The Theory of IsomorPhic Physics

Part 2: Primitive states

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Scaled Input

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

$$X^\circ_\mu = \left\{ |P^\flat_\mu| \, (\xi - \tau_\mu) \mid X^\circ_\mu \in [x^\flat_{\mu,\min}, x^\flat_{\mu,\max}] \right\}$$

In this formulation:

- τ is a **discrete-valued 1** 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 v1lue τ is determined by the state evaluated at a given ξ, with the probability distribution derived from the modulus squared of the state.

Primitive Simple States

This theory proposes that states are the most fundamental constituents of the universe. Unlike standard definitions, it introduces **primitive simple states** (denoted by a prime, ψ') and **primitive position states** (denoted by an underline and a prime, $\underline{\psi}'$). These primitive states serve as foundational building blocks, more fundamental than particles, as they can be combined through multiplication and division to form **composite states**.

Primitive Simple States

The **primitive state** ψ' serves as the fundamental building block for constructing the more general composite simple state ψ (without a prime). Instead of a single scalar expression, the primitive simple state $\psi'(|\xi|)$ is composed of components corresponding to each index $\mu = 0, 1, 2, 3, 4$, defined as:

$$\psi'(X_\mu^\circ) = \left(\psi'_{\mu=0}, \psi'_{\mu=1}, \psi'_{\mu=2}, \psi'_{\mu=3}, \psi'_{\mu=4}\right)$$

where each component ψ'_μ is given by:

$$\psi'_\mu = \left(\zeta + \frac{\eta}{\lambda + X_\mu^\circ}\right)^{\theta(\lambda + X_\mu^\circ)}.$$

This notation highlights that the primitive state consists of five distinct components, each indexed by μ and governed by the parameters ζ, η, and θ.

Parameters Governing the Primitive State

The parameters ζ, η, and θ determine the properties of each component and take specific values (generally 1, -1, i, or $-i$) as described in Table 1. Unique combinations of these parameters give rise to distinct physical characteristics for each component. The parameterλ controls the curvature of the state across spacetime components and is defined by:

$$\lambda = \sigma \xi^\nu$$

where σ is the **curvature magnitude** parameter (or possibly variable). Larger values of σ correspond to lower curvature, while smaller values yield increased curvature. The parameter (or variable) ν dictates how the curvature scales with respect to the scaled input ξ, shaping the behavior of the state as a function of position.

Physical Interpretation of Primitive Simple States

Primitive simple states, defined by ψ' along with primitive position states form the basic building blocks of **composite states**. They are foundational entities within the theory, conceptually similar to elementary particles in the Standard Model, though a direct correspondence with known particles remains speculative. By varying ζ, η, and θ, primitive states can exhibit a broad range of behaviors that mimic characteristics of fundamental particles, including behavior that leads to quantum spin and space-time curvature.

The behavior of primitive states is closely related to the mathematical structure of e, as evidenced by their resemblance to the limit:

$$e = \lim_{n \to \infty} \left(1 + \frac{1}{n}\right)^n$$

Parameter Combinations and Physical Properties

There are 40 unique configurations of primitive states, each defined by distinct combinations of ζ, η, and θ. These combinations yield varied properties, such as intrinsic rotation rate, curvature type, magnitude scale, zero-point orientation, and peak offset, as outlined in Table 1. The influence of each parameter on these properties is crucial for understanding the diversity of physical phenomena these states can represent.

The Properties of Primitive States

Below is an abridged version that gives the notation for the given primitive state, its zeta, eta, and theta values, and the resulting properties.

Notation	ζ	η	θ	intrinsic rotation rate	Curvature Type	Magnitude Scale	Zero-Point Orientation	Peak Offset
$\overleftarrow{\psi}'_{-A,\text{scale}:e}$	i	i	1	-4	$-A$	e	1	0
$\overrightarrow{\psi}'_{A,\text{scale}:e}$	i	$-i$	-1	4	A	e	1	0
$\overrightarrow{\psi}'_{A,\text{offset}:1/e}$	-1	$-i$	1	2	A	1	1	$1/e$
$\overleftarrow{\psi}'_{-B,\text{offset}:-1/e}$	i	1	1	-4	$-B$	1	1	$-1/e$
$\overline{\psi}'_{F,\text{offset}:1/e}$	1	1	i	0	F	1	1	$1/e$
$\overline{\psi}'_{-C,\text{scale}:1/e}$	1	-1	1	0	$-C$	$1/e$	1	0

Table 1: This table gives the resulting properties of a given set of Z, H, and Θ.

The unabridged table is provided in Appendix D.1.

Intrinsic Rotation Rate: Definition and Properties

The intrinsic rotation rate is a fundamental property that characterizes the phase evolution of a wavefunction or state, independent of external scalar factors such as k, ω, or $P^\flat_\mu$. It is defined as:

$$\text{Intrinsic Rotation Rate} = \frac{\text{Cycles}}{\Delta(\text{scaled input})},$$

where the scaled input includes contributions from E, p, and m (e.g., X°_μ) in this theory. For the standard wavefunction, the scaled input corresponds to kx or ωt. By treating the scaled input as a single parameter, the intrinsic rotation rate is unaffected by the specific scalar values, making it distinct from angular frequency or wavenumber. Instead, it reflects the intrinsic rotational behavior encoded in the wavefunction's form.

Examples of Intrinsic Rotation Rate

Standard Wavefunction

For the standard quantum mechanical wavefunction:

$$\psi_{\text{standard}}(x) = e^{i(kx-\omega t)},$$

a complete rotation in the complex plane corresponds to an increase of 2π in the scaled input kx. Thus, the intrinsic rotation rate is:

$$\text{Intrinsic Rotation Rate} = \frac{1}{2\pi}.$$

This rate is independent of k or ω, reflecting a property intrinsic to the wavefunction.

Primitive States

Primitive states exhibit a range of intrinsic rotation rates based on their parameters ζ, η, and θ, with ζ and θ primarily determining the rate:

$$\psi'(|\xi|) = \left(\zeta + \frac{\eta}{\lambda + |\xi|}\right)^{\theta(\lambda+|\xi|)}.$$

As $\lambda \to \infty$ (flat condition), $\psi'(|\xi|)$ approximates:

$$\psi'(|\xi|) \approx \zeta^{\theta(\lambda+|\xi|)}.$$

The intrinsic rotation rate is determined by ζ (e.g., i, $-i$, -1, 1) and the handedness is flipped by θ:

- **For $\zeta = i$:** Completes one cycle every four input units ($i^4 = 1$):
  - Right-handed ($\theta > 0$): $\frac{1}{4}$,
  - Left-handed ($\theta < 0$): $-\frac{1}{4}$.
- **For $\zeta = -1$:** Completes one cycle every two input units ($(-1)^2 = 1$):
  - Right-handed ($\theta > 0$): $\frac{1}{2}$,
  - Left-handed ($\theta < 0$): $-\frac{1}{2}$.
- **For $\zeta = 1$:** Does not rotate:

$$\text{Intrinsic Rotation Rate} = 0.$$

Implications for Quantum Spin and Angular Momentum

The intrinsic rotation rate plays a key role in linking primitive states to physical properties such as momentum and angular momentum. By quantizing intrinsic rotation rates, we establish a foundation for deriving quantized momentum values, leading directly to quantized angular momentum. For example:

- A state with an intrinsic rotation rate of $\frac{1}{2}$ corresponds to a quantized angular momentum of $\hbar/2$.
- Similarly, $\frac{1}{4}$ corresponds to $\hbar/4$.

This quantization naturally leads to phenomena like quantum spin, which will be explored in subsequent sections.

Two-Handedness of Primitive States

Primitive states in this theory are inherently "two-handed," meaning their intrinsic rotation rate can be flipped without altering the sign of X°_μ. This property enables a richer representation of physical phenomena, allowing both left- and right-handed rotations to emerge naturally.

Theta

As theta, like k, is in the exponent, flipping the sign of theta flips the handedness when real valued. When complex valued, the function of theta is more complicated, but when real valued it flips the handedness that we would otherwise get from zeta, just as flipping the sign of k does.

Consolidating Primitive States and the Standard Wavefunction

By demonstrating the intrinsic rotation rate for primitive states and comparing it to the standard wavefunction, we establish their compatibility. Primitive states can adopt various intrinsic rotation rates based on their parameters, while the standard wavefunction represents a specific case ($1/2\pi$).

This unified approach ensures that the states in this theory are structurally consistent with traditional quantum mechanics while extending its descriptive power to new physical scenarios.

Synchronized States and Star Notation

In this theory, states can share identical values for certain key parameters, specifically E, p, m, and X°_μ, yet differ in other intrinsic properties. We refer to these as **synchronized states**. Synchronized states arise when two or more states possess the same parameter values but exhibit distinct properties due to variations in the parameters ζ, η, θ, or λ.

To denote synchronization, we introduce a star (*) subscript notation. If two states share a star subscript, they are synchronized, meaning they are aligned in E, p, m, and X°_μ but can have differing characteristics based on their ζ, η, θ, or λ values. This distinction is valuable when constructing composite states, as synchronized states can be combined through multiplication or division to yield a resultant composite state that inherits the parameters E, p, m, and X°_μ of the synchronized states while incorporating the varied properties of each.

Flat Notation for Limiting States

The **flat notation** is used to denote a state that has been "flattened" by taking the limit as lambda approaches infinity, denoted as $\psi^\flat_\alpha$, and defined:

$$\psi^\flat_\star = \lim_{\lambda \to \infty} \psi_\star$$

We will omit the $a\star$ and just use the flat subsequently as the synchronization no longer needs to be expressed.

$Incontextswhereitisclearwhichstateisbeingflattened, thesubscriptmaybeomittedforsimplicity.$

In this theory, the flat symbol ($^\flat$) represents a conceptual approach where the parameter λ is taken to an exceedingly high value, approaching what might be thought of as an "infinite" value in mathematical terms. However, it is important to note that this language is somewhat figurative. Since this theory attempts to describe mathematics that are isomorPhic to physical reality, λ is treated as having a definite, albeit extremely high, physical value.

Thus, the notation $\lim_{\lambda\to\infty}$ is intended to communicate that the parameter λ is exceedingly large—sufficiently large to yield a negligible curvature in the context of the state. In physical terms, λ is not truly infinite but is treated as if it were for practical purposes of analysis, allowing $\psi_\alpha^\flat$ to approximate a "flat" state with minimal curvature or deviation.

Formal Definition

Let ψ_1^* and ψ_2^* represent two synchronized states. Then:

$$E_{\psi_1^*} = E_{\psi_2^*}, \quad p_{\psi_1^*} = p_{\psi_2^*}, \quad m_{\psi_1^*} = m_{\psi_2^*}, \quad X^\flat_{\mu,\psi_1^*} = X^\flat_{\mu,\psi_2^*}$$

where ψ_1^* and ψ_2^* may differ in properties such as ζ, η, θ, or λ, allowing them to exhibit unique rotation rates, curvature types, or other attributes. When synchronized states are combined, the resulting composite state retains the synchronized parameters while reflecting a blend of the distinct properties of each synchronized state.

Applications of Synchronized States

Synchronized states are particularly useful when forming composite states, where properties like rotation rates or curvature types are combined while maintaining consistent values for E, p, m, and X_μ°. For example, if ψ_1^* is a left-handed quarter-rotation state and ψ_2^* is a right-handed half-rotation state, the composite state $\psi_1^* \cdot \psi_2^*$ will inherit the common E, p, m, and X_μ° values while displaying a unique combination of the rotation properties of ψ_1^* and ψ_2^*.

This notation and terminology provide a concise method for describing and manipulating states that share synchronized parameters but exhibit distinct intrinsic properties, facilitating clarity in the construction and analysis of composite states.

Curvature for Simple States

Primitive states do not contain the same type of curvature as the orbital states we will later define, so we will delay a definition of it as the type of curvature that primitive states have does not seem relevant to physical descriptions (a curvature in the probability distribution). In the context of orbital states, curvature is the change in the angular frequency, wavenumber (or theoretically, the mass) over time, space or spacetime respectively.

Magnitude Scale of Primitive States

The magnitude scale of a state refers to its amplitude, determined by the parameters ζ, η, and θ of the state. Primitive states exhibit three primary magnitude scales: e, 1, or e^{-1}. These scales are indicated using the following subscript notation:

- scale:e: Indicates a magnitude scale of e.
- scale:$1/e$: Indicates a magnitude scale of e^{-1}.
- No subscript: Indicates a magnitude scale of 1.

Mathematically, these can be expressed as:

$$|\psi'_{\text{scale:}e}| = e, \quad |\psi'| = 1, \quad \left|\psi'_{\text{scale:}1/e}\right| = e^{-1}.$$

The magnitude scale depends on the compatibility and behavior of ζ, η, and θ. Below, we detail the specific cases leading to each magnitude scale.

Case 1: Magnitude Scale of e

When $\zeta = \eta = \theta = 1$, the primitive state approximates exponential growth, yielding a magnitude scale of e as $\lambda + |X^\circ_\mu|$ approaches infinity. Consider the state:

$$\psi'(|X^\circ_\mu|) = \prod_{\mu=0}^{4} \left(\zeta + \frac{\eta}{\lambda + |X^\circ_\mu|}\right)^{\theta(\lambda + |X^\circ_\mu|)}.$$

Substituting $\zeta = \eta = \theta = 1$, the state simplifies to:

$$\psi'(|X^\circ_\mu|) = \left(1 + \frac{1}{\lambda + |X^\circ_\mu|}\right)^{\lambda + |X^\circ_\mu|}.$$

In the limit as $\lambda + |X^\circ_\mu|$ becomes large, this expression converges to e, giving:

$$|\psi'_{\text{scale:}e}| = e.$$

Case 2: Magnitude Scale of 1

When ζ and η are incompatible (e.g., differing signs or types such as real vs. complex values), the primitive state exhibits a stable magnitude of 1. For example, let $\zeta = 1$, $\eta = i$, and $\theta = 1$. The state becomes:

$$\psi'(|X^\circ_\mu|) = \prod_{\mu=0}^{4} \left(1 + \frac{i}{\lambda + |X^\circ_\mu|}\right)^{\lambda + |X^\circ_\mu|}.$$

Here, the alternating values introduced by $\eta = i$ inhibit cumulative growth, resulting in:

$$|\psi'| = 1.$$

Case 3: Magnitude Scale of e^{-1}

When $\theta = -1$ and ζ and η are compatible (e.g., both i), the primitive state exhibits inverse exponential growth, resulting in a magnitude scale of e^{-1}. For instance, let $\zeta = i$, $\eta = i$, and $\theta = -1$:

$$\psi'(|X_\mu^\circ|) = \prod_{\mu=0}^{4} \left(i + \frac{i}{\lambda + |X_\mu^\circ|} \right)^{-(\lambda + |X_\mu^\circ|)}.$$

The negative exponent causes the expression to approach a reciprocal of exponential growth, yielding:

$$\left| \psi'_{\text{scale:}1/e} \right| = e^{-1}.$$

Complex θ

Primitive states with intrinsic rotation rates of zero can exhibit complex θ, leading to non-standard magnitude scales. These states generally do not fit into the categories of e, 1, or e^{-1}, as their configurations produce unique, non-exponential behaviors.

Summary of Magnitude Scales

The following summarizes the observed cases:

- **Magnitude Scale e:** Occurs when $\zeta = \eta = \theta = 1$, enabling exponential growth.
- **Magnitude Scale 1:** Occurs when ζ and η are incompatible, suppressing growth.
- **Magnitude Scale e^{-1}:** Occurs when $\theta = -1$ and ζ and η are compatible, causing inverse exponential behavior.
- **Complex θ:** Leads to unique behaviors beyond exponential trends.

Consistency with Physical Reality

Primitive states that do not have a magnitude scale of 1 will be divided or multiplied with other states to ensure the overall state retains a magnitude scale of 1. This ensures consistency with physical observables, where the magnitude corresponds to normalized probabilities or amplitudes.

Proof by Example

The trends discussed above have been validated through rigorous derivation and proof by example, as demonstrated in the accompanying supplementary Mathematica notebook.

Peak Offset in Primitive States

The concept of peak offset refers to the location of a state's first peak, a property that becomes particularly relevant in quarter or half primitive states. For these states, the first peak may occur at $\xi = 0$, $\xi = \frac{1}{e}$, or $\xi = -\frac{1}{e}$, depending on the intrinsic rotation rate and the specific parameters defining the state.

Peak Offset in Rotational States

In states with non-zero intrinsic rotation rates (e.g., quarter or half primitive states), the peak offset reflects the dynamic interplay of ζ, η, and θ. For instance:

- When $\zeta = i$ or $-i$ and $\eta = 1$ or -1, the first peak may shift to $\xi = \frac{1}{e}$ or $\xi = -\frac{1}{e}$.
- These shifts result from the rotational behavior induced by complex components, which redirect growth into oscillatory patterns. This rotation alters the phase alignment and, consequently, the position of the first peak.

This phenomenon highlights how the intrinsic rotation rate and the combination of real and complex parameters contribute to defining the peak offset.

Peak Offset in Zero States

For zero primitive states (with no rotation), the concept of peak offset becomes abstract. These states are complex-valued but do not rotate through the complex plane, meaning that their behavior differs fundamentally from rotating states. Despite this, peak offset can still be understood in terms of composite states. For example:

- Dividing a state with a peak offset of $\frac{1}{e}$ and a rotation rate of 1 by a scalar-valued state with a peak offset of $\frac{1}{e}$ and a rotation rate of 0 results in a state with no peak offset, where the first peak is centered at $\xi = 0$.

This illustrates the interplay between rotation rates and peak offset in both rotating and non-rotating states.

Qualitative Insights into Rotational Growth

When ζ or η includes complex components, the growth of the state takes on a rotational character. This rotation does not affect the magnitude scale but instead redirects growth into oscillations, resulting in predictable offsets for the first peak. Thus, peak offset values such as $\frac{1}{e}$ or $-\frac{1}{e}$ emerge as a natural consequence of rotational behavior in primitive states.

Peak Offset in the Standard Wavefunction

In contrast, the standard wavefunction e^{ikx} has no peak offset, with its first peak always centered at $x = 0$. This lack of peak offset reflects the simpler structure of the standard wavefunction, which does not exhibit the rotational complexity of primitive states.

Computational Verification

Computational analysis supports the observed patterns in peak offset. For instance:

- In states with mixed real and complex parameters, simulations show consistent peak offsets of $\frac{1}{e}$ or $-\frac{1}{e}$, depending on the specific configuration of ζ, η, and θ.
- Mathematica notebooks included in the supplementary materials provide detailed examples, demonstrating the dependence of peak offset on these parameters and verifying the qualitative insights presented here.

Furthermore, as can be verified by the table, if a state has a non-unitary magnitude, then it has a peak offset and vice versa. This suggests that, loosely speaking, the exponential growth aspect of the primitive state is devoted to either the magnitude or the phase.

Implications for Physical Experiments

While the concept of peak offset is abstract and does not directly correspond to a measurable physical quantity in standard quantum mechanics, it provides valuable insight into the internal structure of primitive states. Later sections will explore methods to normalize this property, ensuring consistency across states while preserving their theoretical significance.

Zero-Point Orientation in Primitive States

The zero-point orientation of a state describes its value (phase) at the input nearest to zero, specifically at $|X_\mu^\circ| = 0$. This property depends on the parameter λ, intrinsic rotation rate, and handedness of the state, and it serves as the reference phase for calculating phase evolution.

Definition and Influence of Parameters

For primitive states, the zero-point orientation is determined by the relationship between λ, $|X_\mu^\circ|$, intrinsic rotation rate, and handedness. Starting with the general form of the primitive state:

$$\psi'(|X_\mu^\circ|) = \left(\zeta + \frac{\eta}{\lambda + |X_\mu^\circ|}\right)^{\theta(\lambda + |X_\mu^\circ|)},$$

we observe that the term $(\lambda + |X_\mu^\circ|)$ functions as a unified input that scales the phase of ψ' proportionally. This implies that variations in λ influence the phase in the same way as variations in $|X_\mu^\circ|$, allowing us to describe the zero-point orientation using the intrinsic rotation rate and handedness.

Intrinsic Rotation Rate and Handedness The intrinsic rotation rate determines how rapidly the phase advances, completing one cycle every $1/r$ units, where r is the rotation rate. Handedness, determined by the sign of the intrinsic rotation rate, defines the direction of phase progression:

- Right-handed states $(+r)$ progress in one direction.
- Left-handed states $(-r)$ progress in the opposite direction.

When $|X_\mu^\circ| = 0$, the zero-point orientation is influenced by λ and these phase progression properties. For example:

- If $\lambda = 4$ and $r = \frac{1}{4}$, the phase will have completed one full cycle, resulting in a zero-point orientation of 1.
- If $\lambda = 1$ and $r = \frac{1}{4}$, the zero-point orientation will be i for right-handed rotation and $-i$ for left-handed rotation.
- If $\lambda = 2$ and $r = \frac{1}{4}$, the zero-point orientation will be -1, regardless of handedness.

This relationship demonstrates that λ and the intrinsic rotation rate work together to establish the initial phase of the state.

Zero-Point Orientation in Zero States

For zero primitive states (with an intrinsic rotation rate of 0), the concept of zero-point orientation becomes more abstract. These states do not rotate in the complex plane but still exhibit a defined phase at $|X_\mu^\circ| = 0$, determined by λ. Composite states reveal a deeper connection: dividing a state with a non-zero rotation rate and a peak offset by a scalar-valued zero state can produce a result centered at $|X_\mu^\circ| = 0$, aligning their zero-point orientations.

Zero-Point Orientation of the Standard Wavefunction

The standard wavefunction:

$$\psi_{\text{standard}}(x) = e^{ikx} = \cos(kx) + i\sin(kx),$$

has a fixed zero-point orientation determined by evaluating at $x = 0$:

$$\psi_{\text{standard}}(0) = e^{i\cdot k\cdot 0} = \cos(0) + i\sin(0) = 1.$$

This property holds regardless of the wavefunction's frequency (k) or other parameters, as the phase at $x = 0$ always evaluates to 1. The standard wavefunction thus has a consistent zero-point orientation of 1.

Physical Interpretation and Normalization

While physical experiments may not directly correspond to this property, understanding zero-point orientation provides insight into how states evolve from their initial configuration. Later sections will explore methods to normalize zero-point orientation, maintaining consistency across states by fixing this property at 1 in all cases.

Conclusion

Zero-point orientation offers a fundamental phase reference for primitive states and standard wavefunctions:

- For primitive states, it is determined by λ, intrinsic rotation rate, and handedness, reflecting the initial configuration of the state.
- For the standard wavefunction, it remains fixed at 1, independent of other parameters.

This property underscores the structural equivalence between primitive states and standard wavefunctions, contributing to their broader isomorphic relationship.

Definition of Primitive Position States

Primitive position states in this theory are constructed to directly encode position magnitude as an intrinsic property, eliminating the need for operators to determine position. This formulation provides a novel approach to representing quantum mechanical properties, where the magnitude of the state grows proportionally to the input $|X^\circ_\mu|$, mimicking the behavior of position eigenfunctions in standard quantum mechanics.

General Definition of Primitive Position States

A primitive position state is defined component-wise, where each component of the state is constructed as:

$$\underline{\tilde{\psi}}'(X^\circ_\mu) = \Lambda^2 \left(\left(Z + \frac{H}{\Lambda + X^\circ_\mu} \right)^{\Theta(\Lambda + X^\circ_\mu)} - \left(-Z - \frac{H}{\Lambda - X^\circ_\mu} \right)^{\Theta(\Lambda - X^\circ_\mu)} \right).$$

Here:

- Λ: A large parameter used to "flatten" the state, ensuring consistency with flat spacetime properties.
- $\zeta = Z$, $\eta = H$, and $\theta = \Theta$: Parameters defining the specific behavior of the primitive position state.

- The subtraction of the two terms introduces phase synchronization and meaningful cancellation between components.
- The scaling factor Λ^2 ensures the resulting state has a normalized magnitude consistent with the chosen scale (e.g., e, 1, or e^{-1}).

This construction ensures that the state exhibits linear magnitude growth proportional to $|X^\circ_\mu|$, directly corresponding to the position eigenfunction scaling $x\psi(x)$.

Special Cases and Synchronization of Components

The primitive position state is formed by combining two primitive states that differ in the sign of their spatial components. This ensures that:

- Their intrinsic rotation rates are oppositely signed, leading to opposite rotation directions in the complex plane.
- Their phases are synchronized, enabling meaningful cancellation and resulting in a unified phase for the composite state.

The limit of this construction for $\Lambda \to \infty$ reveals a state with magnitude proportional to $|X^\circ_\mu|$, mathematically expressed as:

$$\lim_{\Lambda\to\infty}\left(\left(1+\frac{1}{\Lambda+X^\circ_\mu}\right)^{(\Lambda+X^\circ_\mu)}-\left(1+\frac{1}{\Lambda-X^\circ_\mu}\right)^{(\Lambda-X^\circ_\mu)}\right)=\frac{eX^\circ_\mu}{\Lambda^2}.$$

For scale-1 states, this simplifies to:

$$\underline{\tilde{\psi}}'(X^\circ_\mu) \propto |X^\circ_\mu|.$$

This linear magnitude growth aligns with the behavior of position eigenfunctions in standard quantum mechanics, establishing the foundation for isomorphism.

Preliminary Definition and Generalization

While this definition focuses on flat, scale-1 states, the general formalism for primitive position states incorporates additional properties, such as curvature. These generalizations will be addressed in later sections, as they require more advanced notation and language. For now, this definition suffices to demonstrate the alignment with position eigenfunctions.

Isomorphism Between Primitive States and the Standard Wavefunction

We demonstrate that primitive states in this theory are isomorphic to the standard quantum mechanical wavefunction

$$\psi_{\text{standard}}(x) = e^{i(kx-\omega t)}.$$

Definition of Isomorphism Two wavefunctions are considered isomorphic if:

1. Their magnitudes are equivalent under scaling.
2. Their phase evolution, characterized by intrinsic rotation rate, aligns through appropriate scaling of input parameters.
3. Variations in zero-point orientation and peak offset can be adjusted using phase factors and translations.

Magnitude Behavior Primitive states are defined with a constant magnitude in flat space, $|\psi'| = 1$, which matches the magnitude of the standard wavefunction $|\psi_{\text{standard}}(x)| = 1$.

Phase Evolution Primitive states possess quantized intrinsic rotation rates (cycles per scaled input), while the standard wavefunction's intrinsic rotation rate depends on k and ω. By adjusting the scaling parameters of the primitive states, we can align their phase evolution with that of the standard wavefunction, ensuring structural equivalence.

Adjusting Zero-Point Orientation and Peak Offset Discrepancies in initial phase (zero-point orientation) and the location of the first peak (peak offset) can be reconciled by:

- Applying a global phase factor to align initial phases.
- Translating input coordinates to match peak positions.

Conclusion Primitive states are isomorphic to the standard wavefunction because:

1. They share equivalent magnitude behavior.
2. Their intrinsic rotation rates can be matched through scalar adjustments.
3. Differences in initial phase and peak offset can be corrected using permissible transformations.

This isomorphism ensures that primitive states align with established quantum mechanical structures, providing a solid foundation for further developments in this theory.

Primitive Position States

Primitive position states are analogous to position eigenfunctions. Unlike traditional eigenfunctions, however, they do not require a position operator to determine their magnitude (which serves as an analog to an eigenvalue). Instead, these states intrinsically possess a magnitude that is theoretically proportional to the position. This formalism presents an alternative approach to quantum mechanics, one that does not rely on operator formalism, but instead will be category-theoretic. The aim is to provide a more direct representation of physical properties, avoiding the abstraction of operators, which can be challenging to define physically.

Isomorphism Between Primitive Position States and Position Eigenfunctions

In this section, we demonstrate that flat scale-1 primitive position states are isomorphic to the position eigenfunctions of standard quantum mechanics, specifically the form $x\psi(x)$, where the wavefunction is scaled by the spatial coordinate x.

Primitive Position States and Position Magnitude

Primitive position states in this theory inherently encode position magnitude as a property of the state itself, rather than relying on an operator. For a flat, scale-1 primitive position state, the magnitude grows proportionally to the input $|X^\circ_\mu|$.

We define the primitive position state as:

$$\underline{\psi}'(|X^\circ_\mu|) = \Lambda^2 \left(\left(Z + \frac{H}{\Lambda + |X^\circ_\mu|} \right)^{\Theta(\Lambda + |X^\circ_\mu|)} - \left(-Z - \frac{H}{\Lambda - |X^\circ_\mu|} \right)^{\Theta(\Lambda - |X^\circ_\mu|)} \right),$$

where:

- Λ is a large parameter that flattens the state.
- Scaling by Λ^2 restores the state to a normal scale.
- $\zeta = \eta = \Theta = 1$ is an example choice that yields specific results. In this case, the state has a scale of e, as explained below.

Taking the limit as $\Lambda \to \infty$, the difference between the two terms constructs an e-like function scaled by $|X^\circ_\mu|$. Specifically:

$$\lim_{\Lambda \to \infty} \underline{\psi}'(|X^\circ_\mu|) = \frac{eX^\circ_\mu}{\Lambda^2}.$$

For scale-1 states, this reduces further. Since the scale is 1, we remove the scaling factor e, resulting in:

$$\underline{\psi}'(|X_\mu^\circ|) \propto |X_\mu^\circ|.$$

Thus, primitive position states naturally exhibit linear magnitude growth with the input $|X_\mu^\circ|$, analogous to $x\psi(x)$ in quantum mechanics.

The Role of ζ, η, Θ, and Scale

The example $\zeta = \eta = \Theta = 1$ illustrates a specific construction where the state has a scale of e. This arises because:

- The two terms in the definition effectively construct two expressions for e, one with X_μ° added to Λ and the other with X_μ° subtracted.
- The difference between these terms scales $|X_\mu^\circ|$ by e, yielding $\frac{eX_\mu^\circ}{\Lambda^2}$ after restoring the scale.

However, for a general scale-1 state, the result simplifies to:

$$\underline{\psi}'(|X_\mu^\circ|) = \text{scale} \cdot |X_\mu^\circ| = |X_\mu^\circ|.$$

Synchronization and Phase Alignment

To construct primitive position states with meaningful cancellation properties, we combine two primitive states that differ in the sign of their spatial components. This subtraction ensures alignment in phase, achieved by:

1. Negating ζ and η in one component, ensuring that their intrinsic rotation rates are oppositely signed.
2. Synchronizing the phases of the two components, such that their difference instills a unified phase in the resulting state.

This construction ensures that the primitive position state exhibits coherent phase behavior, aligned with standard wavefunctions.

Key Isomorphism Properties

By aligning the magnitude and phase properties of primitive position states with position eigenfunctions, we establish their isomorphism:

1. **Magnitude Scaling**: Primitive position states grow linearly with the input $|X_\mu^\circ|$, matching the position eigenfunction scaling $x\psi(x)$.
2. **Phase Behavior**: Intrinsic rotation rates and phase adjustments (e.g., zero-point orientation and peak offset) ensure alignment with standard wavefunctions.
3. **Flat State Assumption**: Restricting to flat primitive states ensures curvature-free behavior, consistent with the structure of position eigenfunctions.

Conclusion

Flat scale-1 primitive position states are isomorphic to position eigenfunctions. This is captured succinctly in the key limit:

$$\lim_{\Lambda\to\infty}\left(\left(1+\frac{1}{\Lambda+X^{\circ}_{\mu}}\right)^{(\Lambda+X^{\circ}_{\mu})}-\left(1+\frac{1}{\Lambda-X^{\circ}_{\mu}}\right)^{(\Lambda-X^{\circ}_{\mu})}\right)=\frac{eX^{\circ}_{\mu}}{\Lambda^2}.$$

For scale-1 states, this simplifies to:

$$\underline{\psi}'(|X^{\circ}_{\mu}|)\propto|X^{\circ}_{\mu}|,$$

demonstrating that the primitive position state naturally encodes the position magnitude property of eigenfunctions in quantum mechanics.

Zero Primitive Position States

The second type of primitive position state is defined for zero position states that have a rotation rate of zero. These states are represented as:

$$\underline{\overline{\psi}}'(X^{\circ}_{\mu})=\left(\underline{\overline{\psi}}'_{\mu=0},\underline{\overline{\psi}}'_{\mu=1},\underline{\overline{\psi}}'_{\mu=2},\underline{\overline{\psi}}'_{\mu=3},\underline{\overline{\psi}}'_{\mu=4}\right)$$

where each component $\underline{\tilde{\psi}}'_{\mu}$ is defined as:

$$\underline{\overline{\psi}}'(X^{\circ}_{\mu})=\Lambda^2\left(\left(Z'+\frac{H'}{\Lambda+X^{\circ}_{\mu}}\right)^{\Theta(\Lambda+X^{\circ}_{\mu})}-\left(Z'+\frac{H'}{\Lambda-X^{\circ}_{\mu}}\right)^{\Theta(\Lambda-X^{\circ}_{\mu})}\right)$$

For these zero position states, there is no need to synchronize the phases of the components, as they do not rotate. Consequently, there is no requirement to negate ζ, η, or θ. The subtraction of the two components in this case is straightforward, as their phases are already aligned. The output magnitude is directly proportional to the input, as shown in the case of half and quarter flat primitive position states with magnitudes scale 1:

$$\left|\overline{\psi}'^{\flat}_{\vee}\right|=\Xi$$

In the case of zero primitive position states, the behavior is similar to that of position eigenfunctions but without any intrinsic rotation rate.

Complications with Λ

In order for the primitive position states to exhibit coherent behavior, the parameter Λ must take on specific values, especially for zero states. Specifically, Λ must be an integer multiple of 2. If Λ is allowed to take continuous values while X°_{μ} is also continuous, the state may become misaligned, resulting in phases that are not synchronized for each term in the position state. Below, we present several potential solutions to address this issue:

1. **Quantization of Λ and X_μ°**: This approach requires both Λ and X_μ° to be integer-valued. By quantizing ξ into sufficiently small units, even for particles with high energy, the product $P \cdot \xi$ remains very small. This ensures that the steps in the state are sufficiently small to approximate continuous rotation through the complex plane, preserving coherence.

2. **Rounding Λ to the Nearest Integer**: A ceiling function can be applied to round Λ to the nearest integer. While this introduces minor discontinuities, it ensures that Λ is appropriately quantized, thereby maintaining overall coherence in the state.

3. **Using zero Primitive Position States**: Only quarter and half primitive position states require Λ being an integer multiple of 2. As an alternative, the zero primitive position states can be used, taking the limit as $\lambda \to \infty$. This results in states without curvature, and the curvature types of other primitive states can be utilized instead.

4. **Applying a Ceiling Function to Λ**: To further ensure coherence, a ceiling function can be applied, rounding Λ up to the nearest integer multiple of 2. This avoids potential desynchronization by ensuring consistent alignment of the oscillatory components.

5. **Defining a Rotation Function to Align Peaks**: For cases where Λ is not an integer multiple of 2, a rotation function can be defined to synchronize the phases of the state components, ensuring that $\psi(X_\mu^\circ)$ always peaks at the correct values. This approach is explained in more detail below.

Rotation Function to Correct Λ

We define a phase rotation function that shifts the zero-point of the state to align with a peak. The phase adjustment is given by:

$$e^{i\pi(\Lambda - \lfloor \Lambda/2 \rfloor \times 2)}$$

This rotation adjusts the state by an amount proportional to the deviation of Λ from an integer multiple of 2. For instance, if $\Lambda = 101$, the phase shift becomes:

$$e^{i\pi(101-100)} = e^{i\pi}$$

which corresponds to a half-cycle shift. Consequently, the general state is adjusted as follows:

$$\psi'(X_\mu^\circ) \to e^{i\pi(\Lambda - \lfloor \Lambda/2 \rfloor \times 2)} \psi'(X_\mu^\circ)$$

This phase correction ensures that the zero-point of the state is aligned with a peak, even when Λ is not an integer multiple of 2. By applying this adjustment, the coherence of the oscillatory behavior of the state is preserved, preventing desynchronization and maintaining the intended physical representation.

These corrections to Λ are crucial for ensuring that the primitive position states exhibit consistent and coherent oscillatory behavior, which is fundamental for accurately modeling physical phenomena within the framework of this theory.

The Properties of Primitive Position States

The Position Magnitude Property

Every primitive position state possesses a "position magnitude property" by definition. This means that a primitive position state intrinsically yields position magnitudes without the need for an operator or additional multiplication by position variables. This allows us to avoid an operator-based approach by treating position as an inherent property that can be transferred, acquired, or canceled through the interactions of states, which is arguably a more natural description.

appendix

Position Magnitude in Primitive States

In this theory, the primitive position state $\underline{\psi}'(|X^\circ_\mu|)$ provides a natural position magnitude that grows linearly with the input $|X^\circ_\mu|$. Unlike the standard position eigenfunction in conventional quantum mechanics, where position is scaled by an operator, this model incorporates the scaling directly into the state itself.

Formulation of the Position Magnitude

The primitive position state is defined as:

$$\underline{\psi}'(|X^\circ_\mu|) = \Lambda^2 \left(\left(1 + \frac{1}{\Lambda + |X^\circ_\mu|}\right)^{(\Lambda + |X^\circ_\mu|)} - \left(1 + \frac{1}{\Lambda - |X^\circ_\mu|}\right)^{(\Lambda - |X^\circ_\mu|)} \right)$$

where Λ is a large parameter approaching infinity, acting as a "flattening" factor. The goal is to demonstrate that, as $\Lambda \to \infty$, the state behaves such that the output magnitude scales with $|X^\circ_\mu|$.

Analyzing the Magnitude Scaling

The difference between the terms in the expression above leads to a position magnitude that approximates $|X^\circ_\mu|$, specifically:

$$\lim_{\Lambda \to \infty} \left(\left(1 + \frac{1}{\Lambda + |X^\circ_\mu|}\right)^{(\Lambda + |X^\circ_\mu|)} - \left(1 + \frac{1}{\Lambda - |X^\circ_\mu|}\right)^{(\Lambda - |X^\circ_\mu|)} \right) = \frac{e|X^\circ_\mu|}{\Lambda^2}.$$

This relationship holds because: 1. As Λ grows, $\left(1+\frac{1}{\Lambda+|X_\mu^\circ|}\right)^{(\Lambda+|X_\mu^\circ|)}$ becomes slightly larger, while $\left(1+\frac{1}{\Lambda-|X_\mu^\circ|}\right)^{(\Lambda-|X_\mu^\circ|)}$ becomes slightly smaller. 2. The difference between these two terms is directly proportional to $|X_\mu^\circ|$ and scales with $\frac{1}{\Lambda^2}$.

Position Magnitude in the Flat Limit

In the limit as $\Lambda \to \infty$, the Λ^2 factor outside the difference restores the magnitude scale to match the original states. Thus, in the absence of curvature, this primitive state's structure results in an output magnitude that is identical to the input, effectively making:

$$\lim_{\Lambda\to\infty} \underline{\psi}'(|X_\mu^\circ|) = |X_\mu^\circ|,$$

which is the desired behavior for a position state.

In this way, the position magnitude is inherently encoded in the structure of the state, scaling linearly with the input $|X_\mu^\circ|$ in flat conditions.

End appendix

Curvature

We will wait until we define orbital states in order to define curvature more rigorously. For primitive position states, curvature is a deviation from the expected output where the expected output is given by X_μ°.

Magnitude Scale

The magnitude scale of primitive position states refers to the scale of their position magnitudes. For consistency, we assume that all magnitude scales used will have a value of 1 to ensure that the position magnitude is on the correct scale. Primitive states with non-unit magnitude scales will interact with other primitive states such that the scales effectively cancel. For example, a primitive state with magnitude scale e might multiply a state of magnitude e^{-1}, or be divided by a state with magnitude e, resulting in a magnitude scale of 1.

Zero-Point Orientation

The zero-point orientation for primitive position states varies and can take values of 1, i, -1, or $-i$, which means that the first peak (the first location with a purely i, $-i$, 1, or -1 value) can have different initial values.

Peak Offset

The peak offset for primitive position states is defined similarly to primitive states. If we divide a primitive position state by the input ξ, then the resulting state's peak offset property remains the same.

We often find it necessary to work with scalars that have a position magnitude. Peak offset can cause these to be non-scalars, so like magnitude scale, we will assume that the states have a peak offset of 0

Primitive State Properties and Completeness

Primitive states are characterized by properties that fully describe them (fully describe their phase and magnitude). Given $P_\mu^\flat$, X_μ° and λ:

- The **phase** of a primitive simple state can be predicted if we know:
    1. The intrinsic rotation rate,
    2. The zero-point orientation, and
    3. The peak offset.
- The **magnitude** can be determined by:
    1. The magnitude scale,
    2. The curvature type, and
    3. The presence or absence of the position magnitude property.

These properties form a complete set of descriptors for primitive states, ensuring that both their phase and magnitude can be fully determined at any input value.