The Theory of Isomorphic Physics

Part 1: Realigning Relativity and Classical Physics with Quantum Mechanics

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This theory will define an infinite set of states, and posit that a subset is capable of mapping to the universe one to one and onto. For this reason it is the most thoroughly and rigorously testable theory ever devised, limited only by out ability to calibrate it and compute it. This theory will be able to hone down the set via wave equations (or state equations, more generally), but will ultimately leave this as a prediction needing not only physical but also computational testing.

This theory proposes a groundbreaking framework with the potential to predict physical phenomena with unprecedented accuracy, limited only by computational resources. The theory introduces a robust set of equations that, once properly calibrated, could yield predictions for everything from dark matter and dark energy to resolving the vacuum energy catastrophe. The challenge lies in identifying the correctly calibrated subset of these equations—a task demanding significant computational innovation and theoretical insight.

This series of papers will embark on a transformative journey in theoretical physics. The first paper will critically examine and strip away what we perceive as unnecessary assumptions of classical physics. By removing these constraints, we aim to reveal new relationships and principles that align more closely with relativity and quantum mechanics, without the confines of classical interpretations.

The subsequent two papers will focus on defining and detailing a novel equation for a new state that supersedes the traditional roles of wavefunctions and scalar functions in quantum physics. We will explore how these new state equations integrate and interact within a structured matrix group, setting the stage for dynamic models reminiscent of atomic systems.

In the fifth paper, we will introduce the wave equations that directly map to foundational physical concepts such as Minkowski spacetime, the energy-momentum relationship, and the Hamiltonian. This paper will lay out the mathematical derivations and the theoretical underpinnings that connect these new equations to established physical laws.

The concluding papers will delve into the physical ramifications and empirical predictions of the theory. Here, we will discuss how this theory not only fits within the current experimental data but also makes novel predictions that could be tested with future experiments. These discussions will include potential technological impacts, implications for cosmology and particle physics, and a thorough consideration of criticisms and alternative perspectives from the theoretical physics community.

By systematically developing and substantiating this theory through a series of methodically structured papers, we aim to provide a robust theoretical framework capable of redefining our understanding of the universe. Each step in this series is designed to build upon the last, culminating in a comprehensive and empirically testable theory presented for rigorous peer review and potential publication in top-tier journals.

1 Metaphysics

One of the central philosophical ideas of this theory is that the universe came from nothing. In the context of a theory where mathematics are isomorphic to physical reality, this means that these mathematics equate to zero, represented by the "zero equations." These zero equations are Minkowski spacetime (MST) and the energy-momentum relationship, both of which can be equated to zero by subtracting time or energy. This foundational concept underpins the entire framework of the theory. It also leads into the idea that the universe can be expressed or be isomorphic to a set of scalars.

This paper introduces a novel approach to the fundamental structure of quantum mechanics and relativity. At its core, the theory redefines the state by inherently incorporating spacetime curvature, providing a more natural framework for describing quantum spin and the masses of particles in the standard model. This new state is represented within uniquely defined 4x4 quaternion-valued matrices, forming a group that gives rise to an algebra capable of describing both individual particles and composite systems, such as atoms.

Grounded in fundamental wave equations derived from Minkowski spacetime, the energy-momentum relationship, and aspects of the Schrödinger equation, the framework simplifies many of the classical constructs of physics, offering a more unified understanding of the universe. By grounding this theory in multiple foundational equations—Minkowski spacetime, the energy-momentum relationship, and the Schrödinger equation—we propose a framework that increases descriptive power at the foundational level. Consequently, many classical constructs and aspects of physics are rendered unnecessary, allowing for a more streamlined and unified understanding of the universe's fundamental workings.

In this theory, classical concepts like mass, length, and time, traditionally expressed in dimensional units, are replaced by pure scalar magnitudes that connect directly to the state. The use of quaternion-valued 4x4 matrices, which represent states and eigenfunctions with curvature and intrinsic quantum spins, enables novel dynamic descriptions that are well-suited for quantum physics.

By emphasizing state dynamics, the theory eliminates the need for classical constructs, advocating for a novel approach centered on states, probability distributions, and the mathematical principles of relativity. By adopting this new mathematical foundation, the theory aims to transcend the limitations inherent in classical approaches, which often relied on the assumptions of dimensional analysis, which I argue to be ultimately incompatible with the more streamlined version of relativity implemented in these papers. Instead, we emphasize the essential nature of the scalar magnitudes of physical quantities, stripping away unnecessary classical constructs to distill physics into its purest mathematical form. This approach unifies relativity, quantum mechanics, and states under a single, streamlined framework.

2 Reconsidering Units and Dimensional Analysis

Classical physics relies heavily on units and dimensional analysis, where quantities like energy, momentum, mass, and time are constrained by physical dimensions (e.g., mass (m), length (L), or time (T)). This theory challenges that reliance, instead proposing that the universe's true building blocks are states, along with their resulting probability distributions, eigenfunctions, and associated eigenvalues.

The limitations of dimensional analysis became evident when Minkowski introduced the idea of spacetime as a unified four-dimensional continuum, blending space and time into a single framework. This theory extends that concept further by centering everything on states, where space, time, and mass are fundamentally interconnected components governed by the same dynamics.

By rejecting the constraints of classical units and focusing on the scalar properties inherent to states, this theory provides a clearer, more unified view of the universe. The magnitudes that arise from states—such as energy, momentum, and mass—are the measurable quantities that ultimately lead to our physical measurements using scales, rulers, and clocks, all with the same magnitudes but without the need for units.

This scalar-based framework offers a more coherent way to describe physical reality, where the behavior of states dictates the evolution of the universe, free from the complications that arise from dimensional analysis. Notably, within the state, terms like ωt and kx are already scalar-valued, suggesting that each component can be understood without reference to physical units, supporting the overall argument for a unitless framework.

3 Energy, Momentum, and Mass as Rates

In this section, we explore the rates of change through different components of the state, focusing on spatial dimensions, time, and an additional scalar dimension denoted as S. This scalar component S appears in the equation for Minkowski Spacetime (MST) and is treated, in this theory, as an eigenvalue of a scalar function that affects the position in MST without directly altering wave propagation in the usual spatial dimensions. By incorporating S, the theory reconciles discrepancies between traditional wave mechanics and the behavior of massive particles.

In this framework, the rate of change of the state with respect to time (t) is proportional to energy (E), while the rates of change with respect to spatial dimensions (x, y, z) correspond to momentum components. Extending this concept, the rate of change of the scalar component S is proportional to mass (m). The inclusion of S allows for an extended interpretation of mass, incorporating it as an active parameter that affects the system's configuration in MST.

Unlike energy and momentum, which directly influence state dynamics, the scalar nature of m and S ensures that they affect the overall configuration of the system without altering its oscillatory dynamics. This scalar property enables mass to shift the balance between time and space without disrupting the fundamental oscillations of the state.

The framework aligns with the familiar energy-momentum relation:

$$-E^2 + p^2 + m^2 = 0$$

Correspondingly, the MST relation is expressed as:

$$-t^2 + x^2 + y^2 + z^2 + S^2 = 0$$

where ω, k_x, k_y, k_z, and m ensure that the eigenvalues sum to zero. This equation is isomorphic to the energy-momentum relation, indicating an intrinsic compatibility between the two forms.

The association of mass with the rate of change through the scalar component S is rooted in the concept of balancing "rise" (through time) and "run" (through space). For instance, a particle moving at the speed of light has zero mass and does not move through S. In such a scenario, the particle maximizes its rise versus run ratio, emphasizing pure spatial motion. Conversely, a particle with no momentum but with mass has all rise (motion through time) and no run (motion through space). The scalar S allows for combinations between these two extremes, with mass emphasizing rise while momentum emphasizes run. By definition, S influences the ratio of rise to run, with mass m acting as the rate through S.

The presence of S as an independent scalar dimension enhances the ability of this theory to align seamlessly with the energy-momentum relationship and MST. In traditional quantum mechanics, mass is treated primarily as a parameter affecting the curvature of the state, without explicit consideration of a scalar dimension like S. In contrast, this theory posits that S actively affects the system's configuration within MST without directly modifying wave propagation in the usual spatial dimensions.

Velocity in this framework is defined as:

$$v = \frac{p}{E}$$

which represents the rate of spatial propagation relative to the system's total energy. However, the inclusion of the scalar dimension S makes this relationship more nuanced. While S does not directly contribute to wave propagation along x, y, z, it plays a role in defining the mass, which influences the curvature of spacetime and thereby affects how energy and momentum interact.

This additional scalar degree of freedom offers a richer structure for understanding how mass influences the evolution of wave packets. Rather than being a passive parameter, mass, through S, actively contributes to the geometric configuration of MST, shaping how wave packets evolve without altering their inherent oscillatory characteristics.

Mapping this theory to the standard quantum mechanical framework involves understanding the role of S as a hidden dimension that affects mass indirectly, without being part of the conventional wave equation. In standard quantum mechanics, the state evolves according to:

$$i\hbar \frac{\partial \psi}{\partial t} = \hat{H}\psi$$

where $\hat{H}$ is the Hamiltonian operator. In this framework, the Hamiltonian must also account for contributions from S, which influence the mass term but not the direct temporal evolution of ψ. This implies that, although the state's evolution in space and time remains consistent with the Schrödinger equation, the presence of S modifies the underlying structure of MST, adding an additional layer of complexity that indirectly influences the state's behavior through its relationship with mass.

In conclusion, the inclusion of the scalar dimension S provides an expanded understanding of mass as an active participant in the dynamics of MST, bridging gaps between traditional descriptions of states and their observed behavior in the presence of mass. This framework supports the natural compatibility of the energy-momentum relationship and MST while offering new insights into the interplay between mass, energy, and momentum.

4 Unified Inputs into the state: Space, Time, and Mass

In this theory, we unify space, time, and the scalar component S as inputs into the state through a single scalar input, denoted by ξ. The scalar input ξ encapsulates the fundamental relationship between space, time, and mass, providing a more comprehensive interpretation of states as fields over the entire spacetime continuum.

Throughout this paper, unless otherwise specified, x will be used to symbolically represent all three spatial dimensions (x, y, z). This simplification improves readability and conciseness since the discussion often applies symmetrically to all spatial dimensions.

A significant challenge in field-based interpretations is satisfying discrete relationships, such as the Minkowski spacetime interval (MST) and the energy-momentum relationship, in a continuous field. This theory addresses this challenge by employing the unified scalar input ξ, where:

$$\xi = t = x = y = z = S,$$

governing the state across all dimensions. The components of space, time, and mass are treated as scaled versions of the input ξ, expressed as follows:

$$E\xi = t',$$
$$p\xi = x',$$
$$m\xi = S',$$

where t', x', and S' represent the scaled versions of time, space, and the scalar mass component, determined by the particle's energy, momentum, and mass. By having $-E\xi$, $p\xi$, and $m\xi$ as inputs, we ensure that when E, p, and m satisfy the energy-momentum relationship, it is also naturally the case that t', x', and S' satisfy the MST equation.

To demonstrate how this scaling unifies the MST and the energy-momentum relationship, consider a geometric representation where time, space, and mass form a triangle:

$$-t' = -E\xi, \quad x' = p\xi, \quad S' = m\xi.$$

These scaled components form the basis of the MST:

$$-t'^2 + x'^2 + S'^2 = 0,$$

which can be understood as a Pythagorean-like relationship, with the components representing the legs of a triangle. Energy, momentum, and mass also satisfy a similar form:

$$-E^2 + p^2 + m^2 = 0,$$

indicating intrinsic compatibility between MST and the energy-momentum relationship. Scaling ξ effectively resizes the triangle but preserves the relationships between these components, allowing continuous fields to satisfy these critical physical equations.

In this representation, the total energy (E) is the hypotenuse of a right triangle, while momentum (p) and mass (m) represent the legs. Using the Pythagorean theorem, we express the relationship between these quantities as:

$$E^2 = p^2 + m^2.$$

The velocity of a particle can then be understood as the ratio of the momentum leg (p) to the hypotenuse (E):

$$v =$$

racpE,

capturing the contribution of spatial evolution (p) to the total rate of change (E). When $m = 0$, $E = p$, resulting in a velocity of $v = 1$, corresponding to the speed of light. When $m > 0$, E is greater than p, resulting in a velocity less than 1, consistent with the relativistic concept that massive particles cannot reach the speed of light.

The overall scale of the triangle determines the "resistance to change" property of the system. Larger triangles, with greater values of E, p, and m, represent systems with more energy and momentum, making them more influential in interactions, whereas smaller triangles represent systems with less energy and momentum.

Additionally, this framework introduces two perspectives on space, represented by x and x'. The input x represents the unscaled coordinate, while x' represents the momentum-modified view, where:

$$x' = p \cdot x,$$

scales the spatial coordinate by the particle's momentum. This scaling implies that x', from the particle's momentum perspective, appears larger than x, analogous to length contraction in relativity, where measurements of space change due to the observer's motion but the underlying reality remains unchanged.

The introduction of a shift parameter au_μ further localizes position eigenfunctions, shifting the starting point of each eigenfunction and enabling the localization of the state in both space and time. This shift allows us to reconcile continuous fields with point-particle localization, with the probability of collapsing to a particular point determined by the state's amplitude at the primed coordinates.

In summary, the unified scalar input ξ serves as a foundation for understanding the state as a field over all dimensions, integrating space, time, and mass. By treating these components as scaled versions of ξ, the theory aligns with the MST and energy-momentum relations, providing an elegant representation of how states evolve and interact across spacetime.

5 Three-Layer System for Space and Time Dilation/Contraction

In this section, we describe the three-layer system of contraction and dilation of space and time, focusing on the scaling by energy, momentum, and mass, the curvature inherent in the states themselves, and its connection to relativistic dynamics.

The first layer explains why different dimensions evolve at varying rates. The evolution of time and space is driven by the scaling effects of energy (E), momentum (p), and mass (m). This scaling determines how the inputs—time (t), space (x), and the scalar eigenvalue (S)—evolve according to these quantities. Specifically:

- **Time Scaling (by Energy):** The time coordinate is scaled by energy, leading to the transformation $t' = E\xi$, ensuring that when energy satisfies the energy-momentum relationship, the scaled time t' also satisfies the Minkowski spacetime interval (MST). - **Space Scaling (by Momentum):** The spatial dimension is scaled by momentum, with the transformation $x' = p\xi$. This ensures that when momentum is related through the energy-momentum relationship, the scaled spatial coordinate x' also satisfies the MST equation. - **Scalar Component Scaling (by Mass):** The scalar eigenvalue S is scaled by mass, with the transformation $S' = m\xi$. When mass $m = 0$, there is no motion through the scalar component S, resulting in a light-like interval.

The second layer introduces additional curvature inherent in the state itself, in particular, in a state that is an analog to the position eigenfunction. In this layer, the output is not simply a scaled version of the input; rather, it undergoes a further transformation that results in a slightly adjusted output due to the intrinsic curvature properties of the state. This will be detailed later but X' approximately equates to X", meaning this second layer of curavature, is small as it has to do with a macro perspective on quantum forces. This layer accounts for deviations from the expected magnitudes after the first scaling. We denote this transformation by adding a second prime to the output, such that:

- **Curvature Due to State Properties:** The transformation at this layer takes the form $x'' = \underline{\overline{\psi}}(x')$, where $\underline{\overline{\psi}}$ represents the curvature inherent in the state. This curvature affects the magnitudes and ensures that the state correctly reflects the physical curvature present in space and time.

The third layer represents the familiar relativistic effects described by the Lorentz transformation. This layer describes how time and space are contracted or dilated as seen by a moving observer, based on the velocities or rates from the first two layers. For example, when energy equals momentum ($E = p$), the mass term becomes zero, resulting in a light-like interval—mirroring the behavior of massless particles, such as photons, in relativity.

The Lorentz transformation introduces contraction or dilation as seen by a moving observer:

$$t''' = \gamma \left(t'' - \frac{vx''}{c^2} \right), \quad x''' = \gamma \left(x'' - vt'' \right),$$

where $\gamma = \frac{1}{\sqrt{1-\frac{v^2}{c^2}}}$ is the Lorentz factor, and v is the relative velocity between observers.

The three-layer system integrates quantum and relativistic perspectives:

- The **first layer** provides the initial scaling of dimensions by energy, momentum, and mass. - The **second layer** introduces the intrinsic curvature of the state, resulting in slight deviations from the initial scaling. - The **third layer** applies the relativistic contraction and dilation to these dimensions as seen by a moving observer.

$$x' = p\xi$$
$$S' = m\xi$$

These equations represent the rate of change in various quantities over the input parameter ξ, indicating how flat space-time coordinates (t, x, y, z, S) are transformed into curved counterparts. This transformation is consistent with both position states and energy-momentum states, providing a philosophically coherent way to move from uncurved to curved space-time.

Behavior of Position Magnitudes

The second sense of "curvature" is associated with the behavior of position magnitudes. Specifically, if the input of a position state is ξ, the magnitude of the output may differ from this input value due to the curvature introduced by $\underline{\overline{\psi}}$. This difference in magnitudes represents spatial or temporal distortions.

The magnitude of the output from $\underline{\overline{\psi}}$ takes into account both types of curvature: 1. **Scaling by E, p, and m**: The output is scaled by the appropriate values of energy, momentum, and mass, corresponding to the relevant space-time component. 2. **Intrinsic Curvature of Position States**: The curvature inherent in the nature of position states affects the magnitude, causing deviations from the expected input value.

- When the state is uncurved but possesses a position magnitude, the output matches the input exactly. This means the magnitudes of the uncurved state correspond directly to the values of the flat space-time coordinates Ξ. - When curvature is introduced through $\underline{\overline{\psi}}$, the magnitudes of the output adjust to reflect this curvature, meaning they may slightly deviate from the input values, representing the geometric effect of curvature on space and time.

To express this formally:

$$\underline{\overline{\psi}}(\Xi) = \Xi \quad \text{(if uncurved, where } \Xi \text{ is the input and the magnitude of the output)}$$

This relationship holds true as long as no curvature is present. When curvature is introduced, the transformation $\underline{\overline{\psi}}$ adjusts the magnitudes accordingly.

General Formulation of Ψ

To capture both flat and curved scenarios, we define Ψ as follows:

$$\Psi = \psi^\flat\Big|_{\Xi \to \underline{\overline{\psi}}}$$

In this expression:

- $\psi^\flat$ is the state defined in flat space-time.
- $\underline{\overline{\psi}}$ is the transformation that takes flat space-time inputs and outputs curved space-time, modifying the space-time structure as needed.

- Ξ represents the flat space-time coordinates (t, x, y, z, S).

This formulation ensures that the state retains correct magnitudes, even in the presence of curvature. The transformation $\overline{\underline{\psi}}$ governs the deviation of these magnitudes, effectively mapping the system's transition from flat to curved space-time.

6 Curvature and Force

$$-t'^2 + x'^2 + S'^2 = 0,$$

which can be understood as a Pythagorean-like relationship, with the components representing the legs of a triangle. Energy, momentum, and mass also satisfy a similar form:

$$-E^2 + p^2 + m^2 = 0,$$

The above equations describe both free particles and those under the influence of forces. This is because in this theory all forces are described as changes in the energy, momentum or mass that occur over space, time or space-time. As long as the change in E is countered by the changes in p and or m such that the zero equation is still satisfied, then this allows us to describe both free particles and particles involved in forces with the same equation.

If energy (E), momentum (p), and mass (m) (as well as time (t), space, and mass) form a right triangle, then curvature can be visualized as changes in the scales and/or the ratios of the sides over time. This introduces a way to conceptualize force as the evolution of these relationships.

As will be discussed in greater detail in subsequent papers, this curvature in space and time (and in energy, momentum, and mass as fields over space and time) can explain not only gravity but also all fundamental forces more generally. These curvatures occur naturally in the state, adhering to the wave equations outlined in the zero equations, and can be present even in the absence of explicit external forces. This implies that the geometry of space and time itself, represented by evolving relationships between energy, momentum, and mass, contributes to the manifestation of forces.

The Inputs as a Set

In this theory, functions are defined over the set $|P_\mu^\flat|$, which governs the position of a particle or system in flat spacetime. The set is expressed as:

$$|X_\mu'^{\,\flat}| = \left\{ |P_\mu^\flat| \, (\xi - \tau_\mu) \mid x_\mu^\flat \in [x_{\mu,\min}^\flat, x_{\mu,\max}^\flat] \right\}$$

In this formulation:

- τ is a **discrete-valued** parameter that is subtracted from each element of ξ. When τ is positive, it shifts the particle's location by increasing the magnitude of the negative elements and decreasing the magnitude of the positive elements in the set. This effectively repositions the **zero-point** of the position eigenfunction, representing the particle's location in flat spacetime.
- The particle's position is represented as the zero-point of the position eigenfunction, which permeates the universe as a field. The shift introduced by τ adjusts the location of this zero-point, shifting both the positive and negative elements of ξ, thereby moving the particle's location in the universe.
- The probability of collapsing to a particular value τ is determined by the state evaluated at a given ξ, with the probability distribution derived from the modulus squared of the state.

Role of ξ in Determining Space-Time Relationships

The parameter ξ plays a crucial role in defining how different points in time and space align, establishing a consistent basis for causal relationships in the quantum realm. This model suggests that wavefunctions expand over time, dictating the distance at which events can be causally related. For instance, a wavefunction associated with a light-like speed propagates at the speed of light, whereas a wavefunction with mass expands more slowly.

The equations involving ξ, such as:

$$\xi = x = y = z = S = t_x = t_y = t_z = t_S,$$

and the input definition:

$$|X'^{\flat}_{\mu}| = \left\{ \mathcal{U}^{\flat}_{\mu} \left(\xi - \tau_{\mu} \right) \mid x^{\flat}_{\mu} \in [x^{\flat}_{\mu,\min}, x^{\flat}_{\mu,\max}] \right\},$$

help explain the evolution of a wavefunction over time and space. The parameter $\mathcal{U}^{\flat}_{\mu}$ represents different components of momentum, mass, and energy for the corresponding space and time dimensions. This relationship ensures that the wavefunction remains consistent with the Minkowski spacetime interval (MST) and the energy-momentum relationship, providing a coherent picture of causality within the quantum framework.

Mapping to Physical Quantities

Each ξ (five-dimensional space) and $\mathcal{U}^{\flat}_{\mu}$ (five-momentum and energy components) maps to specific physical quantities, all defined in flat spacetime. These terms will later contrast with the general curved spacetime formulation.

In the Flat Spacetime Context:

- $x_0^\flat$ corresponds to $|t^\flat|$, the magnitude of time in flat spacetime, when no external forces or interactions are present.
- $x_1^\flat$, $x_2^\flat$, and $x_3^\flat$ represent the magnitudes of the spatial components $|x^\flat|$, $|y^\flat|$, and $|z^\flat|$, respectively, in flat spacetime.
- $x_4^\flat$ corresponds to $|S^\flat|$, a scalar related to the flat spacetime, representing an internal scalar without dimensional components.

In the Flat Energy-Momentum Context:

- $\mathcal{U}_0^\flat$ corresponds to the magnitude of energy $|E_t^\flat|$ for the time component t, in flat spacetime.
- $\mathcal{U}_1^\flat$, $\mathcal{U}_2^\flat$, and $\mathcal{U}_3^\flat$ represent the magnitudes of the momentum components $|p_x^\flat|$, $|p_y^\flat|$, and $|p_z^\flat|$, respectively, in flat spacetime.
- $\mathcal{U}_4^\flat$ corresponds to mass, $|m^\flat|$, in flat spacetime.
- $\mathcal{U}_5^\flat$, $\mathcal{U}_6^\flat$, and $\mathcal{U}_7^\flat$ represent the magnitudes of the energy components associated with spatial dimensions, such as $|E_x^\flat|$, $|E_y^\flat|$, and $|E_z^\flat|$.
- $\mathcal{U}_8^\flat$ represents the energy associated with the scalar component S, denoted $|E_S^\flat|$.

In both contexts, τ acts as the localized zero-point of collapse, allowing the position eigenfunction or energy/momentum eigenfunction to spread from this specific point, establishing the basis for causal relationships within the model.

-The radial nature of t can be thought of as analagous to how starlight collapses upon our perspective. -Spacetime and mass as "filler", taking up energy without contributiung to wave-dynamics. -Our perceptions are abstractions -If one of the major goals of quantum physics with general relativity, these state equations offer a clear path forward. -Particles are not fields over all space and time but radiate out as xi grows. -Need a proof that Planck's constant maps to QM's definition. -Need a proof that the Total state maps.