The Theory of Isomorphic Physics
Part 4: Theoretical Ramifications

John Henke

September 28, 2024

Bosons

In this theory, bosons are represented by the elements I, A, B, and C from the dualistic group. Each of these elements can be subscripted to represent specific bosons, including force carriers like the photon, W and Z bosons, and gluons, which mediate interactions between fermions.

- **General Bosons:** The elements I, A, B, and C represent different possible boson types. They carry specific transformation properties that correspond to gauge bosons in the Standard Model.
- **Subscripts for Bosons:** Specific bosons like the photon, W, Z, and gluons are indicated using subscripts:
  - I_γ: Represents the photon, the mediator of electromagnetic interactions.
  - I_W, A_W, B_W, C_W: Represent the W and Z bosons, responsible for mediating the weak force.
  - I: Can represent the neutral gluons (7th and 8th gluons), which are the neutral combinations of color and anti-color. These mediate the strong force in the context of Quantum Chromodynamics (QCD).
- **Color-Charged Gluons:** The elements A, B, and C are associated with the gluons that carry specific color-anticolor charges. These elements are essential in QCD for mediating the interactions between quarks.
  - A: Represents gluons with green and anti-blue, or anti-green and blue, color charges.
  - B: Represents gluons with red and anti-blue, or anti-red and blue, color charges.
  - C: Represents gluons with red and anti-green, or anti-red and green, color charges.

Each of these combinations of color and anti-color corresponds to the non-neutral gluons, which participate in the strong interactions between quarks. The specific subscript notation distinguishes between different types of gluons in this formalism, with A, B, and C mediating the exchange of color charges between quarks.

The bosonic elements in this theory can interact to form more complex structures. The normalization and zero-equation properties discussed earlier extend naturally to bosons, meaning that any superposition or combination of these elements retains certain normalization conditions. For example, a photon, gluon, or W boson may combine with fermions or other bosons, subject to the algebraic and symmetry constraints imposed by the theory.

Fermions

Fermions are represented by the elements G, X, Y, and Z from the dualistic group. These elements correspond to leptons and quarks, which are the fundamental building blocks of matter.

- **Leptons:** The element G represents leptons, such as electrons, neutrinos, and their associated anti-particles. In this context, G can be thought of as representing the fundamental fermionic states with no color charge (since leptons are color-neutral).
  - G_e: Represents the electron.
  - G_ν: Represents the neutrino.
  - $G_{\bar{e}}$: Represents the positron (anti-electron).
- **Quarks:** The elements X, Y, and Z represent quarks, which possess color charges and participate in the strong interaction. Each of these elements corresponds to quarks with different color charges:
  - X: Represents quarks with red (and anti-red) color charges.
  - Y: Represents quarks with green (and anti-green) color charges.
  - Z: Represents quarks with blue (and anti-blue) color charges.

  These elements can be used to construct the quark content of baryons (such as protons and neutrons) and mesons, where quarks combine in specific ways to form bound states. For instance:

  $$\alpha_p = X_u Y_u Z_d$$

  could represent a proton, consisting of two up quarks (u) with red and green color charges and one down quark (d) with a blue color charge.

Fermion and Boson Interaction

In this framework, fermions and bosons interact according to the algebraic rules discussed earlier. Fermions, represented by G, X, Y, and Z, can interact with bosons, represented by I, A, B, and C. These interactions are subject to symmetry and conservation laws that arise naturally from the structure of the algebra.

For example, an electron interacting with a photon might be represented as:

$$\alpha_{G_e}\alpha_{I_\gamma} = \alpha_{G_e}$$

This represents the fact that the electron can absorb or emit a photon without changing its fundamental fermionic nature (although its energy and momentum may change). Similarly, interactions between quarks and gluons involve the exchange of color charge:

$$\alpha_{X_u}\alpha_A = \alpha_{Y_u}$$

This could represent a red up quark interacting with a green-antiblue gluon, resulting in a green up quark.

Conclusion

This dualistic group provides a unified framework for describing both fermions and bosons. The elements I, A, B, C correspond to bosons, while G, X, Y, and Z correspond to fermions. The interactions between these elements follow from the algebraic structure of the group, with subscripts denoting specific types of particles such as W and Z bosons, gluons, quarks, and leptons. The formalism also accommodates color charge in QCD and the quantum numbers associated with the Standard Model particles.

Interaction Notation

This section uses the algebra of the group elements to describe interactions between fermions and bosons, as well as fermion-antifermion annihilation. Each interaction corresponds to a physical process and is represented using algebraic multiplication in the group. These interactions can be mapped to the corresponding processes in Feynman diagrams. The results of the interactions are bosons or new fermions, depending on the process.

- $X_\mathrm{q} \cdot X_{\overline{\mathrm{q}}} = I_\gamma$:

    This equation represents quark-antiquark annihilation, where a quark (X_q) and its corresponding antiquark ($X_{\overline{\mathrm{q}}}$) annihilate to form a photon (I_γ). This describes how quark-antiquark pairs can annihilate into gauge bosons such as photons, which are mediators of the electromagnetic force.

    In Feynman notation: $\mathrm{q} + \overline{\mathrm{q}} \to \gamma$

Mathematically, the result follows from the group structure, where fermion-antifermion pairs annihilate to form bosonic elements like I_γ.

- $G_{e^-} \cdot G_{e^+} = I_\gamma$:

  This represents electron-positron annihilation, where an electron (G_{e^-}) and a positron (G_{e^+}) annihilate to form a photon (I_γ). This is the standard electron-positron annihilation process seen in Quantum Electrodynamics (QED), where the particle-antiparticle pair results in a photon.

  In Feynman notation: $e^- + e^+ \to \gamma$

  In the algebraic structure of the group, this interaction reflects the ability of fermions and their anti-particles to annihilate into bosonic elements such as I_γ, consistent with physical particle interactions.

- $X_{q_{\text{red}}} \cdot Y_{\overline{q}_{\text{green}}} = -C_{g_{\text{red anti-green}}}$:

  Here, a red quark ($X_{q_{\text{red}}}$) interacts with an anti-green quark ($Y_{\overline{q}_{\text{green}}}$) to produce a gluon ($-C_{g_{\text{red anti-green}}}$). This is a strong interaction where the color charge of the quarks leads to the emission of a gluon carrying the appropriate color-anticolor charge combination.

  In Feynman notation: $q_{\text{red}} + \overline{q}_{\text{green}} \to g_{\text{red anti-green}}$

  In the algebra, gluons are produced by the interaction of color-charged quarks, and this algebraic notation captures the exchange of color charge between fermions via gluon emission.

- $-C_{g_{\text{red anti-green}}} \cdot Y_{q_{\text{green}}} = X_{q_{\text{red}}}$:

  The gluon $-C_{g_{\text{red anti-green}}}$ interacts with a green quark ($Y_{q_{\text{green}}}$) to produce a red quark ($X_{q_{\text{red}}}$). This process describes how gluons can mediate the exchange of color charge between quarks in Quantum Chromodynamics (QCD).

  In Feynman notation: $g_{\text{red anti-green}} + q_{\text{green}} \to q_{\text{red}}$

  The group notation captures the interaction of a gluon with a quark, resulting in the transfer of color charge and the formation of a new quark with a different color.

- $Y_{q_{\text{green}}} \cdot Z_{\overline{q}_{\text{blue}}} = -A_{g_{\text{green anti-blue}}}$:

  A green quark ($Y_{q_{\text{green}}}$) interacts with an anti-blue quark ($Z_{\overline{q}_{\text{blue}}}$) to form a gluon ($-A_{g_{\text{green anti-blue}}}$). This is another example of a strong interaction, where the quark-antiquark pair emits a gluon.

  In Feynman notation: $q_{\text{green}} + \overline{q}_{\text{blue}} \to g_{\text{green anti-blue}}$

The algebra reflects how quark-antiquark pairs interact through the exchange of gluons with specific color-anticolor charges.

- $-A_{g_{\text{green anti-blue}}} \cdot Z_{q_{\text{blue}}} = Y_{q_{\text{green}}}$:

  The gluon $-A_{g_{\text{green anti-blue}}}$ interacts with a blue quark ($Z_{q_{\text{blue}}}$) to return a green quark ($Y_{q_{\text{green}}}$). This describes how gluon exchange results in color charge transfer, with the blue quark becoming a green quark.

  In Feynman notation: $g_{\text{green anti-blue}} + q_{\text{blue}} \to q_{\text{green}}$

  The interaction dynamics of gluons and quarks are captured by the algebra, showing how color charge is exchanged in QCD processes.

Probability of Interaction

The probability of interaction between two particles is given by the parentheses of their respective wavefunctions. This quantifies the likelihood of the two particles interacting when they are in proximity. For instance, for two particles α_1 and α_2, the probability of interaction is expressed as:

$$P_{\text{interaction}} = (\alpha_1 \cdot \alpha_2 | \alpha_1 \cdot \alpha_2)$$

This formula provides the probability that the two particles, represented by their group elements, will interact and form a new particle or gauge boson as described by the interaction rules above. It reflects the normalization conditions of the wavefunctions, ensuring that interactions follow the algebraic structure.

The Weak Force

The weak force in this theory can be understood using the group property:

$$\alpha_1 \cdot \alpha_2 = \alpha_3 \quad \Rightarrow \quad \alpha_3 \cdot \alpha_2 = \alpha_1 \quad \text{and} \quad \alpha_3 \cdot \alpha_1 = \alpha_2$$

This property suggests a symmetry in particle interactions that applies to the weak force, specifically in the context of particle-anti-particle annihilation and the mediation of transitions by weak bosons. In the framework of your theory, we can make the following interpretations:

Interaction and Weak Bosons

- Let α_1 represent a particle of any type (e.g., an electron, quark, or neutrino). - Let α_2 represent the anti-particle corresponding to α_1. - When α_1 and α_2 interact, they form a new entity, α_3, which represents a weak boson—either a $W^{\pm}$ or Z^0 boson.

This can be expressed as:

$$\alpha_1 \cdot \alpha_2 = \alpha_3$$

Here, α_3 is an analog to a plane-wave for a weak boson that mediates the weak interaction. The key point is that α_3 is formed as a result of the interaction between the particle and its anti-particle.

Superposition of Weak Boson States

The weak boson α_3 exists in a superposition of all possible particle and anti-particle pairs that could form it. For example, a Z^0 boson could exist in a superposition of an electron-positron pair, a quark-antiquark pair, or other lepton-antilepton combinations. Mathematically, we could represent this superposition as:

$$\alpha_3 = \sum_i \alpha_i \cdot \alpha_{\bar{i}}$$

where α_i represents various particles, and $\alpha_{\bar{i}}$ represents their corresponding anti-particles. The weak boson α_3 thus exists as a superposition of these pairs.

Collapse and Weak Force Mediation

When this superposition collapses to a specific eigenstate, α_3 mediates a transition between different particle types. For example, in a charged current interaction, a $W^{\pm}$ boson can mediate the transformation of a quark of one flavor to another, or a neutrino into a charged lepton.

This process can be described by the second part of the group property:

$$\alpha_3 \cdot \alpha_2 = \alpha_1$$

Here, α_3 (the weak boson) interacts with α_2 (the anti-particle) to "replace" it with α_1 (the original particle). The weak boson effectively transforms one particle into another.

For example, in beta decay: - A down quark (α_1) and a W^- boson (α_3) interact, causing the down quark to transform into an up quark (α_2). - The W^- boson decays into an electron and an anti-neutrino, completing the weak interaction.

In the algebraic framework, this corresponds to the collapse of the weak boson's superposition into a specific eigenstate, which determines the particles involved in the interaction.

Interpretation of Weak Force Dynamics

- When α_1 (a particle) and α_2 (an anti-particle) interact, they annihilate to form α_3 (a weak boson). - α_3 exists in a superposition of possible particle-anti-particle states, but upon interaction, it collapses to a specific eigenstate that mediates a transformation. - This transformation results in one particle type being "replaced" by another, as mediated by the weak boson, with the process preserving the symmetry of the interaction.

Thus, the weak force can be seen as a transformation between particle types, mediated by the weak boson, and governed by the algebraic properties of the group.

Probability of Interaction

The probability of interaction between two particles through the weak force is given by the parentheses notation:

$$P_{\text{interaction}} = (\alpha_1 \cdot \alpha_2 | \alpha_1 \cdot \alpha_2)$$

This expression calculates the probability that the interaction between α_1 and α_2 will result in the formation of α_3, a weak boson that mediates the interaction.

Curvature Type and Particle Mass

In conventional quantum field theory, the fact that a given type of particle always has the same mass is explained through field interactions. In contrast, this unique form of the wavefunction provides an alternative explanation for the conservation of mass across different particles of the same type. In this theory, the magnitude of the force varies widely between primitives, but by increasing the value of ρ, we can increase the curvature of the wavefunction linearly. This curvature Φ can be interpreted as a deviation from the pure or ideal eigenvalue, and its magnitude is proportional to ρ and the intrinsic curvature of ϕ:

$$\Phi \propto \rho \cdot \text{Curvature}(\phi)$$

Scaling Curvature and Force

In the case of a force associated with $\mu = 4$, which is interpreted as the mass eigenvalue, the wavefunction's curvature must be scaled across different primitives to ensure a constant value for the force. This is essential to maintain mass conservation across particles in a row of the Standard Model. By adjusting the curvature via ρ, we scale the values of primitives in such a way that the force remains constant for all particles of the same type. The mass must then be scaled accordingly to ensure the force is conserved, leading to predictable mass ratios across different particles.

Mathematically, we propose the following relation for the curvature of the mass eigenvalue $\mu = 4$:

$$\text{Curvature}_{\mu=4} = \rho \cdot \left(\frac{\partial^2 \phi}{\partial \xi^2} \right)$$

This allows us to scale the mass such that the force remains consistent across different particles.

Example Mass Scaling

In the following tables, we present predicted mass ratios for different combinations of σ and ξ, which represent parameters that control the wavefunction's curvature. These mass ratios are based on the scaling behavior discussed above.

The mass ratios predict how different particles with varying σ and ξ values will scale their curvature and force, ensuring that the same fundamental force acts across all particles of the same type.

This framework gives us a clear path to understanding how different force magnitudes and curvature types relate to particle mass scaling. The variation in σ and ξ values allows us to explore different scaling behaviors for particles in the Standard Model and beyond.

Predicted Mass as Ratio	$\sigma = 20, \xi = 1$	$\sigma = 100, \xi = 1$	$\sigma = 100, \xi = 20$	$\sigma = 10000, \xi = 100$
$-a, \nu = 0$	1	1	1	1
$a, \nu = 0$	0.58	0.9	0.70	0.871
$b, \nu = 0$	4.55	8.35	2.15	7.41
$-b, \nu = 0$	20.4	10.86	2.36	12.4
$-c, \nu = 0$	21.89	16.95	6.64	17.83
$c, \nu = 0$	8.35	14.11	5.67	13.14
$-d, \nu = 0$	4.65	28.72	0.83	13.54
$-g, \nu = 0$	4.04	3.78	2.57	3.84
$g, \nu = 0$	2.11	3.32	1.99	3.17
$f, \nu = 0$	30.81	191.18	6.13	100.04
$-A, \nu = 0$	3.39	3.61	32.83	3.42
$A, \nu = 0$	3.13	3.55	32.44	3.42
$B, \nu = 0$	8.79	9.72	88.57	9.31
$-B, \nu = 0$	8.98	9.76	88.86	9.31
$C, \nu = 0$	24.57	26.59	241.83	25.33
$-C, \nu = 0$	23.7	26.38	240.5	25.32
$-D, \nu = 0$	187.68	1065.06	1.44	51631.92
$G, \nu = 0$	1384.94	7869.34	1.06	381511.16
$-a, \nu = 1$	140.97	2.71	1130.87	17177.52
$a, \nu = 1$	61.49	513.68	1130.89	17177.52
$b, \nu = 1$	60.654	379.19	3051.3	46347.86
$-b, \nu = 1$	62.66	381.65	3051.31	46347.86
$-c, \nu = 1$	96.71	1860.58	8316.28	126320.35
$c, \nu = 1$	312.51	1879.69	8316.3	126320.36
$-d, \nu = 1$	19.14	118.16	1121.29	17031.86
$-g, \nu = 1$	253.33	1807.13	3065.78	46567.82
$g, \nu = 1$	423.36	1989.71	3065.8	46567.82
$f, \nu = 1$	182.94	1128.69	8298.42	126049.01

Table 1: Predicted mass ratios for different combinations of σ and ξ.

Predicted Mass as Ratio	$\sigma = 20, \xi = 1$	$\sigma = 100, \xi = 1$	$\sigma = 100, \xi = 20$	$\sigma = 10000, \xi = 1$	$\sigma = 10$
$-a, \nu = 2$	1	1	1	1	
$a, \nu = 2$	0.73	0.94	0.98	0.99	
$b, \nu = 2$	8.45	9.63	9.71	9.96	
$-b, \nu = 2$	8.7	9.69	10.11	9.96	
$-c, \nu = 2$	15.86	16.17	16.36	16.25	
$c, \nu = 2$	12.33	15.37	15.97	16.25	
$-d, \nu = 2$	47.84	272.32	183.55	280842.49	2.
$-g, \nu = 2$	3.67	3.72	3.74	3.73	
$g, \nu = 2$	2.8	3.52	3.68	3.73	
$f, \nu = 2$	455.31	2557.5	1349.81	2.63	2.6
$-A, \nu = 2$	3.67	3.66	3.65	3.66	
$A, \nu = 2$	3.14	3.55	3.64	3.66	
$B, \nu = 2$	9.08	9.77	9.92	9.96	
$-B, \nu = 2$	9.48	9.85	9.92	9.96	
$C, \nu = 2$	26.07	26.87	26.96	27.09	
$-C, \nu = 2$	24.29	26.48	26.96	27.09	
$-D, \nu = 2$	54.27	544.39	2.11	549994.21	5.4
$G, \nu = 2$	400.75	4022.35	2.86	4.06	4.0
$-A, \nu = 1$	81.42	401.5	406.14	400001.52	4
$A, \nu = 1$	71.04	390.27	405.39	399990.06	3.
$B, \nu = 1$	83.84	437.82	47.56	442973.98	4.4
$-B, \nu = 1$	673.64	3841.73	4037.2	3.98	3.9
$C, \nu = 1$	1282.48	6483.12	6599.4	6.5	6.
$-C, \nu = 1$	1194.04	6387.54	6593.02	6.5	6.

Table 2: Predicted mass ratios for different combinations of σ and ξ.

NOTE: NEED A SECTION TALKING ABOUT THE MASSES OF THE PARTICLES AND HOW IT CONNECTS TO CURVATURE TYPE.

NOTE: SHOULD PROBABLY INCLUDE THE "N2" TABLE.

NOTE: SHOULD PROBABLY AT LEAST MENTION THE HIGGS BOSON.