The Theory of IsomorPhic Physics

Part 3: The Composite state

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November 24, 2024

Overview

States are in a hierarchical structure. Primitive states are multiplied and divided to construct composite states. Composite states are used to construct spin states and general states. Spin and generals states are multiplied to construct the total state. The total state is embedded in quaternion-valued matrices to construct particle states. Particle states are added together to form systematic states that describe protons, neutrons and atoms. Curvature states are used to describe curvatures which will map to potential energy in the Hamiltonian. Each of the

Symbol	Adjective	Description
ψ'	primitive	Basic building block for states.
ψ	composite	State formed by combining primitive states.
Ψ	general	A general state of which other states are subsets.
χ	spin	Determines dynamics, properties including general angular momentum.
Ω	total	The spin state multiplied by the general state
β	particle	States describing different particle types.
α	composite-particle	State representing a particle or a composite particle .
Φ	curvature	State describing curvature properties.

Table 1: Symbols for States and Their Corresponding Terms

above types of states can have a number of modifiers that describe either the properties of the states (in the case of primitive states) or the properties that the define the subset that an element of the set of states belongs to.

The Composite State

Composite states are formed by combining primitive states (Ψ') through multiplication or division to produce a more general, unprimed state, referred to as the composite state:

Modifier	Adjective	Explanation
$(state)^{\flat}$	glat	Indicates no curvature in the state.
$(state)$	simple	Refers to a basic state with no position or Epm specification.
$\underline{(state)}$	position	State with a position magnitude.
$\underline{\underline{(state)}}$	Epm	State with energy, momentum and mass magnitudes.
$\underline{\underline{\underline{(state)}}}$	energy	State with energy magnitude.
$\underline{\underline{\underline{\underline{(state)}}}}_{0}$	momentum	Momentum state with magnitudes of p_x, p_y, p_z.
$\underline{\underline{\underline{\underline{(state)}}}}_{1,2,3}$	mass	A zero state with magnitude mass.
$\underline{\underline{\underline{\underline{\underline{(state)}}}}}_{4}$	right-handed	Specifies right-handed rotation.
$\overrightarrow{(state)}$ or $(\overrightarrow{state})$	left-handed	Specifies left-handed rotation.
$\overleftarrow{(state)}$ or $(\overleftarrow{state})$	half	Specifies a 1/4 of rotation.
$\overrightarrow{(state)}$ or $(\overrightarrow{state})$	quarter	Specifies a 1/2 intrinsice rotation rate.
$\overleftarrow{(state)}$ or $(\overleftarrow{state})$	zero	Specifies a 0 intrinsice rotation rate.
$(state)_{\star}$	synchronized	States with same values of E, p, m and ξ but may differ in properties.

Table 2: Modifiers for State Notation and Their Meanings

$$\psi = \prod_{i=1}^{n} \left(\Psi'_{i,\star}\right)^{a_i} \cdot \prod_{j=1}^{m} \left(\underline{\Psi}'_{j,\star}\right)^{b_j}$$

where a_i and b_j can take values of 1, 0, or -1, corresponding to multiplication, exclusion, or division, respectively.

1 Notation for States with Specified Properties

In this theory, the set of states sharing specific properties is defined as:

$$\mathcal{S}(\text{properties}) = \{\psi \mid \text{specified properties of } \psi\}$$

For example, a composite state with a left-handed intrinsice rotation rate of 1/4, a curvature type of $-a$, and a magnitude scale of e can be represented as:

$$\underline{\overleftarrow{\psi}}'_{(-A)\odot} \in \mathcal{S}\left(\text{intrinsice rotation rate} = -\frac{1}{4}, \text{curvature type} = -A, \text{magnitude scale} = e\right)$$

This notation signifies that $\underline{\overleftarrow{\Psi}}'_{(-A)\odot}$ belongs to the set of all states with the specified characteristics, rather than representing a unique state.

The unprimed notation (Ψ) is used to denote an arbitrary element within the set $\mathcal{S}$(properties) such that we are using general language that is describing relations between elements of various subsets of ψ.

General Definition of Primitive Position States

In the earlier sections, we introduced primitive position states, $\underline{\Psi}'(|X_\mu^\circ|)$, with a specific form:

$$\underline{\Psi}'(|X_\mu^\circ|) = \Lambda^2 \left(\left(Z + \frac{H}{\Lambda + |X_\mu^\circ|} \right)^{\Theta(\Lambda+|X_\mu^\circ|)} - \left(-Z - \frac{H}{\Lambda - |X_\mu^\circ|} \right)^{\Theta(\Lambda-|X_\mu^\circ|)} \right).$$

In this section, we expand upon this definition to establish a more general formulation that incorporates the concepts and notation developed in the composite state framework.

General Formulation of Primitive Position States

The original definition of a primitive position state, $\underline{\Psi}'(|X_\mu^\circ|)$, gives a more concrete definition. By contrast, a more general expression for a primitive position state involves subtracting composite states that have particular rates of rotation with the sign of one of their X_μ° being negated:

$$\underline{\Psi}'(|X_\mu^\circ|) = \Lambda^2 \left(\overleftarrow{\Psi}_\star - \overrightarrow{\Psi}_\star \Big|_{X_\mu^\circ \to -X_\mu^\circ} \right),$$

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where:

- $\overleftarrow{\Psi}$ and $\overrightarrow{\Psi}$ represent primitive or composite states rotating in opposite directions.
- The notation $\Big|_{X_\mu^\circ \to -X_\mu^\circ}$ denotes a time, space or spacetime reversal applied to one of the states in the pair. Since flipping the sign of X_μ° flips the handedness of the state, this ensures both states in the expression have the same handedness, allowing their phases to remain aligned as X_μ° grows
- The resulting state, $\underline{\Psi}'(|X_\mu^\circ|)$, is scaled by Λ^2, restoring the scale after subtracting two states that differ by a minute amount due to the fact that one state subtracts

  $$X_\mu^\circ$$

  from λ while the other adds it.

In this way, the original definition of the primitive position state becomes a subset of this more general definition. This more general definition allows for an infinitely broader range of curvature since the two states invoolved in the expression are composite states which have an infinite set of curvatures they can express.

Transformation of Flat to Curved Space-Time with $\overline{\underline{\psi}}$

In this theory, we identify that $\overline{\underline{\psi}}$ as a state that transforms inputs from uncurved (flat) space-time into curved space-time. The function $\overline{\underline{\Psi}}$ represents the behavior of states under curvature. The underline indicates it has a position magnitude while the overline indicates that the state is scalar-valued (assuming no peak offset).

$$\overline{\underline{\psi}} = X_\mu$$

In other words $\overline{\underline{\psi}}$ is a function of the flat time, space and spacetime scaled by flat energy, flat momentum and flat mass respectively (these being E, p and m that do not vary over time, space or spacetime). This is denoted by using an input of $X_\mu^\flat$ but the function of $X_\mu^\flat$ gives an output with a magnitude of X_μ which is curved time, curved space and curved spacetime, which has no flat modifier or otherwise as this is considered the most general expression of time, space and space-time.

1.1 General States

general states will later be used to describe the general angular momentum, but the term is somewhat more general. To capture both flat and curved scenarios, we define Ψ (differentiated by a capital letter) as follows:

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

This general state, unlike composite states, contains curvature in time, space and spacetime impacts phase unlike composite state curvature which only impacted the magnitude of the state. This therefore aligns more closely with how the Schrödinger equation describes forces as changes in the total energy (the angular frequency) over space and time, not as changes in probability amplitude.

Philosophically, this transformation is grounded in the theory that the position states have position magnitudes. If this is the case, then the composite position states take in inputs of $X_\mu^\flat$ and output magnitudes of X_μ, such that the phase of the wavefunction is based on X_μ and not $X_\mu^\flat$. This new formulation is an expression of the same information, as it still takes inputs of $X_\mu^\flat$ since the $\overline{\underline{\Psi}}$ is still a function of $X_\mu^\flat$.

To be clear, all of the generalities of the composite states are carried over to the definition of general states such that general states are an element of subsets defined by particular properties.

Spin States

If we take a state and set its energy, momentum and mass (denoted $P_\mu^\flat$) to 1, the result is a spin state χ, defined:

$$\chi \in \{\Psi^\flat \mid P_\mu^\flat = 1 \text{ for all } \mu\} \tag{1}$$

When $P_\mu^\flat$ is set to 1, χ can only take on quantized values of energy, momentum, and mass determined by the intrinsic intrinsice rotation rate. This value is positive for right-handed rotation and negative for left-handed rotation. There are also position versions of Phi such that the magnitude of a position equates to the input of χ. Though these quantized momenta will be shown to lead to quantum spin, this quantized momenta is just a form of quantized energy, momentum and mass such that this use of the term "spin state" is somewhat more general and abstract than it is normally, and it will be used in several equations not directly germane to quantum spin.

$$\underline{\chi}^\flat = |\xi| \tag{2}$$

Such that we could use $|\xi|$ in place of χ. However, we will use χ and not ξ because the former is a state while the latter is not, such that we stay within the infinite set of Psi when we multiply or divide other states by this factor

Measurement Interpretation and State Equations

This component-specific nature of Epm states ensures that measurement selectively collapses only the relevant component, maintaining an isomorphic structure to quantum mechanics eigenfunctions. The specific handling of momentum components and their aggregation will be further addressed in the paper discussing state equations, where the component-nature of the momentum state will be explicitly treated.

Epm States: Structure and Magnitude Properties

Epm states in this framework represent component-specific magnitudes for energy, momentum, and mass. These states serve as analogs to energy and momentum eigenfunctions in traditional quantum mechanics but apply componentwise, directly aligning with the standard quantum mechanical structure.

Position Magnitude Under Multiplication

We define a position state $\underline{\Psi}$ as a state with a first-order, non-multiplicative position magnitude. Specifically, if $\underline{\Psi}$ has a position magnitude, then it does not require multiplication by x or any additional terms:

$$\underline{\Psi} \in \{\Psi \mid \text{has a non-multiplicative, first-order position magnitude}\}.$$

If we consider two position states, $\underline{\tilde{\Psi}}$ and $\overline{\underline{\Psi}}$, and divide one by the other, the resulting state will lose the position magnitude property:

$$\frac{\underline{\tilde{\Psi}}_\star}{\overline{\underline{\Psi}}_\star} = \tilde{\Psi}_\star.$$

Here, $\tilde{\Psi}_\star$ no longer has a position magnitude, as dividing two states with position magnitudes cancels this property.

Similarly, multiplying two position states results in a state with a higher-order magnitude, which also loses the original position magnitude property:

$$\underline{\Psi}_\star \cdot \underline{\Psi}_\star = \Psi_\star, \quad \text{(quadratic)}.$$

This quadratic state no longer has the first-order position magnitude of the original position states.

However, if we multiply a general position state by a general simple state, the resulting state still retains the first-order position magnitude:

$$\underline{\Psi}_\star \cdot \Psi_\star = \underline{\Psi}_\star.$$

Intrinsic Rotation Rate Under Multiplication

When we multiply two states, their rates of rotation are additive. Below are two examples that illustrate this principle:

1. Multiplying two left-handed quarter general simple states results in a left-handed half general simple state:

$$\overleftarrow{\Psi}_\star \cdot \overleftarrow{\Psi}_\star = \overleftarrow{\Psi}_\star.$$

2. Multiplying a right-handed half general simple state by a zero general simple state results in a right-handed half general simple state:

$$\overrightarrow{\Psi}_\star \cdot \overline{\Psi}_\star = \overrightarrow{\Psi}_\star.$$

Magnitude Scale Under Multiplication

The magnitude scale of a state is multiplicative under multiplication, meaning that the resulting scale of two primitive states is the product of their respective scales. For example:

1. If we multiply an element from the subset of composite states with magnitude e^{-1} by an element from the subset with magnitude e, the result belongs to the subset with magnitude 1:
$$\Psi_{\oslash} \cdot \Psi_{\odot} = \Psi.$$
2. If we divide an element from the subset of states with magnitude e^{-1} by another element with magnitude e^{-1}, the result belongs to the subset with magnitude 1:
$$\Psi_{\oslash} \cdot \Psi_{\oslash} = \Psi.$$

Since magnitude scale applies to position magnitudes, normalization cannot simply eliminate these variations in magnitude. It becomes essential to maintain the correct magnitude scale for states. Specifically, we require the state to have a magnitude scale of 1, achieved through the cancellation of scale factors due to multiplication or division.

Zero-Point Orientation Under Multiplication

The zero-point orientation of a state is multiplicative under multiplication. For example, if an element with a zero-point orientation of i is multiplied by an element with zero-point orientation $-i$, the result has a zero-point orientation of 1:

$$\Psi_{i\star} \cdot \Psi_{-i\star} = \Psi.$$

This ensures that the resulting state has a neutral orientation when combining states with opposite orientations.

Peak Offset Under Multiplication

When dividing a primitive state with a non-zero intrinsic rotation rate and a peak offset of $\frac{1}{e}$ by a primitive with no intrinsic rotation rate but with the same peak offset, the resulting function has no peak offset:

$$\frac{\widetilde{\Psi}_{\vee\star}}{\Psi}$$

$_{\vee\star} = \widetilde{\Psi}_{\star}$.

This suggests that while peak offset is abstract for primitives with zero rotation, the property remains mathematically consistent. In general, peak offsets cancel under division and add under multiplication.

Independence of State Properties

In general, the different properties of a state—such as intrinsic rotation rate, position magnitude, magnitude scale, zero-point orientation, and peak offset—are independent of one another. This means that one property does not affect or influence the presence or behavior of another. Each property can be thought of as orthogonal to the others, so modifying one does not directly alter the others.

For example, consider the multiplication of a state with an intrinsic rotation rate equal to $\frac{1}{2}$ and a position magnitude by a state with no intrinsic rotation rate:

If we multiply a right-handed quarter general position state by a left-handed quarter general simple state, the result is a zero-position general simple state:

$$\underline{\overrightarrow{\Psi}}_{\star} \cdot \underline{\overleftarrow{\Psi}}_{\star} = \underline{\overline{\Psi}}_{\star}.$$

This illustrates that one property (e.g., intrinsic rotation rate) does not affect another (e.g., the position magnitude), as the intrinsic rotation rate cancels out due to the interaction between the states, while the position magnitude is preserved. This independence holds across all properties defined for these states, allowing for flexibility in constructing and analyzing states with different combinations of properties without unintended interactions.

Definition of Epm States

Primitive states are defined as:

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

where each component ψ'_{μ} contributes to the overall structure of the state. Epm states, denoted $\underline{\underline{\Psi}}$, extend this by explicitly associating magnitudes with energy, momentum, and mass. The general form is:

$$\underline{\underline{\Psi}} \in \left\{ \Psi \mid \underline{\Psi}/\overline{\underline{\chi}}^{\flat} \right\}.$$

Epm states include energy (E), momentum (p_x, p_y, p_z), and mass (m) components, described as:

$$\underline{\underline{\Psi}}_{0} \in \left\{ \Psi \mid \underline{\Psi}/\overline{\underline{\chi}}^{\flat}_{0} \right\}, \quad \underline{\underline{\Psi}}_{1,2,3} \in \left\{ \Psi \mid \underline{\Psi}/\overline{\underline{\chi}}^{\flat}_{1,2,3} \right\}, \quad \underline{\underline{\Psi}}_{4} \in \left\{ \Psi \mid \underline{\Psi}/\overline{\underline{\chi}}^{\flat}_{4} \right\}.$$

Component-Specific Magnitudes in Flat Space

In flat space, without curvature, Epm states exhibit magnitudes corresponding to the energy, momentum, and mass components, as shown below:

1. $\underline{\underline{\Psi}}_{0}$ (Energy State): Its magnitude corresponds to the energy component E, affecting the time component of the state.

2. $\underline{\underline{\Psi}}_{1,2,3}$ (Momentum States): Each component corresponds to the respective spatial momentum components p_x, p_y, and p_z.

3. $\underline{\underline{\Psi}}_{4}$ (Mass State): This corresponds to the scalar mass m, representing the mass term in the energy-momentum relationship.

Deriving Epm Magnitudes

To verify that Epm states exhibit the expected magnitudes, consider the following steps:

1. Defining Primitive Position States Primitive position states $\underline{\psi}'$ exhibit a magnitude corresponding to the scaled input X'_μ:

$$\underline{\psi}'(|X^\circ_\mu|) \sim |X'_\mu|,$$

where X'_μ scales the input by energy (E), momentum (p_x, p_y, p_z), or mass (m):

- $t' = E \cdot t$,
- $x' = p_x \cdot x$,
- $S' = m \cdot S$.

2. Scalar State as a Reference Define a scalar state ϕ with unit magnitude:

$$\phi \in \{\psi \mid |P^\flat_\mu|_\mu = 1 \text{ for all } \mu\}.$$

This scalar state provides a reference that isolates scaling effects from E, p, or m.

3. Extracting Epm Magnitudes Divide the primitive position state by the scalar state ϕ to isolate the component-specific magnitudes:

$$\frac{\underline{\psi}'(|X^\circ_\mu|)}{\phi} = \frac{X'_\mu}{|X^\circ_\mu|}.$$

This yields:

- $\frac{t'}{t} = E$ for the energy component,
- $\frac{x'}{x} = p_x$ for the spatial momentum components,
- $\frac{S'}{S} = m$ for the mass component.

Thus, Epm states encode magnitudes directly proportional to E, p, and m, aligning with the energy-momentum relationship.

Interpretation and Alignment with Standard Quantum Mechanics

By construction, Epm states are isomorphic to the eigenfunctions of energy and momentum in traditional quantum mechanics:

- Their magnitudes align component-wise with E, p_x, p_y, p_z, and m.
- They maintain consistency with the energy-momentum relationship.
- Their structure facilitates integration with scalar-based inputs, ensuring compatibility with the broader framework of this theory.

Conclusion

Epm states generalize the concept of energy and momentum eigenfunctions to a component-specific framework, ensuring compatibility with standard quantum mechanics while leveraging the scalar and curvature-based formalism of this theory. Their magnitude properties, derived rigorously, confirm their alignment with E, p, and m, solidifying their foundational role in this framework.

Simple Curvature States

Curvature will manifest in a variety of ways and this manifestation may not map to reality. In this case curvature manifests as a curvature in the probability distribution as it is a difference between the expected (flat) value and the actual value. Though we will eventually eliminate this form of curvature, we will nonetheless define it as Φ:

$$\Phi = \psi_{\star}^{\flat} - \underline{\psi}_{\star}$$

Position Curvature States

Since primitive position states have position magnitudes, we define space-time curvature in terms of these position magnitudes:

$$\overline{\underline{\Phi}} = \overline{\underline{\psi}}_{\star} - \overline{\underline{\psi}}_{\star}^{\flat}$$

Where this is referring to the composite position states involved in the definition of the general state, being used as if it were an input into the general state. In this way, we're referring to the small deviation from the expected input which is flat space, the above equation being isomorphic to:

$$\underline{\Phi} = X_{\mu} - X_{\mu}^{\circ}$$

This definition suggests that space-time curvature could map to the curvature described in general relativity, potentially offering a pathway towards unifying quantum mechanics with general relativity.

Epm Curvature States

Since Epm states yield energy, momentum, and mass magnitudes, we define Epm curvature states:

$$\underline{\underline{\Phi}} = \underline{\underline{\Psi}}_{\star} - \underline{\underline{\Psi}}^{\flat}_{\star} \tag{3}$$

The above definition requires $\underline{\underline{\Phi}}$ to be in the "paren-theses" notation to function correctly, an analog to the bra-ket that will be defined in paper 5. For now you can think of each state in the above expression as being in absolute values in order to get a better sense of The following table outlines the approchimate scaling behavior of different curvature types with respect to ξ.

Table 1 presents how each curvature type's force curvature scales with χ for the Epm curvature state. This includes both positive and negative curvatures scaling as $1/\xi^0$, with varying magnitudes controlled by σ, making it suitable for describing the strong force. Additionally, forces that scale as $1/\xi^2$, such as those describing electromagnetic and gravitational forces, are included. Interestingly, this approach also suggests that gravity could be explained through space-time curvature scaling as $1/\chi^3$, offering a potential alternative explanation.

Curvature Type	$\nu = 0$	$\nu = 1$	$\nu = 2$	$\nu = 3$	$\nu = 4$
A	$1/\xi^0$	$1/\xi^2$	$1/\xi^2$	$1/\xi^3$	$1/\xi^4$
$-A$	$1/\xi^0$	$1/\xi^2$	$1/\xi^2$	$1/\xi^3$	$1/\xi^4$
B	$1/\xi^0$	$1/\xi^2$	$1/\xi^2$	$1/\xi^3$	$1/\xi^4$
$-B$	$1/\xi^0$	$1/\xi^2$	$1/\xi^2$	$1/\xi^3$	$1/\xi^4$
C	$1/\xi^0$	$1/\xi^2$	$1/\xi^2$	$1/\xi^3$	$1/\xi^4$
$-C$	$1/\xi^0$	$1/\xi^2$	$1/\xi^2$	$1/\xi^3$	$1/\xi^4$
$-D$	$1/\xi^0$	$1/\xi^2$	$1/\xi^4$	$1/\xi^6$	$1/\xi^8$
G	$1/\xi^0$	$1/\xi^2$	$1/\xi^4$	$1/\xi^6$	$1/\xi^8$

Table 3: Full table showing the curvature types and their dependence on parameter ν.

One of the greatest challenges of this theory is that it requires not only physical experimentation to be validated but also extensive mathematical exploration. Currently, with limited resources, we have only been able to perform calculations with relatively low values of λ. Further exploration, most likely involving supercomputers, is needed to determine the appropriate values of σ and corresponding magnitudes for primitive states in a composite state that might yield the correct ratios of mass, energy, momentum, and forces as observed in experiments.

We would like to emphasize the potential of these Epm curvature states to explain all forces as they will later be theorized to have a magnitude proportional, to potential energy, the change in this magnitude over space, time and spacetime being force since these seem to have the correct scaling behavior due to ν and a flechible magnitude due to σ.

Curvature as Deviation

Curvature is defined as the deviation of a state from an ideal value, such as 1 or e. This deviation can be quantified and analyzed in terms of how it changes the behavior of a state. Small deviations, when multiplied, yield an overall result that approximately corresponds to an additive combination of curvatures, an effect that emerges from the properties of multiplicative scaling for small values.

Consider a state with a magnitude of 0.99 for a given input value of χ. The curvature, Φ, is defined as the deviation from the ideal magnitude (in this case, 1):

$$|\Phi_1| = 1 - 0.99 = 0.01$$

If we multiply two such states, the resulting state has a magnitude of:

$$|\Psi_1| \cdot |\Psi_2| = 0.99 \cdot 0.99 = 0.9801$$

The resulting curvature can be determined as:

$$|\Phi_{\text{result}}| = 1 - 0.9801 = 0.0199$$

Thus, the curvatures approchimately add:

$$|\Phi_1| + |\Phi_2| \approx 0.02$$

Improved Approchimation for Smaller Deviations

The approchimation becomes more accurate as the magnitude of the curvature decreases. For instance, if the state has a magnitude of 0.999, then the product of two such states is:

$$|\Psi_1| \cdot |\Psi_2| = 0.999 \cdot 0.999 = 0.998001$$

The resulting curvature is:

$$|\Phi_{\text{result}}| = 1 - 0.998001 = 0.001999$$

This result demonstrates that the deviation more closely approchimates an exact addition of the individual curvatures as the deviation becomes smaller.

In the limit of very small curvatures, such as those encountered on a cosmic scale where quantum forces are minimal, the approchimation becomes nearly exact.

Implications for Physical Systems

For physical systems where deviations from the ideal magnitude (e.g., 1 or e) are minimal, the property of additive curvature under multiplication simplifies modeling. This allows for the efficient representation of systems involving multiple interacting states, as the small curvatures can be treated as nearly

additive, significantly reducing computational complechity. This thoery only uses one scale, a cosmic scale wherein the deviations from the ideal magnitude are extremely small (quantum forces on the scale of the cosmos) such that the approchimation is almost exact.

Dynamics of Multiplying and Dividing States

We defined composite states which multiply and divide primitive states. We have defined these using set theory such that we are describing an element of a subset and the equations define how these subsets interact with other subsets. By defining general states in terms of composite states, general states have absorbed that generality. We therefor in the following subsection will define the dynamics between subsets which are defined by the properties an element (state) in that subset has.

Position Magnitude Under Multiplication

We define a position state $\underline{\Psi}$ as a state with a first-order, non-multiplicative position magnitude. Specifically, if $\underline{\Psi}$ has a position magnitude, then it does not require multiplication by x or any additional terms.

$$\underline{\Psi} \in \{\Psi \mid \text{has a non-multiplicative, first-order position magnitude}\}$$

If we consider two position states, $\underline{\tilde{\Psi}}$ and $\underline{\overline{\Psi}}$, and divide one by the other, the resulting state will lose the position magnitude property:

$$\underline{\tilde{\Psi}}_\star / \underline{\overline{\Psi}}_\star = \tilde{\Psi}_\star$$

Here, $\tilde{\Psi}$ no longer has a position magnitude, as dividing two states with position magnitudes cancels this property.

Similarly, multiplying two position states results in a state with a higher-order magnitude, which also loses the original position magnitude property:

$$\underline{\Psi}_\star \cdot \underline{\Psi}_\star = \Psi_\star, \text{quadratic}$$

This quadratic state no longer has the first-order position magnitude of the original position states.

However, if we multiply an general position state by an general simple state, the resulting state still retains the first-order position magnitude:

$$\underline{\Psi}_\star \Psi_\star = \underline{\Psi}_\star$$

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2. Multiplying a right-handed half general simple state by a zero general simple state results in a right handed half general simple state:

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In general, the different properties of a state—such as intrinsice rotation rate, position magnitude, magnitude scale, zero-point orientation, and peak offset—are independent of one another. This means that one property does not affect or influence the presence or behavior of another. Each property can be thought of as orthogonal to the others, so modifying one does not directly alter the others.

For example, consider the multiplication of a state with a intrinsice rotation rate equal to $\frac{1}{2}$ and a position magnitude by a state with no intrinsice rotation rate:

If we multiply a right-handed quarter general position state by a left-handed quarter general simple state, the result is a zero-position general simple state:

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This illustrates that one property (e.g., intrinsice rotation rate) does not affect another (e.g., the position magnitude), as the intrinsice rotation rate cancels out due to the interaction between the states, while the position magnitude is preserved. This independence holds across all properties defined for these states, allowing for flexibility in constructing and analyzing states with different combinations of properties without unintended interactions.

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Orbital States

Orbital angular momentum is encoded in the state Ψ_μ. In this formalism, Ψ_μ also possesses angular momentum, but unlike Φ_μ, which has fixed rates of rotation, Ψ_μ allows for more flechible rates of rotation. This flechibility permits Ψ_μ to describe much larger, non-quantized values of angular momentum.

For instance, Ψ_μ may have an angular momentum magnitude that corresponds to longer orbits and larger magnitudes of momentum. This flexibility arises because $|P_\mu^\flat|$ is not restricted to 1, allowing the state to represent a broad range of angular momentum values. In this context, general angular momentum is conceptually similar to that in traditional quantum mechanics, but it arises directly from the properties of the state itself, without requiring an operator to extract the magnitude.

2 Pauli Exclusion Principle

In this section, we explore how the Pauli Exclusion Principle (PEP) emerges within our theoretical framework, building upon the concepts of quantum spin established earlier.

2.1 Fermions in Bound States

For particles in a bound state, such as electrons in an atom, the wavefunctions must form standing waves to satisfy the boundary conditions of the system. In our formalism, the total state is given by:

$$\Omega = \chi_\mu \cdot \Psi_\mu, \tag{4}$$

where Ψ_μ is the orbital state contributing to orbital angular momentum, and χ_μ is the spin state contributing to spin angular momentum.

To form a standing wave, two fermions occupying the same bound state must have wavefunctions that are conjugates of each other. This requirement applies to both the orbital and spin components of their states.

2.1.1 Orbital State Conjugation

For the orbital state Ψ_μ, the conjugation corresponds to opposite momenta. Specifically, the two fermions must have orbital states with opposite signs of momentum, leading to opposite orbital angular momentum. This is consistent with the standard understanding in quantum mechanics that standing waves result from the superposition of waves traveling in opposite directions.

2.1.2 Spin State Conjugation

For the spin state χ_μ, conjugation implies that the fermions must have opposite quantum spins. According to our definitions, this means they have opposite spin angular momentum, arising from opposite spin momenta. This requirement ensures that the combined spin states of the two fermions form a standing wave pattern necessary for the bound state.

2.2 Application of the Pauli Exclusion Principle

By requiring both the orbital and spin components of the fermions' states to be conjugates, we effectively prevent two fermions from occupying the same quantum state unless their spins are opposite. This aligns with the Pauli Exclusion Principle, which states that no two identical fermions can occupy the same quantum state simultaneously.

In our framework, the PEP arises naturally from the necessity of forming standing waves in bound states. The combination of opposite orbital momenta and opposite spin states ensures that the overall wavefunction is antisymmetric under particle exchange, as required for fermions.

2.3 Single Particle in a Bound State

For a single fermion in a bound state, the requirement to form a standing wave implies that it must be in a superposition of spin-up and spin-down states. This superposition allows the particle's wavefunction to satisfy the boundary conditions of the system. This prediction is consistent with quantum mechanics, where particles in bound states are often found in superpositions of spin states.

2.4 Bosons and the Pauli Exclusion Principle

Bosons, in contrast to fermions, are not subject to the Pauli Exclusion Principle. In our formalism, bosons are not required to form standing waves in bound states, although they can do so. Since they are not constrained by the requirement of antisymmetry under particle exchange, bosons can occupy the same quantum state without restriction. This explains why the PEP does not apply to bosons within our theoretical framework.

2.5 Conclusion

The Pauli Exclusion Principle emerges in our theory as a consequence of the requirements for forming standing waves in bound states. By mandating that fermions have orbital and spin states that are conjugates of one another, we ensure that no two identical fermions occupy the same quantum state. This result is consistent with the established principles of quantum mechanics and demonstrates how the PEP can be derived from fundamental considerations within our framework.

The Quantization of Spin Angular Momentum in χ_μ

Introduction

In this proof, we demonstrate that the spin angular momentum associated with the spin state χ_μ is inherently quantized, while the orbital angular momentum in Ψ_μ is free to take arbitrary values. This quantization arises directly from the definitions and unique properties of χ_μ and Ψ_μ, their roles in forming the total wavefunction, and the scaling relations defined by the scalar parameter ξ.

Definitions and Setup

The total wavefunction Ω is defined as the product of the spin state χ_μ and the orbital state Ψ_μ:

$$\Omega = \chi_\mu \cdot \Psi_\mu$$

Both χ_μ and Ψ_μ are plane waves with distinct properties:

1. **Spin State χ_μ:**
    - The spin state determines the particle's intrinsic angular momentum. Its energy, momentum, and mass magnitudes are fixed ($|P^\flat_\mu| = 1$) but its intrinsice rotation rate is quantized, taking on specific allowed values.
    - When measuring spin angular momentum, by definition, the measurement pertains to the spin state χ_μ alone.
2. **Orbital State Ψ_μ:**
    - The orbital state encodes the particle's spatial configuration and external angular momentum. Unlike χ_μ, the orbital state allows $|P^\flat_\mu|$ to vary, leading to a continuum of possible momenta.
    - When measuring orbital angular momentum, by definition, the measurement pertains to the orbital state Ψ_μ alone.

We will define measurement dynamics in a subsequent paper, and so will not define this in a mathematically rigorous way now, but angular momentum measurements isolate the spin state χ_μ and orbital angular momentum measurements isolate the orbital state Ψ_μ. Finally, measurements of the total angular momentum are made on the total state (Ω). These distinctions allow us to proceed with analyzing the properties of each state in isolation.

Both χ_μ and Ψ_μ are plane waves. However, their key distinctions are as follows:

1. **Spin State χ_μ:**
    - By definition, $|P^\flat_\mu| = 1$, meaning χ_μ has a fixed magnitude in energy, momentum, and mass.
    - The intrinsice rotation rate of χ_μ is arbitrary, allowing it to take on the following quantized forms:

$$\begin{aligned}
\overline{\chi} &: \text{spin } 0 \quad (\text{no rotation, contributing } k = 0) \\
\overrightarrow{\chi} &: \text{spin } +\frac{1}{2} \quad (\text{right-handed, contributing } k = \frac{1}{2}) \\
\overleftarrow{\chi} &: \text{spin } -\frac{1}{2} \quad (\text{left-handed, contributing } k = -\frac{1}{2}) \\
\vec{\chi} &: \text{spin } +1 \quad (\text{right-handed, contributing } k = 1) \\
\overleftarrow{\chi} &: \text{spin } -1 \quad (\text{left-handed, contributing } k = -1)
\end{aligned}$$

2. **Orbital State Ψ_μ:**
    - Unlike χ_μ, Ψ_μ can take any arbitrary value of P (representing energy, momentum, or mass).
    - The intrinsice rotation rate for Ψ_μ is fixed to $\pm\frac{1}{2}$ (symbolically, an overset right arrow), meaning it cannot take on the other rates of rotation allowed for χ_μ.

Wave Dynamics and Angular Momentum

The total angular momentum arises from the combined contributions of χ_μ (spin angular momentum) and Ψ_μ (orbital angular momentum). Since the total wavefunction $\Omega = \chi_\mu \cdot \Psi_\mu$ involves multiplication of plane waves, their respective wavenumbers add:

$$k_{\text{total}} = k_\chi + k_\Psi$$

Thus, the total angular momentum is the sum of the spin angular momentum S_x and the orbital angular momentum L_x. However, measurements of S_x or L_x refer specifically to the properties of χ_μ or Ψ_μ, respectively, as defined above.

Conclusion

By clarifying the measurement definitions and focusing on the intrinsic properties of χ_μ and Ψ_μ, we establish a foundation for analyzing spin and orbital angular momentum dynamics. While the broader measurement dynamics remain under development, this framework enables a clear separation of spin and orbital contributions in alignment with the structure of this theory.

Wave Dynamics and Total Angular Momentum

The total angular momentum is the sum of the contributions from χ_μ (spin angular momentum) and Ψ_μ (orbital angular momentum). Since wavenumbers add under multiplication of wavefunctions, the total wavenumber k_{total} is given by:

$$k_{\text{total}} = k_\chi + k_\Psi$$

Here, k_χ corresponds to the quantized momentum values contributed by χ_μ, while k_Ψ corresponds to the momentum values contributed by Ψ_μ. The spin angular momentum S_x is defined as the angular momentum arising from χ_μ, while the orbital angular momentum L_x is that due to Ψ_μ.

Quantization of Spin Angular Momentum

Because $|P_\mu^\flat| = 1$ for χ_μ, the magnitude of the energy, momentum, and mass associated with χ_μ is fixed. However, χ_μ is allowed to take on arbitrary rates of rotation, leading to quantized values of momentum:

$$p_\chi = k_\chi$$

where k_χ corresponds to the wavenumber determined by the instrinsic rotation rate. These wavenumbers are directly proportional to the spin angular momentum S_x, as angular momentum is given by:

$$S_x = r \times p_\chi$$

By substituting $r = 1$ (unit radius) and using the quantized values of k_χ, we obtain:

$$S_x = \begin{cases} 0 & \text{for } \overline{\chi} \\ \pm\frac{\hbar}{2} & \text{for } \overrightarrow{\chi} \text{ and } \overleftarrow{\chi} \\ \pm\hbar & \text{for } \overrightarrow{\chi} \text{ and } \overleftarrow{\chi} \end{cases}$$

Thus, the spin angular momentum is quantized into discrete values, corresponding directly to the allowed rates of rotation in χ_μ.

Orbital Angular Momentum and Arbitrary Values

For the orbital state Ψ_μ, the instrinsic rotation rate is fixed, but $|P_\mu^\flat|$ is free to vary, allowing k_Ψ (and thus p_Ψ) to take on arbitrary values. As a result, the orbital angular momentum L_x can take any value, unlike the quantized spin angular momentum S_x.

Scaling Relations and Role of ξ

The scaling relations defined by ξ ensure consistency across dimensions. Specifically, the relationships:

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

and:

$$|E|\xi = |t^\circ|, \quad |p_x|\xi = |x^\circ|, \quad |p_y|\xi = |y^\circ|, \quad |p_z|\xi = |z^\circ|, \quad |m|\xi = |S^\circ|,$$

imply that the spatial and momentum components of the wavefunction are scaled versions of ξ. Since χ_μ and Ψ_μ are functions of ξ, this scaling further ensures that the spin angular momentum is quantized, while the orbital angular momentum remains continuous and unquantized.

Conclusion

Superpositions can be made using superpositions of the total state Ω but not χ or Ψ on its own. This ensures that when we collapse the state to an Epm state (which is similar to a momentum eigenfunction), that we're collapsing to a planewave with two composite planewaves. In this, we ensure that even in collapse, the state has a well-defined quantum spin.

The term Epm also references this theory's suppositions that E, p and m are all manifestations of what are fundamentally the same things: rates.