} = N_{\pi_0} * T_h \\ \sqrt[2]{\left(P_{p\beta ox} - N_{\pi_0} * T_h\right)^2 + (-4.5)^2} = N_{\pi_0} * h \end{gathered} \tag{41}$$





$\boldsymbol{eC_{23}}$**:** 23rd Communication step from {0,0}
$\boldsymbol{eC_{24}}$**:** 24th Communication step from {0,0}
$\boldsymbol{pC_{\beta 24-1}}$**:** 1st Communication step from $\{150.7498263352448\hbar, -4.5\hbar\}$ (see Eq. 38)
$\boldsymbol{eC_{\pi_0}}$**:** Average Object Communication-Moment Intercept
$\boldsymbol{P_{p-\beta\pi_0}}$**:** Modelled Proton Moment Computation Point

Figure. 45. Point of Communication/Interception

In which $P_{p-\beta\pi_0}$ is the point of interception where the mean electron signal intercepts the mean jump-step location of the proton-electron pair (with 2D coordinates $\{(x),(y)\}$, eC_{π_0} is the communication-step radius at $P_{p-\beta\pi_0}$, and N_{π_0} is the number of steps (communication and jump) that have occurred such that the location of $P_{p-\beta\pi_0}$ coincides with communication radius eC_{π_0}. Specifically, we are mathematically reflecting in equation 41 the following logical train of assertions:

Assertion 29: The electron and proton in a Proton-Electron Pair maintain a specific and constant average relationship as the pair progress through Spacetime

Assertion 30: The number of jump steps pertaining to the proton, occurring at trajectory increments < c, and the number of communication steps (communication increments = c), communicating the location and relationship of the electron to the proton, are identical.

Assertion 31: A point of computation occurs when the communication step from the electron coincides, or "reaches" the jump-step location of the proton.

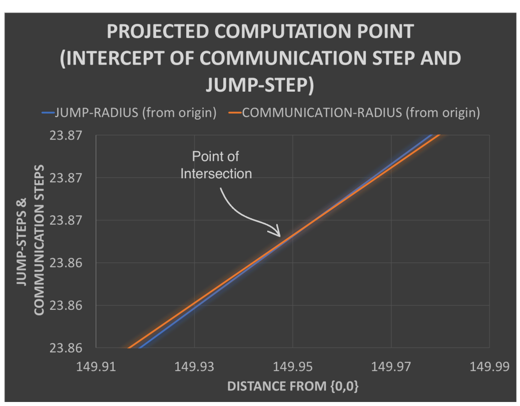


Figure. 46. Interception (Communication Step and Jump-Step)

We can solve a Euclidean Quadratic from our dynamically generated plane of observed point relationships:

$$
\begin{gathered}
\left(P_{p\beta ox}\right)^2 - 2 * P_{p\beta ox} * N_{\pi_0} * T_h + \left(N_{\pi_0}\right)^2 * (T_h)^2 + (-4.5)^2 = \left(N_{\pi_0}\right)^2 * (h)^2 \\
39.4784176043574 * \left(N_{\pi_0}\right)^2 - 34.9159176043574 * \left(N_{\pi_0}\right)^2 \\
-104.747752813072 * N_{\pi_0} - 78.5608146098042 - 20.25 = 0 \qquad (42) \\
4.56250000000001 * \left(N_{\pi_0}\right)^2 - 104.747752813072 * N_{\pi_0} - 98.8108146098042 = 0 \\
N_{\pi_0} = \{23.865\,865\,158\,328, or - 0.907\,453\,582\,860\,25\}
\end{gathered}
$$

We formerly approximated the location of our computation as existing at a location somewhere between jump-step 23 and jump-step 24; we now have a precise location (Figure 46). We are now positioned to estimate the value of π_0. It is productive at this point to review precisely what we are describing with the constant π_0. We will describe our interpretation of the meaning of π in our model through a series of assertions, that recapitulate some of our previous arguments, descriptions, and illustrations.

Assertion 32: A point with dynamic trajectory generates a line progressing through hyperbolic space.

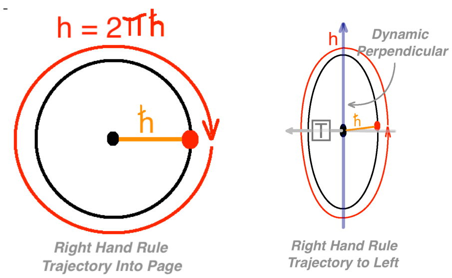
Assertion 33: A first dimension is generated at a minimum observable distance; the point observes "I have been here 'before'".

Assertion 34: A second dimension – the observation of "time passing" and a multi-object coordinate space, is generated when a second trajectory jump-step occurs.

Assertion 35: It is possible for an object spanning 2 minimum observable distances to exist; for these objects, a 4D spacetime manifold is necessary to describe observed Spacetime location(s) of the object. The additional dimensions emerge dynamically.

Assertion 36: In addition to location, additional relationships of the object to other objects manifest as fundamental forces of nature.

Assertion 37: The number π describes a distance observed and experienced within a Spacetime object, and in relationship to other Spacetime objects, pertaining to the dynamic emergence (over a trajectory) of an observed 3rd dimension from 2D space (i.e., the emergence of a 4D manifold).



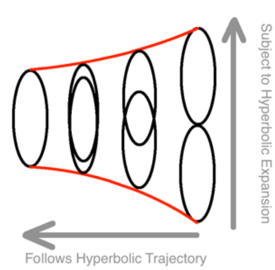
Partial Reproduction of Figure 4

Returning now to Figures 40,41,43, and 45, recall we are taking the perspective of a "Flatland Observer" inhabiting our flat, dynamically generated plane. Recall also our perspective; dimensionality is arriving on our 2D plane from an "imaginary" plane. The observer now "looks back" to observe and compute the emergence of this new spatial dimension (a plane existing outside of the current plane). We know the observed relationship between the two furthest points is precisely $6\hbar$ at distance $2h$ ($= 4\pi\hbar$). However, we calculate (our Euclidean estimate) that the communication of this relationship occurs 23.865865158328 jump-steps later – and the communication is impacted by the hyperbolic expansion of

Spacetime. We can use these relationships to estimate the value π_0. We start from the premise that a full observation can be modelled as a full transit around a circle of radius $\hbar$. Two jump-steps, as we have demonstrated, are required to make a full observation – i.e. to observe the "orbit" (the full dimension), we must observe the object "arrive" from one side, and "progress" to the other. For ease, we take only a half orbit, "arriving" to our perpendicular from the new dimension. We can accordingly define the following relationships, ignoring the antidromic[3] trajectory (i.e. -0.90745358286025) for now:

$$
\begin{gathered}
GIVEN\ AN\ ESTIMATE\ THAT\ C_{r\beta-\pi_0} = \ 23.865\,865\,158\,328h \\
C_{H-\pi_0} = C_{r\beta-\pi_0} - 2h = 21.865865158328h \\
R_{HC} = \frac{\sinh\left({}^{1}/_{2\pi}\right)}{\left({}^{1}/_{2\pi}\right)} = \frac{(0.159827701552778)}{(0.159154943091895)} = 1.004227066076697 \\
R_{HE-1} = \frac{(R_{HC} - 1)}{2} + 1 = 1.002113533038348 \\
D_R = 6\hbar \\
2\pi_0 = D_R * (R_{HE-1})^{C_{H-\pi_0}} \\
2\pi_0 = 6 * (1.002\,113\,533\,038\,348)^{21.865865158328} = 6.283486042064188 \\
\pi_0 = 3.141743021032094 \\
\frac{\pi_0}{\pi} \cong 1.000047863443444\ (\sigma{\sim}10^{-5})
\end{gathered}
\tag{43}
$$

Specifically, we are stating, based on a hyperbolic projection combining location and communication time, a Planck-scale observer of diameter $2\hbar$ must traverse a distance of $3.141743021032094\hbar$ to arrive at our dynamic perpendicular from another dynamic plane. Recalling the A_{pqT} property of axis rotation can give us a shortcut to complete the visualization. Projections are inherently distorted, and do not contain all information; the calculations above are therefore on the order of a "proof of concept" rather than a mathematical proof, which can come later. Additionally, note in equation 35 we proposed a model of π as a summation; the above formulation is not inconsistent; we can formulate equation 43 as a series of incremental hyperbolic adjustments occurring at each jump-step. Note we have not placed a specific "point of observation" pertaining to this estimate. However, since the "point of observation", or observer frame, must lie between the proton and the electron in this formulation, this observer point would itself be predicted to be subject to a dynamically generated hyperbolic perspective expansion along the vertical axis (see figure below for re-acquaintance with intuition, if needed). This perspective expansion will have important consequences for a more accurate estimation of π, which we will address in a future work.



Partial Reproduction of Figure 15 Relativistic Expansion

[3] In typical use, "Antidromic" refers to an electrical impulse traveling in an opposite direction to the normal transmission direction of a neuron. In this case, we redefine or "recoin" the term antidromic to refer to a movement against the prevailing directional motion of Spacetime. In later works, we (or other authors) may in time discuss the relationship between antidromic motion in Spacetime and antimatter.

4.6. Hyperbolic Expansion and the "Edge of the Observable Atom"

We state in this paper that a Proton-Electron Pair is a structure of length $2h$ progressing through hyperbolic Spacetime. In this section, we introduce, conceptually, how an object of length $2h$ can manifests as an atom. According to our model, a communication of the electron reaches the proton at approximately jump-step $23.865865158328h$. As we have discussed, a full "return to line" formulation, due to embedded axis rotation, requires 2 jump-steps ($\approx 47.7317303166560\ h$). In order for a full observed 4D manifold, we must observe all dimensions manifest ($\approx 50.7317303166560\ h$) and based on first principles the full object must exist at least 2 spacetime locations, at least 2 jump-steps apart (($+2h$). These very preliminary approximations should be considered highly subject to adjustment, however they can provide us a basis for intuitively grasping how we can generate an object the scale of an atom from our model. Specifically, we can calculate an associated hyperbolic circumference at a jump-step radius of $\approx 53\ h$:

$$
\begin{gathered}
R_{pe} \approx 53\ h \cong 333\hbar \\
R_{pe-H} \approx \frac{(e^{53}-1)}{(e^{53}+1)} \\
R_{pe-H} = 0.99999999999999999999998079463989098264794 \\
C_{pe-\mathbb{S}^1_\infty} = 2\pi \sinh\left(C_{pe-H}\right) \cong 3.272 * 10^{23} \\
C_{pe-\mathbb{S}^h_\infty} = 2\pi * C_{pe-\mathbb{S}^1_\infty} \cong 2.056 * 10^{24}
\end{gathered}
\tag{48}
$$

In which R_{pe} represents a putative 53 step trajectory length of a 4D Spacetime object, C_{pe-H} represents the map location of the circumferences in Poincaré Space (unit distance). $C_{pe-\mathbb{S}^1_\infty}$ is the calculated (unit) hyperbolic radius at R_{pe-H}, and $C_{pe-\mathbb{S}^h_\infty}$ is the radius in increments of $\hbar$ if we assign a unit value of h. The above demonstration is not meant to be precise, but illustrative. At 53 communication steps, for an object of length $2h$, the potential extent of hyperbolic (Planck, or energy) space implied to account for all possible positions and communications of the object is on the order of at least $\sim 10^{23} - 10^{24}$ Plancks in extent. As a comparison, note that a Planck length (in meters), is on an order of magnitude of 10^{-35}m, while the diameter of a hydrogen atom is on the order of 10^{-12}m, an order of magnitude difference of $\sim 10^{23}$. Note we do not fracture Spacetime into meters/seconds or account for a "communication cone"; these precise measurements and relationships can be addressed in future work.

5. Modelling Atomic Structure and Strong and Weak Interactions

Summary of Section: In prior sections, we outlined a model of Spacetime based on dynamic expansion of a momentum-space over time. Space, time, and forces of nature are generated through the observations and experiences of observers moving through the momentum-space we have defined. Protons, neutrons, and electrons in this space are generated referring to a communication dynamics model in the absence of particles, or waves; a particle or wave observation (or experience) is defined by the nature of the observation and interaction within this momentum-space.

In this section, we expand out, in a limited fashion, a more general description of fundamental forces of nature by describing the emergence of observed 3D space, some (preliminary) estimated parameters of weak interactions, how our model can accommodate atomic structure (specifically describing hydrogen, deuterium, and tritium), and a proposed relationship between observed 3D space and quarks. In this section, in summary, we begin to plot how our model can practically be applied to fundamental problems of physics in a fashion that can complement the perspectives of quantum physics.

5.1. Neutron, and an Exploration of Planck-Scale Hyperbolic Expansion

In order to understand a Proton-Electron Pair and the emergence of 3D space, we must first study in more detail some mathematical approximations pertaining to a Neutron. In 5.1, we will first provide some background information, and we will second describe some mathematical approximations of Neutron structure, illustrating these concepts with hybrid figures incorporating both Euclidean and hyperbolic elements.

Table. 4. Euclidean versus Hyperbolic Circumference

Euclidean Circumference	$\boldsymbol{2\pi r}$
Hyperbolic Circumference	$\mathbf{2\pi sinh}\ (\boldsymbol{r})$
This well understood relationship is highlighted as it is central to our understanding of the experience of a Euclidean Observer progressing through hyperbolic space.	

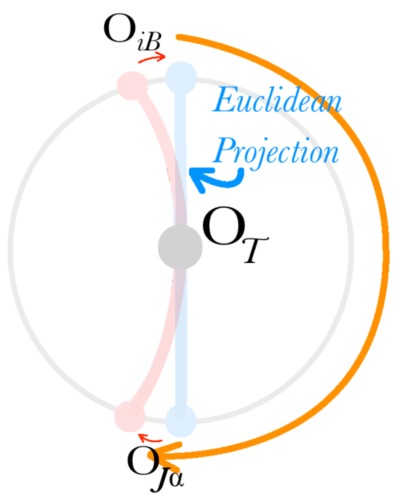
Background Principles (Neutrons): In hyperbolic geometry, the circumference of a circle is greater than $2\pi r$ (Table 4). For geometric intuition in a Euclidean frame, we can represent this "extra distance" travelled as an additional increment of Space that a point must travel to complete a circle (Figure 47). In Figure 48, we present a Hyperbolic Projection of this same phenomenon. These two, seemingly contradictory projections are consistent when we consider a fundamental property of projection: dimensional collapse. Figure 47 collapses a 6-parameter space to 2D+T. Specifically, hyperbolic trajectory and rotational expansion are collapsed to a Euclidean 2D frame. To account for the hyperbolic expansion of spin we must map an "extra degree of rotation" onto our Euclidean circle. In Figure 48, we present a far more complex diagram or "pseudo-projection", placing an object in a Poincaré space in which we distort the relative sizes of objects to allow us to use a Euclidean frame for our intuition. A "red curve" incorporating $P_{i\beta}$, represents a Euclidean, observed, 3-Ball posterior position of P. A "blue curve", incorporating $P_{J\alpha}$, incorporates an anterior 3-Ball destination for P. The dynamic rotation $P_{i\beta} \to P_{J\alpha}$ is observed in our model as a Euclidean Rotation of precise length $1/2h$ occurring over time, but because we are moving through hyperbolic space, an additional increment of rotation has occurred, experienced as something other than space or time (ie we propose this extra rotation is experienced as a force). More specifically, let us examine 3 points – the jump step involving $P_{iB}, O_T, \&P_{J\alpha}$. A Poincaré disk plane bisects our object. O_T is placed at a reference frame point (the plane intersection of the central circle). When our disk centered on O_T is observed to move a single jump-step $J_{2\pi}$ (jump length h from O_{iB} to $O_{J\alpha}$), P must jump a distance greater than h, but less than $2h$. Pertaining to Figure 49, from an axiomatic perspective, it is now productive to review some fundamental precepts:

- Observation is Discrete, but Spacetime is Continuous
- The Speed of Communication is Constant
- All relationships must be described in terms of Rotation, Trajectory, and distance

Defining Characteristics of a Neutron: Having reviewed these precepts, we can now discuss Figure 48 in detail. By focusing on our two points P_{iB} and $P_{J\alpha}$ we generate a series of points that represent various dynamically observed locations of P and O_p with respect to O_T that we can describe in terms of Rotation, Trajectory, and distance. We can now approximate a series of observed distances, representing some parameters of a single Neutron Jump-Step (Equation 49) from the perspective of an adjacent Stationary Spacetime Moment:

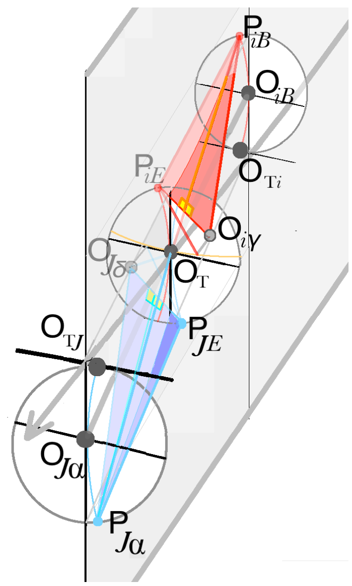
$$\begin{gathered} O_{iB}O_p = O_pO_{J\alpha} = P_{iB}P_{iE} = P_{J\alpha}P_{JE} = {}^{h}/_{2} \\ O_iO_p = O_pO_J \cong {}^{h}/_{2} * \cos\left(\arcsin\left({}^{1}/_{\pi}\right)\right) \\ P_{iB}O_p = O_pP_{J\alpha} \cong \sqrt{\left(O_iO_p\right)^2 + (2)^2} \\ P_{iB}P_{J\alpha} \cong 2 * \sqrt{\left(O_pO_j\right)^2 + (2)^2} \\ \boldsymbol{O_{iB}O_{J\alpha} = h} \end{gathered} \tag{49}$$

$$\boldsymbol{P_{iB}P_{J\alpha} > h}$$



When illustrating a dynamic trajectory through hyperbolic space, we must represent at least 6 parameters of trajectory and rotational freedom, and possibly 8 or more – which is not tractable for human intuition. However, we can project the Space into our Euclidean framework. Note that in Figure 48, we flatten trajectory.

Figure. 47. Euclidean Projection



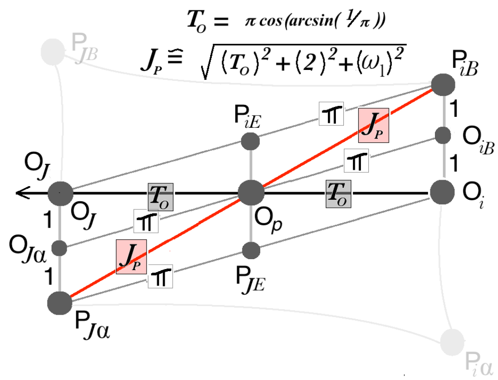
Focusing on the observation(s) of P as it transitions from P_{iB} to $P_{J\alpha}$, a variety of perspectives are generated regarding the location of its associated point O_p. Locations cannot be measured, but can be computed, and modelled to exist as parameters at O_T.

Figure. 48. Pseudo-Hyperbolic Projection

Note that as we have dynamically generated Euclidean space by rotating our 3-Ball through hyperbolic space, our mathematical formulation of observed trajectory coordinates respect the Euclidean. A second jump-step along the same linear trajectory, in the absence of interaction can be modelled as an equilateral triangle, with sides of equal length h ($= 2\pi\hbar$). Since all referenced points are placed along the Euclidean “3-Ball” surface, Euclidean trigonometric relationships apply. Two points are excluded from Equation 49: $O_{iB\gamma}$ and $O_{J\alpha\delta}$; these points will be approached later.

In Figure 49 we explicitly display the dynamically generated 3-Ball surface as a flat plane for better visualization. We can now name points, as follows:

- P_{iB} is the initial observed location of P
- $P_{j\alpha}$ is the final observed location of P, after the Spacetime Moment has expanded by a trajectory jump-step $J_{2\pi}$ (from O_{iB} to $O_{J\alpha}$)
- $P_{i\beta E}$ and $P_{J\alpha E}$ are the respective $\frac{1}{2}J_{2\pi}$ (or $\frac{1}{2}h$) distance points for P_{iB} and $P_{J\alpha}$
- O_p is the center of the Spacetime Moment M_p
- O_{iB} and $O_{J\alpha}$ are the respective $\frac{1}{2}J_{2\pi}$ (or $\frac{1}{2}h$) distance points for O_p
- O_i and O_J are the respective $\hbar$ (where $\hbar = \frac{h}{2\pi}$) distance points perpendicular to trajectory $O_i \to O_p \to O_J$, for O_{iB} and $O_{J\alpha}$

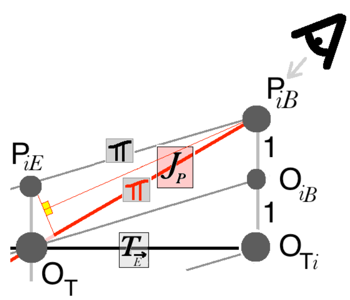


Neutron Jump-Step, from the perspective of O_p. Note here O_p is a dynamic perspective generated by a co-traveling Stationary Spacetime Moment (see Figure 34, top, for intuition), allowing us to generate the flattened trajectory based on $\pi cos\left(arcsin(1/\pi)\right)$. Using this A_M formulation, Euclidean trigonometric relationships apply, but the relationships between P_{iE}, P_{JE} and O_p are dynamic (lighter points reminds us we can spin our perspective in hyperbolic space). A dynamic hyperbolic generation of Euclidean space allows either a "spin up" (light) or "spin down" (dark) object to occupy a given Spacetime Moment location. Note $P_{iE}O_J$ and O_iP_{JE} are out of frame.

Figure. 49. Neutron Jump-Step

The distance J_p implies a non-integer Jump-Step for P, and we must describe this jump-step within the parameters of the model, i.e. *simultaneous distance, rotation, and trajectory***.** We can address this within an A_M axis formulation by adding a third dimension. In Figure 50, we take the perspective now of point P_{iB} observing a point O_T within a Spacetime Moment M_T. Since we axiomatically state (Axiom 4) that Spacetime is continuous, we calculate communications within the Spacetime moment based on this Axiom. Specifically:

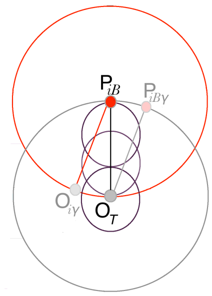
1) We select $h/2$ as a distance of simultaneous measurement for point P_{iB} communicating with O_T.
2) We then describe a rotation that can describe the relationship between P_{iB} and O_T



P_{iB} cannot "see" the location of O_T in this Spacetime representation; it must see O_T at a different trajectory/rotational location, which can be modelled as a new dimension, projecting from the page towards the reader.

Figure. 50. Simultaneous Perception Distances (Neutron)

Observation is occurring as the moment M_p is dynamically moving through Spacetime. Visualizing our equivalent distance in Figure 50, we can see that the sight line (point of simultaneous distance) for P_{iB} does not extend to O_T in the 2-D projection. However, our model is dynamic; P_{iB} can see O_T at a different trajectory and rotational location, which we can project into another dimension (Figure 51). We now apply Axiom #8; in the absence of communication or interaction, momentum is conserved. P_{iB} observes stable rotation and trajectory. It however experiences that O_T has "moved" a distance $< h$. As Spacetime is continuous (Axiom #4), this experience must be communicated within the Spacetime moment.



Trajectory T is flattened "thumb into the page", Euclidean representation (we ignore the hyperbolic dimension). Using the right-hand rule, O_T observes a stable trajectory; P_{iB} rotates Clockwise. Conversely, P_{iB} observes that O_p makes a Counter-Clockwise rotation. Both locations agree on relative distance and trajectory.

Figure. 51. Observer-Point Perspective Disagreements

Communications move at the speed of communication and are therefore bosonic. Symmetrically, we can also note that O_T experiences a stable location and trajectory; P_{iB} has "moved". Therefore P_{iB} and O_p agree on trajectory and relative distance along the trajectory but disagree on rotational position within the Moment. Respective points according with these rotational positions in Figure 51 are named $O_{i\gamma}$ to $O_{J\delta}$. We can define some distances with respect to these points, based on first principles, specifically:

$$\begin{aligned} \boldsymbol{P_{iB}P_{iBE}} &= \frac{\boldsymbol{h}}{\boldsymbol{2}} \Longrightarrow \boldsymbol{P_{iB}O_{iB\gamma}} = \frac{\boldsymbol{h}}{\boldsymbol{2}} \\ \boldsymbol{P_{J\alpha}O_{J\alpha E}} &= \frac{\boldsymbol{h}}{\boldsymbol{2}} \Longrightarrow \boldsymbol{P_{J\alpha}O_{J\alpha\delta}} = \frac{\boldsymbol{h}}{\boldsymbol{2}} \end{aligned} \tag{50}$$

In other words, $P_{iB}P_{iBE}O_{iB\gamma}$ and $P_{J\alpha}O_{J\alpha E}O_{J\alpha\delta}$ can also be modelled as isosceles triangles. We can use these isosceles triangles to now define an energy relationship occurring within a Spacetime Moment as it traverses Spacetime.

Defining Characteristics of a Proton-Electron Pair: We can use a similar process to now describe a proton-electron pair in our model (flattened representation, Figure 52). For consistency, we maintain nomenclature, but note we replace P_{iB} with P_{iC}; the reason for this substitution will become clear shortly. Important distinguishing properties of this object include

- An elongated jump-step $2J_P$
- Distinct angular relationships (for example, $\angle P_{iC}O_pO_{iC}(Electron) \neq \angle P_{iB}O_pO_{iB}(Neutron)$

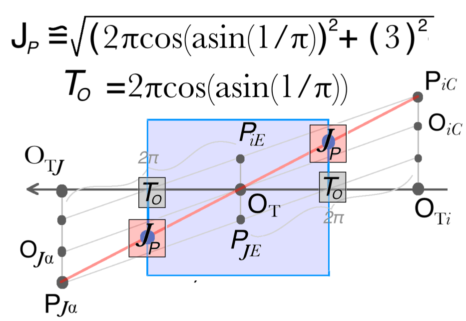
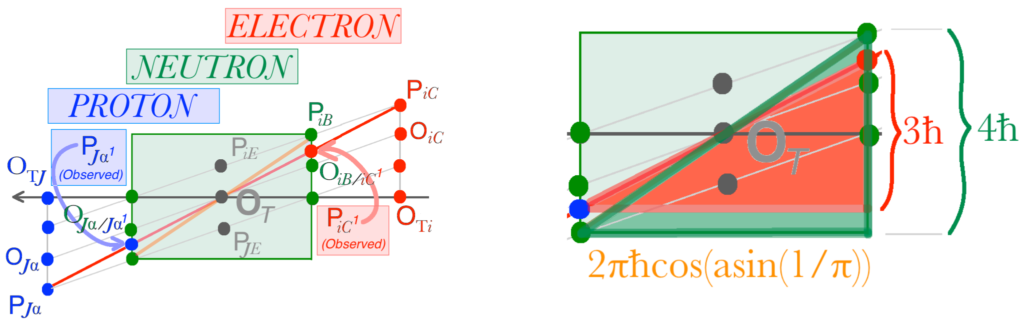


Figure. 52. Flattened Point-Trajectory Representation of a Proton-Electron Pair

Note we can bound a central, "observing" Spacetime moment (blue line). J_P is superimposed on the average position of the Electron as observed/experienced by the Moment (right, superior blue dot) and proton (left, inferior blue dot). As we have discussed throughout this paper, all computation can be assumed to occur within the confines of a Spacetime Moment.

Directly Comparing Characteristics of a Neutron with a Proton-Electron Pair: Understanding that the characteristics of the central Spacetime Moment computes the property of the object, we can now directly now compare hyperbolic (experienced) and Euclidean (observed) differences between a Proton-Electron Pair and a Neutron, for a given Spacetime Object, as computed by a given centrally located (dynamically generated) O_T (Figure 53, Equation 51).



A Proton-Electron Pair is a coherent Spacetime object in which two Spacetime Moments share an overall trajectory ($O_{Ti} \rightarrow O_{TJ}$) over two jump-steps. Note a Neutron to "return to line" similarly evolves over two jump-steps. Because of the change in rotational characteristics, however, in the case of a Proton-Electron Pair, O_T observes, experiences, and computes, properties from both Jump-Steps.

Figure. 53. Rotational characteristics of a Proton-Electron Pair Compared to a Neutron

In Figure 53, we overlap a Proton-Electron Pair with a Neutron, as both Spacetime Objects straddle a reference frame defined by a dynamic perpendicular through O_T. The central Spacetime Moment computes properties at Planck-length for both objects. At an equivalent computational distance, O_T observes and experiences differences between jump trajectory and rotational characteristics of the respective objects. We can approximate these differences by noting the Euclidean differences between the two objects:

NEUTRON

$$O_{iB}O_T = O_TO_{J\alpha} = P_{iB}P_{iE} = P_{J\alpha}P_{JE} = {}^{h}/_{2}$$
$$T_{oN} = O_{Ti}O_T = O_TO_{TJ}$$
$$T_{oN} \cong {}^{h}/_{2} * \cos\left(\arcsin\left({}^{1}/_{\pi}\right)\right)$$
$$P_{iB}O_T = O_TP_{J\alpha} \cong \sqrt{(O_iO_T)^2 + (2)^2}$$
$$P_{iB}P_{J\alpha} \cong 2 * \sqrt{\left(O_pO_j\right)^2 + (2)^2}$$
$$\boldsymbol{O_{iB}O_{J\alpha} = h}$$
$$\boldsymbol{P_{iB}P_{J\alpha} > h}$$
$$\boldsymbol{P_{iB}P_{iBE} = {}^{h}/_{2} \Rightarrow P_{iB}O_{iB\gamma} = {}^{h}/_{2}}$$
$$\boldsymbol{P_{J\alpha}O_{J\alpha E} = {}^{h}/_{2} \Rightarrow P_{J\alpha}O_{J\alpha\delta} = {}^{h}/_{2}}$$
$$\angle P_{iB}O_pO_{iB} = \angle P_{J\alpha}O_pO_{J\alpha}$$
$$\cong \arctan\left({}^{2}/_{T_{oN}}\right) - \arctan\left({}^{1}/_{T_{oN}}\right)$$

PROTON-ELECTRON PAIR

$$O_{iC}O_T = O_TO_{J\alpha} = P_{iC}P_{iE} = P_{J\alpha}P_{JE} = h$$
$$T_{oPE} = O_iO_T = O_TO_J$$
$$T_{oPE} \cong h * \cos\left(\arcsin\left({}^{1}/_{\pi}\right)\right)$$
$$P_{iC}O_T = O_TP_{J\alpha} \cong \sqrt{(O_iO_T)^2 + (3)^2}$$
$$P_{iC}P_{J\alpha} \cong 2 * \sqrt{\left(O_pO_j\right)^2 + (2)^2}$$
$$\boldsymbol{O_{iC}O_{J\alpha} = 2h} \qquad (51)$$
$$\boldsymbol{P_{iC}P_{J\alpha} > 2h}$$
$$\boldsymbol{P_{iC}P_{iCE} = h \Rightarrow P_{iC}O_{iC\gamma} = h}$$
$$\boldsymbol{P_{J\alpha}O_{J\alpha E} = h \Rightarrow P_{J\alpha}O_{J\alpha\delta} = h}$$
$$\angle P_{iB}O_pO_{iC} = \angle P_{J\alpha}O_pO_{J\alpha}$$
$$\cong \arctan\left({}^{3}/_{T_{oPE}}\right) - \arctan\left({}^{2}/_{T_{oPE}}\right)$$

$$\angle P_{iB}O_pO_{iB} > \angle P_{iB}O_pO_{iC}$$

The above classical relationships, once we add relativistic considerations, can provide a basis for comparing the dynamic energy state of a Neutron, with that of a Proton-Electron pair. We have claimed that differences between the dynamic energy state of the Neutron and Proton-Electron pair generate observable 3D+T space through the process of beta-decay; we preliminarily explore the energy states associated with this transition in more detail in Section 5.2 below.

5.2. The Emergence of Three Spatial Dimensions from the Process of Beta Decay and the Emergence of Neutrinos as a Transmission of Reference Frame Energy State

Earlier in this paper, we calculated a Euclidean rotation constant π_0 as a natural consequence of the expansion of Spacetime. Here, we provide another visualization of this process to improve our intuition of how a 2-Planck object moving through Spacetime inevitably generates a 3- dimensional observation of Spacetime. We have asserted that, pursuant to the existence of a minimum observation distance h, an average point O_p for a given Spacetime Moment M_O can be modelled to contain the information content of the moment (Trajectory, Rotation, and Instantaneous Communication). We now return to the visual concept we introduced in Figure 48, to discuss the divergent properties of a Neutron and Proton-Electron Pair and describe the emergence of three observable dimensions of space. We can start by placing an illustration, from the perspective of a dynamically generated O_T pertaining to the properties of a Neutron, compared to the properties of a Proton-Electron pair (Figure 54). We note that $O_{i\gamma}$ and $O_{J\delta}$ and $O_{i\gamma}$ have angular and distance relationships with P, O_T, and $O_{J\delta}$ definable on the Hyperbolic pqT axes; the relationships can be modelled as a planar structure.

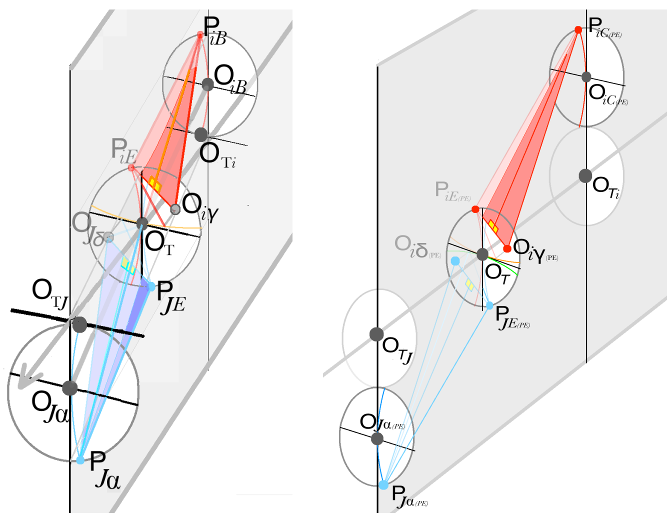


Figure. 54. Poincaré Comparison, Neutron vs Hydrogen

Added intuition is provided in Figures 55 and 56. In these figures, we rotate the front and back ring, rotate the axes as we have demonstrated previously, and place $O_{i\gamma}$ and $O_{J\delta}$ which project into the emerging 3D frame over 2 jump-steps (note green plane merging in Figure 55). Note, a different spin-state generates a distinct intersecting plane with the same trajectory characteristic. In Figure 56, we examine a 2D projection of the plane we show in Figure 55. We can note, specifically, that P does not observe O_T directly as a center of rotation at distances $< h$. Rather, P observes $O_{Bi\gamma}$ move to $O_{J\alpha}$ as P_{iB} transits to $P_{J\alpha}$, which we can model to occur over a curved Spacetime distance Φ. We can define a radius of the half-step as w_0. Since the speed of communication is constant, the excess trajectory distance equals the rotational displacement, and an isosceles triangle can be used to generate an estimate of half-step radius w_0. Recall that in our model, all observations occur along a dynamically generated Euclidean 3-Ball surface.

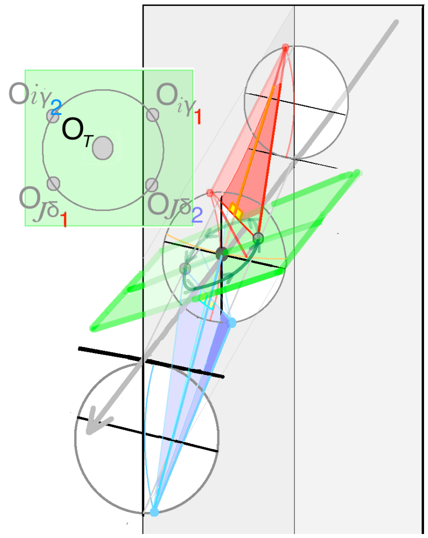


Figure. 55. Poincaré Sphere, Spin Plan

We can accordingly approximate the **expected Euclidean** location of $O_{i\gamma}$ and $O_{J\delta}$ for a single jump-step for a Neutron, compared to a Proton-Electron pair, as follows:

NEUTRON	**PROTON-ELECTRON PAIR**
$\boldsymbol{T_{O(N)} \cong \pi * \cos\left(asin\left({}^{1}/_{\pi}\right)\right)}$	$\boldsymbol{T_{O(PE)} \cong 2\pi * \cos\left(asin\left({}^{1}/_{\pi}\right)\right)}$
$\boldsymbol{J_p \cong \sqrt[2]{\left(T_{O(N)}\right)^2 + (2)^2}}$	$\boldsymbol{J_p \cong \sqrt[2]{\left(T_{O(PE)}\right)^2 + (3)^2}}$
$\boldsymbol{\delta_T = \delta_{PQ} = \delta_{O(N)} \cong J_P - \pi}$	$\boldsymbol{\delta_T = \delta_{PQ} = \delta_{O(PE)} \cong J_P - 2\pi}$
$\boldsymbol{\omega_{O(N)} \cong \sqrt[2]{2 * \left(\delta_{O(N)}\right)^2}}$	$\boldsymbol{\omega_{O(PE)} \cong \sqrt[2]{2 * \left(\delta_{O(PE)}\right)^2}}$

$$\boldsymbol{\omega_{O(N)} > \omega_{O(PE)}} \tag{52}$$

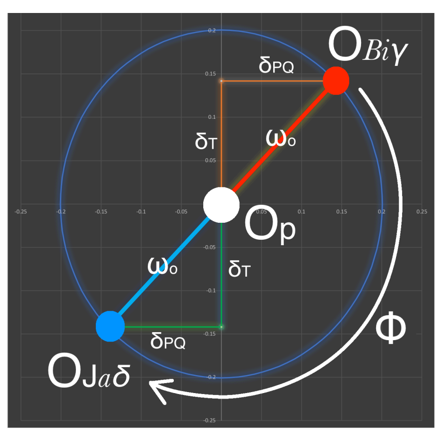
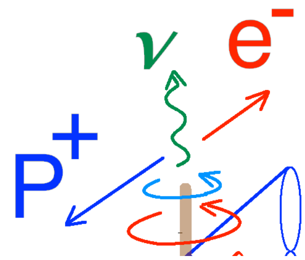


Figure. 56. Flattened Representation of Plane of Spine

In Equation 52, we demonstrate the intuition we provided in section 4.4 (illustrated in Figure 32 – see also Figure 57). When a Proton-Electron Pair is generated from a Neutron, there is an apparent reduction of energy stored at the reference frame. Note a reciprocal relationship exists between O_T and perceived locations of all points O_i, O_J, and P, generating the projected planes displayed in Figures 55 and 56, for both the Neutron and Proton-Electron pair. The difference in scale between an observable distance ($\geq h$) and experienced, unobservable distances $\left(< h, \cong {}^{h}/_{2}\right)$ differentiates the observed properties of a Neutron from the properties of a Proton-Electron Pair.

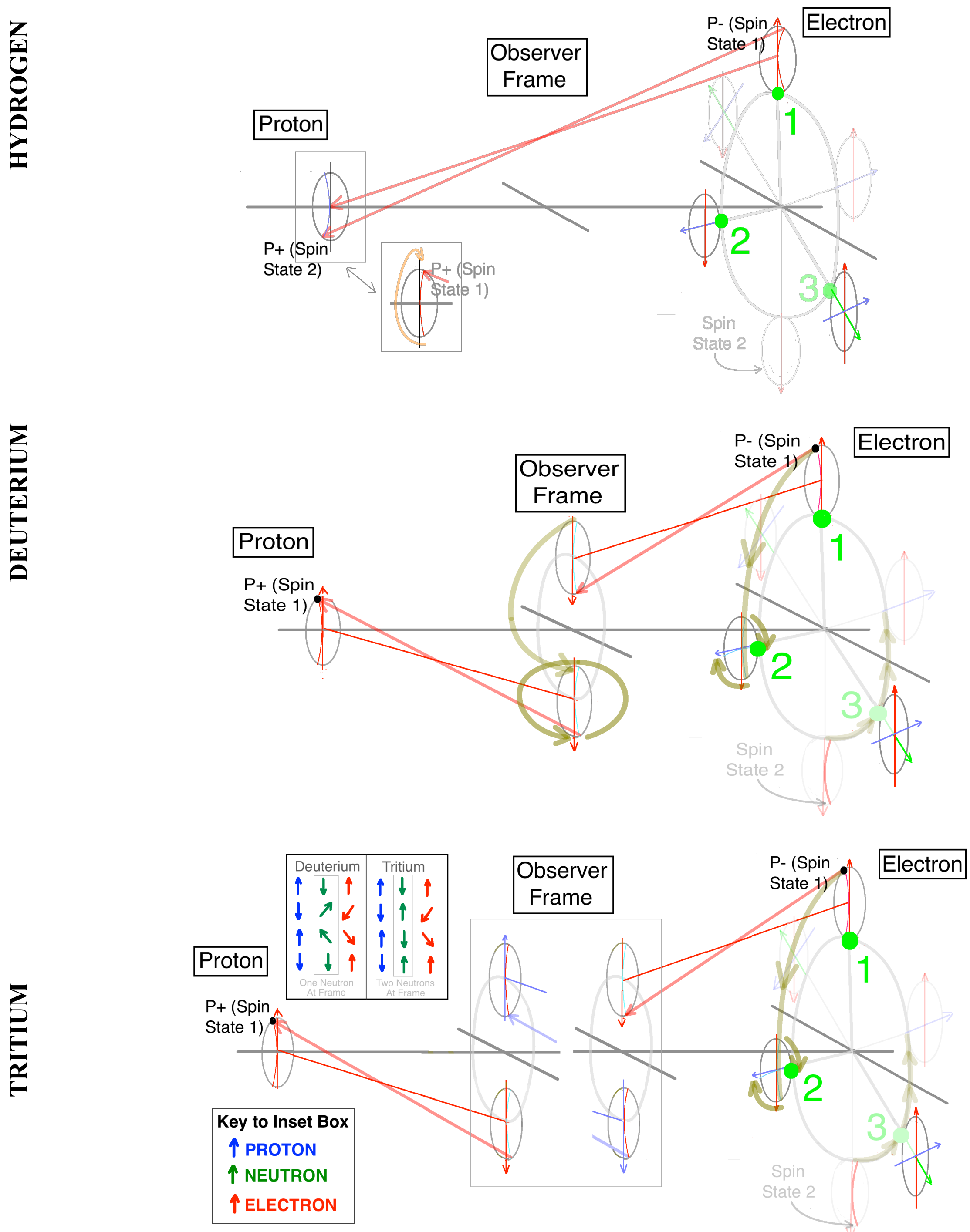


More apparent energy is stored by a Neutron at the reference frame (red loop), compared to a Proton-Electron Pair (blue loop). Beta Decay is energetically favorable in low density energy states.

Figure. 57. Energy Stored at the Reference Frame (Projection)

We have taken the perspective of O_T for both objects, however returning to definition 18, we note that a Proton-Electron Pair is a Spacetime Object of length $J = 2h$, consisting of a Proton and Electron following the same Hyperbolic Spacetime Trajectory. To provide intuition regarding how this manifests in Spacetime, and how, for example, we can incorporate further objects within the Proton-Electron pairing (ie Neutron(s)), we provide Figure 58. In Figure 58, we present a model of isotopes of the Hydrogen molecule. A simple Proton-Electron pair exists as single "spin" or energy transform across a $2h$ jump length. Note the spin characteristic of an electron may be concurrent with the proton or diverge. Also note that our model reads onto current quantum theory in that a divergent spin state (in which the proton spin diverges from the electron spin) is more energetically favourable, as it requires less rotational energy to describe. In Deuterium, an additional spin (additional rotational energy) at the reference frame admits an observable Neutron. Tritium exists when two possible spin states exist at the reference frame. An additional important point, examining Figure 58, is the observation that fully describing the Euclidean position of two Neutrons in our model requires 6 jump-steps ($6h$, 4 shown for Tritium). To an observer with sufficiently precise measurement, it may appear that the two Neutrons "trade spins" at a high frequency as Tritium progresses through Spacetime. However, our new object generates something far more magical than the possibility of 2 Neutrons in one "location" generated from 1 dimension of energy expansion. The existence of a single hydrogen atom in Spacetime dynamically generates three-dimensional space (Fig 59).

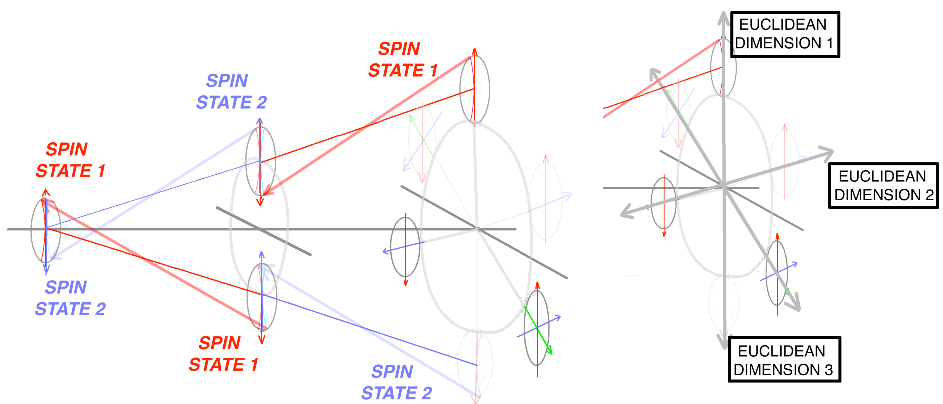
Figure 58 is complex, and we will dwell this figure a bit as we finish 5.2. First, let's delve into the concept of spin in more detail. We visually introduced the concept of spin in Figures 27 and 29 and also, in part, in Figure 14. Turning to Figure 14, we can observe that a 3-Ball dynamically rotating along a single spin axis along a trajectory implies two possible jump-step configurations. Conceptually, an object of length 1 jump-step observes two dimensions of space, and experiences additional characteristics that manifest as dimensionality at larger/longer observation distances as "energy" and "spin states". Individual protons, neutrons, and electrons therefore can be modelled to exist in and observe a two-dimensional frequency space. In a 2 jump-step object, a 3rd spatial dimension becomes manifest and observable to a point O_T located at the frame, as it observes dynamic objects locates a distance h behind, or ahead of the respective frame. To borrow language and a concept from the fields of neurology and psychiatry, we can note that in order to maintain "object permanence" as a 2 jump-step contiguous object (jump-step length of h, spin distance h), the observer frame must observe the overall trajectory of P through hyperbolic space



As is observed in nature, protons and electrons of the same, or opposite spin states can be associated, but an opposite spin-state system is energetically slightly more favorable. Shown is hydrogen in its lowest energy state configuration, and proposed structures for Deuterium, and Tritium. Note, observer placement impacts perspective (and projection) of rotational direction(s).

Figure. 58. Hypothetical Model-Based Visualization of Isotopes of Hydrogen

in incremental steps of $> h$. An average observer frame for hydrogen can be defined (top image, Figure 58), which observes P progress from P^- to P^+ as a single jump of average length $2 * h$. The forward element P^+ defines the trajectory of the object through hyperbolic space and can be represented as a consistent destination for all points P^-. From a model perspective, when P "reaches" P^+, the object has now moved from State 1 (bright green) to State 2 (bright green). The minimum Euclidean distance traversed for P^- to its next state must be at least 1 Planck ($h = 2\pi\hbar$). As the "height of the cone" is $3\hbar$, the Euclidean, observed circumference (correlating with the number of possible positions) can be represented as $2 * \pi * 3h = 6\pi\hbar$. The construct of a proton, and an electron, is generated by the internal communication between P^-, P^+, and the Observer Frame (representing the average position of Spacetime Object P^-P^+). Along an observation length of 3 jump-steps we can describe in the model 1 proton (the destination for the object), and the movement of one electron moving through the 3-dimensional states (in either of two spin characteristics as shown in Figure 58). An added spin straddling the observer point admits an additional Spacetime object – a Neutron. If the spin characteristics of the Neutron correlate with that of the electron (a lower object energy state), we observe Deuterium (Figure 58, middle). If the Neutron spins independently from the electron (a higher energy state), over 6 jump-steps ($6h = 12\pi\hbar$) up to 2 neutrons can be described following the same trajectory (Tritium, lower image in Figure 58) – however since a proton-neutron-electron system can be described efficiently in 3 jump-steps, we can intuitively understand that a 6 jump-step version might be inherently less stable, and "decay" or revert to a more energetically favourable state (decay from tritium to deuterium).



Placing P in a dynamic, hyperbolic space, with axis rotations to "bring us back" to the 1-D energy expansion gives rise to Spin and observed Euclidean 3-dimension space.

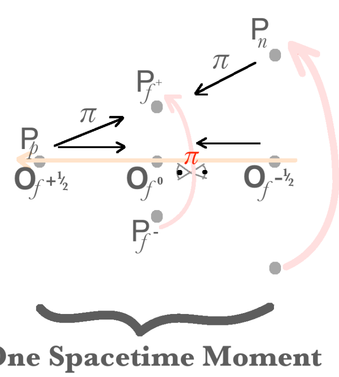
Figure. 59. Spin States and Dimensionality

5.3. Modelling the Strong Force, and Quarks, as a Sub-Planck Correlate of the Emergence of Euclidean Space

We have defined protons, neutrons, and electrons in a Communication Dynamics-based model in the absence of particles, or waves. We proposed, rather, that the observation of particles and waves are emergent properties derived from a linear expansion of Spacetime. We defined in this model how a point can give rise to the observation of 1D motion, how 1D motion through hyperbolic space generates 2D, and how dynamic rotation in hyperbolic space generates the perception of 3D Euclidean space progressing through a 4th trajectory dimension (Figure 59). We claimed that this model provides an analog, or translation, of our observed 4D Spacetime, with emergent observed dimensions defined by a single universal metric we define as "Plancks". A dynamic expansion of Plancks over a trajectory gives rise to the experience of energy localized in dimensional Spacetime. Specifically, various translations of this underlying energy become the observations and experiences of Space, Time, particles, waves, and fundamental forces of nature. In this context, we now propose the notion that Quarks can be modelled as a correlate of Euclidean dimensionality, projected on a sub-Planck scale (i.e. below the level of direct Euclidean observation). To explain this proposition, we can place an observer point at the centre of a reference frame determined by the position of a proton ("ahead" in Spacetime) and a Neutron (arrayed along the dynamic perpendicular – Figure 60). We observe the communication from the proton, propagating from the "future", and the Neutron, in which communication is generated from our experienced dynamic perpendicular. While a Proton-Electron Pair exists within an object of jump length $2h$, the distinction between a proton and neutron is more subtle. Figure 60 presents a 4D representation of a frame point in transition between a "past point" ($f^{-1/2}$) and a future "infinite point" ($f^{+1/2}$); the frame can be modelled to exists at an average, perpetual "transition point" (f^{0}) between past and future. Our average frame point never exists in the past, nor in the future, but always in the liminal state of "emerging" from the past and "arriving" at the future (also see 5.4 for more intuition on this concept). We model energy of the neutron to exist at P_n, along the observed dynamic perpendicular. We model that the energy of the proton exists at a future point P_p. We can note, within the Spacetime Moment, that, as a first approximation:

$$\begin{gathered} O_{f^{+1/2}} \to O_{f^0} \approx O_{f^{-1/2}} \to O_{f^0} \\ P_p \to P_f \approx P_n \to P_f \end{gathered} \tag{49}$$

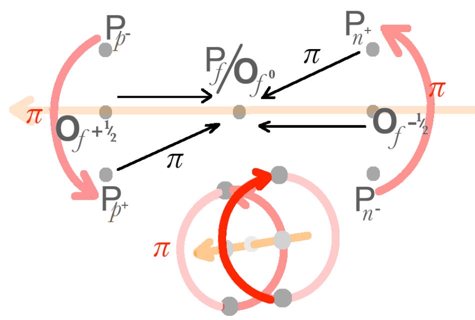
In which $P_p \to P_f$ is the "communication distance/time" between P_p and P_f , $P_n \to P_f$ is the "communication distance/time" between P_n and P_f , $O_{f^{+1/2}} \to O_{f^0}$ is the average dynamic location parameter associated with the trajectory/ communication between the proton and the frame, and $O_{f^{-1/2}} \to O_{f^0}$ is the average dynamic location parameter associated with the trajectory/ communication between the neutron and the frame. Let us now take the perspective of the frame. Recall, in the absence of interaction, our frame point observes neither trajectory nor rotation; it rather observes itself following an inertially neutral path as objects "rotate around it"; we can model this trajectory as a straight line, but here both the



The relationship between Proton, Neutron, and Observation Frame from the perspective of the Proton.

Figure. 60. A Reference Frame Can Experience Incipient, Sub-Planck Dimensionality

proton (P_p) and the Neutron (P_n) are modelled to traverse Spacetime bracketing a dynamic frame ($O_{f^{-1/2}} \to O_{f^0}/P_f \to O_{f^{+1/2}}$ – Figure 61). Note P_f never "leaves" $O_{f^{-1/2}}$, nor does it ever "arrive" at $O_{f^{+1/2}}$; these points are "virtual points" that parameterize the perpetual computation occurring at P_f as it transits spacetime in a liminal state, poised dynamically between the past and future. It is productive now to review the concept of "observation" in this context. P_f observes neither past, nor future, but rather observes simultaneous location information of objects at a defined radius. We define the radius of observation in this case at ½ Planck, or $\frac{1}{2}h = \pi\hbar$.



Each point in Planck-Space, in the absence of interaction, perceives its own trajectory as inertially neutral. The energy of Spacetime flows around any selected point P as a hyperbolic trajectory and rotation vector as the Universe expands.

Figure. 61. An Observer Experiences (rather than Observes) Perspective Disagreement

Our defined P_f observes two distinct rotational parameters. Communications from our proton can be modelled to appear as "clockwise" rotations. Conversely, communications from our neutron can be modelled to appear as "counter-clockwise" rotations since these communications emerge from the dynamic perpendicular "behind" P_f/O_f. Note we have embedded P_f as the point also observing the emergence of 3-dimensional dynamic spacetime, generated by the electron.by the electron. Let us now embed this dimensionality on our sub-Planck Frame (Figure 62). In row 1 of Figure 62, we can observe the perspective of the P_f observing system $\left\{P_{p^-}, O_{f^{+\frac{1}{2}}}, P_{p^+}\right\}$ (top left), and observing, simultaneously, system $\left\{P_{n^-}, O_{f^{-\frac{1}{2}}}, P_{n^+}\right\}$ (top right).

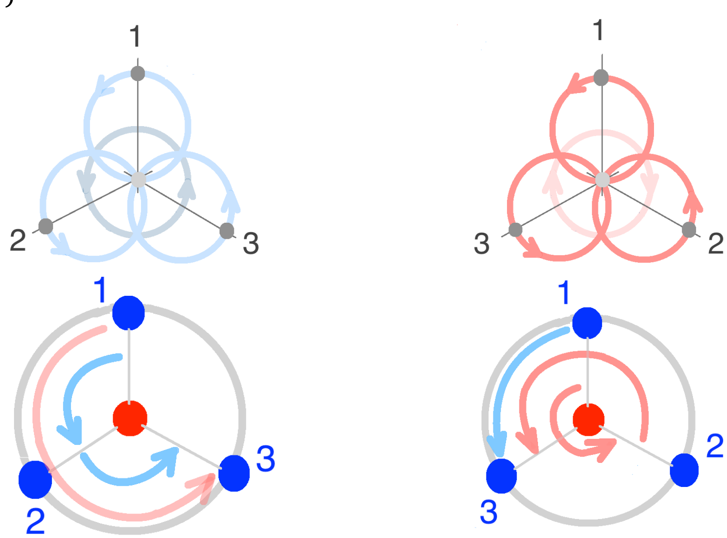


Figure. 62. Flattening the Projected Experience of the Observer (Proton, versus Neutron)

Note we model the position of the three dynamic perpendiculars generated from the emergence of 3D+T Spacetime, driven by the emergence of the electron. As we are below Planck scale, we cannot specifically measure position; we rather can measure three possible relationships given our model of unidirectional, accelerating spacetime:

$$Q_R = \{1 \to 2, 1 \to 3, 2 \to 3\} \tag{50}$$

In which we call Q_R our potential Quark Relationships. In row 2, let us now plot these relationships on a single Planck. We can see from the perspective of our dynamic frame, the rotation of dynamic perpendicular from 1 to 2, and from 2 to 3, represent small (let us call them "convergent") rotations, while the rotation from 1 to 3 is further ("divergent"). Conversely, when our frame point looks backwards, we see two divergent rotations, and only one convergent rotation. If we were to return to our modified hyperbolic frame, in which our neutron is "behind", the proton "ahead", a quick examination would show we could translate our perspective of the proton's communication (towards, towards, away) as distinct from the neutron's communication (away, away, towards). A relationship between quark states and particle identity analogous with quantum theory becomes apparent:

$$\begin{array}{l} Proton \to \{convergent, convergent, divergent\} \sim \{towards, towards, away\} \sim \{up, up, down\} \\ Neutron \to \{divergent, divergent, convergent\} \sim \{away, away, towards\} \sim \{down, down, up\} \end{array} \tag{51}$$

This simple illustration is more a visual poem than a proof, but does allow us to make an assertion that can be explored in future research:

> **Assertion 42:** Quarks, and Strong interactions, are sub-Planck manifestations of the generation of observed Spacetime dimensionality.

A quark, in our model, cannot be separated from a neighbouring quark not because of a specific property of a gluon, but rather for the same reason that "up" cannot be separate from "left" or "forward". Quarks are expressions of emergent Euclidean space, experienced on a sub-Planck level. If we wish to further make comparisons with our 3D frame of reference, we could state that in our standard Euclidean dimensionality, when we move in a certain direction, we move away from two other dimensions (i.e. we move in what we perceive as a "straight line" in 3D space, over time). In the peculiar (to us) dimensionality of the frame as it visualizes the proton, two dimensions progress "towards" the frame, and only one "away". When a neutron expands to an object of length $2h$, a 3D perception of space emerges relativistically, visualized as a beta decay, with two dimensions of space perpetually spinning away from the observer point in the 3D+T translation of Spacetime generated to describe the experience.

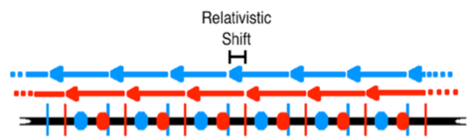
5.4. The Point of the Matter

We close this section by noting that, for the observers we have defined, ***there is only 1 point P traversing Spacetime along a single dimension***. A reader can readily question – "where do all these spins come from – what is driving the observed energy states in this model?" To address this question, consider Figures 58-62 are static representations of a dynamic process. Spacetime generates a rendering of 3D+T space and time for an observer analogous to an artist that generates a coherent sketch without lifting a pen. In brief, in this paper we attempt to describe properties of our experience of Spacetime with a model that represents a more parsimonious underlying reality, which we claim is best understood as a continuous 1D expansion of energy observed under the condition of the existence of a minimum observation distance h and a defined speed of communication c. Different perspectives are generated by objects that are "out of phase". All Spacetime objects observe dimensions, and forces of nature, but to maintain a 1D trajectory all observation must "return (or rotate) back to the origin" to maintain object permanence. Our model chops Spacetime into moments, but ***the movement of an observer is continuous***. Until a given wave-function for the entire system (the Universe) concludes, observers exist in a continual state of "becoming". P^- never "arrives at" P^+. O_p observes P in a persistent process of arriving (Table 5). In other words, while a large-scale energy process (e.g. a "Universe") is expanding, the smallest possible observers never experiences a full trajectory from a past to a future. The observer is liminal, perpetually in the process of looking back at "where it has been", and forward to "where it is going".

Table. 5. Model and Reality

Point Trajectory Model	1D Spacetime
$\boldsymbol{P^-}$ traverses or "jumps through" $\boldsymbol{O_p}$ and "arrives at" point $\boldsymbol{P^+}$	$\boldsymbol{O_p}$ observes the dynamic act of $\boldsymbol{P^-}$ progressing through continuous Spacetime to $\boldsymbol{P^+}$

Our model conveniently frames Spacetime as a dynamically generated set of 3D+T locations with embedded energy. We model discrete "jump-steps" of length h, implying defined borders. However, we present this model as a convenient way to frame observations and experience of a continuous underlying 1D energy expansion from a point. O_p, the observer perspective, continuously and dynamically generates observed 3D+T Spacetime as a computation or communication of this dynamic 1-D energy expansion as P progresses through Spacetime. P^- never "arrives at" P^+. Existence is the act of observation of P^- ***in the process of arriving***. Each Spacetime object accordingly represents the sum of all observations and experiences, from the beginning of the Universe to its current location. The existence of h, a minimum observation distance, admits relativity.



6. Examining Hypotheses

This paper started from what could have been considered the naïve perspective 8 years ago, spurred by conversations with my good friend Murat Tanik, that Planck-scale objects, based on visualizations of Communication Dynamics Theory, could lead to a better understanding of atomic structure and fundamental constants of nature. In Section 2, we presented the 3 principle hypotheses that emerged over time:

Hypothesis 1: Communications, can mathematically represent bosons.

Hypothesis 2: Accelerated Moments, can mathematically represent fermions.

Hypothesis 3: Stationary Observers located at average moment computational positions, can account for properties of fermions, including spin, apparent perspectives of motion and rotation, and relativistic effects that differentiate leptons from hadrons.

We believe that this work does provide initial evidence that a hyperbolic, relativistic translation of Communication Dynamics Theory provides an intuitively useful approach to understanding space, time, matter, and fundamental forces of nature as a natural consequence expanding Spacetime. Further evidence will be needed to fully evaluate the usefulness of our theoretical construct, but the findings in this paper suggest the possibility that a proton, neutron, and electron are the same Spacetime Object, seen from different observer perspectives. The same model provides evidence that quarks and strong interactions might be modelled as sub-Planck manifestation of the dynamic emergence of the dimensionality of our experience of Spacetime. In this context the weak force is a manifestation of energy, in locales where energy is spread over large trajectory-spaces, to manifest location in 3 dimensions of space and time. The emergence of the fine structure constant is intimately connected with the emergence of this observed 3D+T space, as a Neutron decays to a Spacetime Object capable of observing a more complex Spacetime location.

We cannot replicate the precision of Quantum Physics in a single work. For example, we have proposed a 6 (or more)-parameter model (a point progressing and rotating through hyperbolic space). Slight discrepancies between our estimates of $e, \alpha,$ and π could benefit from adding additional parameters (or emergent dimensionality). However, we predict that our general approach, based on communication theory, will be robust enough to both incorporate the observations of Quantum Physics, and provide more precise estimates of the characteristics of matter and energy by integrating special and general relativity into a unified theory of matter and energy.

7. Conclusion

Quantum Theory, embodied most directly by the Standard Model, underpins many of the most dramatic scientific and technical advances of the 20th Century. For over 90 years, experimenters have meticulously tested the theory without calling its foundations into question. A longstanding, fundamental problem however has long been recognized to exist: the current Standard Model of Physics and General Relativity are incompatible. A philosophical debate exists at the centre of this incompatibility. Physics, in the early 20th century divided into two general camps (Table 6) – the realists, and the anti-realists (Smolin, 2019).

Table. 6. The Realists and the Anti-Realists

Anti-Realist Perspective	The Realist Perspective
• The observer is the fundamental arbiter of natural phenomena • Observers create the Universe they inhabit • Each observer inhabits their own Universe • The future state of any given physical system is not predictable	• The Universe exists independent of our minds • This Universe can be described by deterministic laws • In principle, with enough information, the future state of a given physical system can be predicted

Quantum physics, and the Standard Model of Physics, is largely based in the anti-realistic perspective. Sir Frances Bacon, so eloquently referenced by Steven Weinberg in the forward to this issue, believed that the way to learn nature is through patient observation. After data is amassed, the nature of reality becomes apparent (Logicus, 1889). Quantum Physics is very much in the tradition of Bacon. Based purely on the power of observation, an a-priori assumption of the existence of Space and Time, an ill-defined "particle-wave duality", and quantum coin tosses, the Standard Model offers a dizzying array of particles and interactions (Quig, 2005; also see Wolchover 2020). Particles (Fermions) act via a series of force carriers (Bosons). Fermions come in two "flavors", Quarks and Leptons. Gauge Bosons (Photon, Gluon, W, Z) are linked in some fashion to a so called "God Particle", the Higgs Boson. Quarks have unexplainable rules; solitary quarks are never seen and have partial charges. Quarks have "handedness" and come in 3 colors (Red/Green/Blue). Left-handed Up/Down Quarks interact via the Weak and Strong Bosons, but Right-handed Up/Down Quarks do not interact via Weak or Strong Bosons – except that any Quark can be bound in a 3-part grouping by Gluons (the mediator of the Strong Force). Conversely, Leptons have no structure or color – and for unexplainable reasons, a neutrino is close to massless. Further, for unexplainable reasons, right-handed neutrinos have never been detected. For unexplained and unexplainable reasons, 3 versions of each particle exist that are identical in all properties except for one – mass. A series of unexplained constants permeate the theory. The Standard Model is a triumph of human ingenuity based on a simple premise. Put simply, theory rejects any underlying unseen or unseeable structure to the Universe. Rather, the model rests on a single column of inquiry – experimental observation. An unobserved theoretical underpinning is neither necessary, nor desirable.

Einstein was a founder of the field of study that became Quantum Physics, but in the end he found the anti-realist perspective un-satisfying, famously stating "God does not play dice with the Universe", prompting Bohr to retort "Einstein, stop telling God what to do" (Bohr 1917). Einstein in later writings hedges "God tirelessly plays dice under laws which he has himself prescribed" (Einstein 1945). Neverthless, Lee Smolin, a modern day gladiator for the Realist perspective, identifies Einstein, de Broglie, and Schrödinger as realists, individuals who believed, for example, that "an electron was real and somehow existed as both a wave and a particle", compared to Bohr and Heisenberg, "enthusiastic anti-realists, who believed we have no access to reality, only to tables of numbers which represent the interactions with the atom, but not the atom directly" (Smolin, 2019).

We identify our theory as falling within the Realist camp, but with a twist. In Communication Dynamics, the Universe knows very well its processes and destinations. It is observation, not the Universe, which is quantized. Advances in human understanding typically occur when we remove ourselves from a privileged position. When Copernicus placed the sun at the centre of the cosmos (Copernicus, 1543), he upended established scientific thought, leading to an advance in understanding of the position of human observers in a larger cosmos. We propose that the Universe exists and generates observers in accordance with a principle of minimum observable distance. Each observer generates their own (quantized) version of reality from a deeper un-observed whole. Because observers communicate at a universal speed in quantized observational increments, for observers constructed from matter the quantum illusion is complete. Like the inhabitants of Plato's cave (Plato, 514b-518a, about 380 BCE), observers are chained to the Universe they inhabit. There is no observer outside the model; all observers exist within the model and communicate with each other using a universal frame of reference to define location and observation.

Lee Smolin defined 5 principles that would inform a model "replacing" Quantum Physics (Table 7, from Smolin 2019). We agree with Einstein, and with Smolin, that Quantum Theory is incomplete. We believe the Communication Dynamics approach agrees with and can in time incorporate and extend the observational power of Quantum Theory. As the theory is based on underlying first principles, we propose as a testable hypothesis that Communication Dynamics can structure and predict "unseen" (unobserved) causes and better approximate what appear, now, to be random, or "Quantum" outcomes. In this sense, we propose a theory not to replace Quantum Theory, but incorporate its strengths, and improve the precision of its predictions.

Table. 7. Principles of a Grand Unified Theory (Lee Smolin)

Principle		Quantum Theory	Communication Dynamics
1	Background Independence: The theory should depend on structures which evolve dynamically, and do not require any outside matrix.	Does Not Satisfy. Objects are assumed to travel through space and time.	Satisfies. All objects are generated from one matrix.
2	Space and Time are Relational: Specific objects occupy specific spaces at specific times. Space and time location are always relational for all objects.	Does Not Satisfy. Objects can exist in "superposition", occupying multiple Spacetime Locations at once.	Satisfies. Observations/experiences derive from dynamically generated observers interpreting the expansion of a single point of momentum expanding as energy.
3	Causal Completeness: All events have a discernable cause that is derived from within the system. No cause from "outside the system" is needed.	Does not satisfy. Occurrences can be random and unpredictable. Effect does not necessarily follow cause.	Satisfies. Seemingly "random" occurrences are the effect of quantized observation.
4	Reciprocity: If an object A acts on B, then B must also act on A.	May satisfy (unclear)	Satisfies. All objects communicate relativistically at a Universal speed "c"
5	Identity of Indiscernibles: Any two objects that have precisely the same properties are in fact the same object.	Does not satisfy. Two distinct protons are assumed to be identical objects.	Satisfies. Not two objects are the same. Two "distinct protons" differ by location and Universal expansion constraints. All matter is in a state of decay.

In summary, we propose a theoretical model, consistent with Special and General relativity, which generates observers at small scale that we interpret as protons, neutrons, and electrons. The theory claims that the Universe, to observers, appears at small scales to be random and arbitrary because observers are not separate from the Universe, but constructed from it, and subject to rules of observation that prevent the observation of relativistic, cause-effect relationships generated below a minimum observable distance. We openly challenge the notion proposed by Quantum Physics of a random Universe. We claim that effects do not occur without cause, but rather state that quantized observers cannot see the cause of all effects. We propose that all observation, including Space, Time, and all fundamental forces of nature, can be linked by a general, (at least) 6-parameter geometrically accessible and calculable dynamic matrix that generates our 3D+T frame of reference and related perception of fundamental forces of nature. Consequently, we propose that currently unexplained particles, interactions, forces, and constants can be modelled, based on known geometric principles, as extensions of a 1D expansion of energy (Spacetime). By removing the primal position of the observer from physics, our theory is causally complete, and fulfils Smolin's criteria for a model that can both incorporate, and augment Quantum Theory, explaining currently unexplainable constants. We hope our approach can, over time, provide more precise estimates of unseen causal relationships and provide more robust predictions of "Quantum" outcomes.

References

Abbott, E (1884), *Flatland: A Romance of Many Dimensions*. New York: Dover Publications, 19531952.

Bohr N (1917), at 5th Solvay Conference, October 25-29, 1917. Both Einstein and Bohr were at this conference. At this time, the Copenhagen Interpretation of Quantum Mechanics was increasingly becoming dominant. Einstein's position already was becoming isolated. His lack of acceptance of the growing consensus was increasingly considered stubborn, archaic, and rigid.

Copernicus N, (1543). *De revolutionibus orbium coelestium* (On the Revolution of Heavenly Spheres).

Einstein, A (1905a). "Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt" [On a Heuristic Point of View about the Creation and Conversion of Light]. *Annalen der Physik.* 17 (6): 132–148. Bibcode:1905AnP...322..132E. doi:10.1002/andp.19053220607. English translation: http://users.physik.fu-berlin.de/~kleinert/files/eins_lq.pdf

Einstein, A (1905b). "Über die von der molekularkinetischen Theorie der Wärme geforderte Bewegung von in ruhenden Flüssigkeiten suspendierten Teilchen" [Investigations on the theory of Brownian Movement]. *Annalen der Physik* (in German). 322 (8): 549-560. Bibcode: 1905AnP...322..549E. doi:10.1002/andp.19053220806. English translation can be found at: http://users.physik.fu-berlin.de/~kleinert/files/eins_brownian.pdf

Einstein, A (1905c). "Zur Elektrodynamik bewegter Körper" [On the Electrodynamics of Moving Bodies]. *Annalen der Physik* (in German). 17 (10): 891–921. Bibcode: 1905AnP...322..891E. doi:10.1002/andp.19053221004. English translation can be found at: https://www.fourmilab.ch/etexts/einstein/specrel/www/

Einstein, A (1905d). "Ist die Trägheit eines Körpers von seinem Energieinhalt abhängig?" [Does the Inertia of a Body Depend Upon Its Energy Content?]. *Annalen der Physik* (in German). 18 (13): 639–641. Bibcode: 1905AnP...323..639E. doi:10.1002/andp.19053231314. English translation can be found at: https://www.fourmilab.ch/etexts/einstein/E_mc2/www/

Einstein, A (1915a). "Zur Allgemeinen Relativitätstheorie". Sitzungsber.Preuss.Akad.Wiss.Berlin (Math.Phys.) 778-786. English translation: "On the General Theory of Relativity". Presented to the *Prussian Academy of Science*, November 11, 1915. https://einsteinpapers.press.princeton.edu/vol6-trans/110.

Einstein, A (1915b). "Zur Allgemeinen Relativitätstheorie". Sitzungsber.Preuss.Akad.Wiss.Berlin (Math.Phys.) 799-801. English translation: "On the General Theory of Relativity (Addendum)". Presented to the *Prussian Academy of Science*, November 11, 1915. https://einsteinpapers.press.princeton.edu/vol6-trans/120

Einstein, A (1915c). "Erklärung der Perihelbewegung des Merkur aus der allgemeinen Relativitätstheorie". Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften (Berlin), Seite 831-839. English translation: "Explanation of the Perihelion Motion of Mercury from the General Theory of Relativity" Presented to the *Prussian Academy of Science*, November 18, 1915. https://einsteinpapers.press.princeton.edu/vol6-trans/124.

Einstein, A (1915d). "Die Feldgleichungen der Gravitation". Akademie der Wissenschaften, Sitzungsberichte, 1915 (part 2), 844–847. English translation "The Field Equations of Gravitation." Presented to the *Prussian Academy of Science*, November 25, 1915. https://einsteinpapers.press.princeton.edu/vol6-trans/129

Einstein A, Letter to Paul Epstein, 1945.

Heisenberg W (1925), "Über quantentheoretische Umdeutung kinematischer und mechanischer Beziehungen", Z. Phys. 33, 879-893, see also IJR Aitchison, DA MacManus, TM Snyder. Understanding Heisenberg's 'Magical' Paper of July 1925: a New Look at the Calculational Details, arXiv:quant-ph/0404009. English translation of Heisenberg's paper is paper 12 in J. Hendry, *The Creation of Quantum Mechanics and the Bohr-Pauli Dialogue* (Dordrecht, D. Reidel, 1984).

Logicus (1889). The Baconian Method in Science. *Science*. ns-13 (314).

Minkowski H (1908), Die Grundgleichungen für die elektromagnetischen Vorgänge in bewegten Körpern, Nachrichten der K. Gesellschaft der Wissenschaften zu Göttingen. Mathematisch-physikalische Klasse (1908) S. 53-111; reprinted in H. Minkowski, Zwei Abhandlungen über die Grundgleichungen der Elektrodynamik, mit einem Einführungswort von Otto Blumenthal (Teubner, Leipzig 1910) S. 5-57, and in Gesammelte Abhandlungen von Hermann Minkowski, ed. by D. Hilbert, 2 vols. (Teubner, Leipzig 1911), vol. 2, pp. 352-404. English translation "*The Fundamental Equations for Electromagnetic Processes in Moving Bodies*", in https://www.minkowskiinstitute.org/mip/MinkowskiFreemiumMIP2012.pdf (Chapter 4).

Minkowski H (1909), Raum und Zeit, Physikalische Zeitschrift 10 (1909) S. 104-111; Jahresbericht der Deutschen Mathematiker-Vereinigung 18 (1909) S. 75-88; reprinted in Gesammelte Abhandlungen von Hermann Minkowski, ed. by D. Hilbert, 2 vols. (Teubner, Leipzig 1911), vol. 2, pp. 431-444, and in H.A. Lorentz, A. Einstein, H. Minkowski, Das Rela- tivitätsprinzip (Teubner, Leipzig 1913) S. 56-68. This lecture also appeared as a separate publication (booklet): H. Minkowski, Raum und Zeit (Teubner, Leipzig 1909). English translation "*Space and Time*", in https://www.minkowskiinstitute.org/mip/MinkowskiFreemiumMIP2012.pdf (Chapter 2).

Minkowski, H (1915), *Das Relativitätsprinzip, Annalen der Physik* 47, S. 927-938. English translation "The Relativity Principle", in https://www.minkowskiinstitute.org/mip/MinkowskiFreemiumMIP2012.pdf (Chapter 3).

Pan, L; Skidmore, F; Güldal, S; Tanik, M (2022). The theory of communication dynamics application to modelling the valence shell orbitals of periodic table elements. *Journal of Integrated Design and Process Science*. 1-10. 10.3233/JID-221013.

Planck, M (1900), Zur Theorie des Gesetzes der Energieverteilung im Normalspektrum. Verhandlungen der Deutschen Physikalischen Gesellschaft, 2, 237. English translation: On the Theory of the Energy Distribution Law of the Normal Spectrum, from "*The Old Quantum Theory*," ed. by D. ter Haar, Pergamon Press, 1967, p. 82.

Plato (514b-518a, about 380 BCE), Republic. English translation at Shawn Eyer. 2009. "Translation from Plato's Republic 514b–518d ("Allegory of the Cave")." *Ahiman: A Review of Masonic Culture and Tradition*, 1, Pp. 73-78. https://scholar.harvard.edu/seyer/plato-allegory-of-the-cave. Also see Huard, RL. Plato's Political Philosophy: The Cave. New York: Algora, 2007.

Poincaré, H (1895) "Analysis situs". Journal de l'École Polytechnique. (2). **1**: 1–123. English translation of this work, and 5 additional supplements published 1895-1904, can be found at https://www.maths.ed.ac.uk/~v1ranick/papers/Poincaré2009.pdf. Helpful review – Anderson, J. W. "*The Poincaré Disc Model*." Section 4.1 in Hyperbolic Geometry. New York: Springer-Verlag, pp. 95-104, 1999.

Quigg C (2005). The Double Simplex. A New Way to Envision Particles and Interactions. *FERMILAB-CONF-05/371-T***.** arXiv:hep-ph/0509037

Schrödinger, E (1926) An Undulatory Theory of the Mechanics of Atoms and Molecules. *Physical Review*, 28, 1049-1070. https://doi.org/10.1103/PhysRev.28.1049

Smolin L. (2019). *Einstein's Unfinished Revolution: The Search for What Lies Beyond the Quantum*. Penguin Press. ISBN 978-1594206191.

Wolchover N, Velasco S, Reading-Ikkanda L (2020). A New Map of All the Particles and Forces. *Quanta Magazine*.

Suggested Reading

We primarily base our approach to physics from a re-imagining of Einstein's theoretical approach to physics, applied to Communication Dynamics Theory. Works by Lee Smolin, Douglas Stone, and Lee Wilczek approach many of the same topics, and while non-technical, can ground readers in some of the problems facing the field of Quantum Physics that Communication Dynamics Theory attempts to address.

Lee Smolin. (2019). *Einstein's Unfinished Revolution: The Search for What Lies Beyond the Quantum.* Penguin Press. ISBN 9781594206191.

A. Douglas Stone (2013). *Einstein and the Quantum: The Quest of the Valiant Swabian*. Princeton University Press. ISBN 9780691168562.

Frank Wilczek (2021). *Fundamentals: ten keys to reality.* Penguin Press. ISBN 9780735223899.

Author Biographies

Frank M. Skidmore (M.D., Founder, Vice President for Research and Development, Analytical AI, Inc) Dr. Skidmore is a board-certified neurologist who maintains an active neurology practice. As a neurologist, his research has been focused on statistical analysis of brain imaging, focused on using artificial intelligence (AI) as a diagnostic tool for Parkinson's disease, stroke, and other medical conditions. He mentored multiple PhD students, including two who later joined Analytical AI, a company he founded 2018 to develop practical AI applications and where he currently serves as Vice President for Research and Development. Dr. Skidmore developed effective methods for assessing the capability of 3D and higher dimensional imaging data to help diagnose certain neurological conditions, and developed robust statistical methods to understand signal, noise, and statistical power in imaging data. Dr. Skidmore's academic funding included KL-2 and K-23 awards from the National Institutes of Health, innovation awards from the Michael J. Fox Foundation, and computational grants from Oak Ridge National Laboratories. More recent funding has come from the Transportation and Security Agency, Sandia National Laboratories, and the Department of Homeland Security, and the Department of the Airforce. He has published over 70 journal papers, conference papers, review articles, and book chapters and has authored several patents. Dr. Skidmore has maintained a decade-long research collaboration with Dr. Murat Tanik.

Murat M. Tanik (PhD, Professor of Engineering, University of Alabama at Birmingham) Professor Murat Tanik is the Wallace R. Bunn Chair of Telecommunications at the Department of Electrical and Computer Engineering at the University of Alabama at Birmingham (UAB), and, until recently, served as the Department Chair. In 1978, Dr. Tanik received his Ph.D. degree in Computer Science from Texas A&M University. Before joining UAB in 1998, he had previously taught at Southern Methodist University (SMU), New Jersey Institute of Technology (NJIT), University of Texas at Dallas (UTD) and the University of Texas at Austin (UTAustin). He is co-founder of the Society for Design and Process Science (SDPS), an interdisciplinary society. Dr. Tanik has lectured all over the world as an invited speaker and served as Chief Scientist for two different high technology companies. His industry experience is extensive including Collins Radio, ISSI, and more. He has co-authored six books, co-edited eight collected works, and more than 180 journal papers, conference papers, book chapters, and reports funded by various government agencies and corporations. Under his direction, more than 25 Ph.D. dissertations and 20 M.S. theses have been completed. Beginning in the early 2000's, Dr. Tanik increasingly devoted his research time to the development of a communication-theory based approach to computing which led Communication Dynamics Theory.