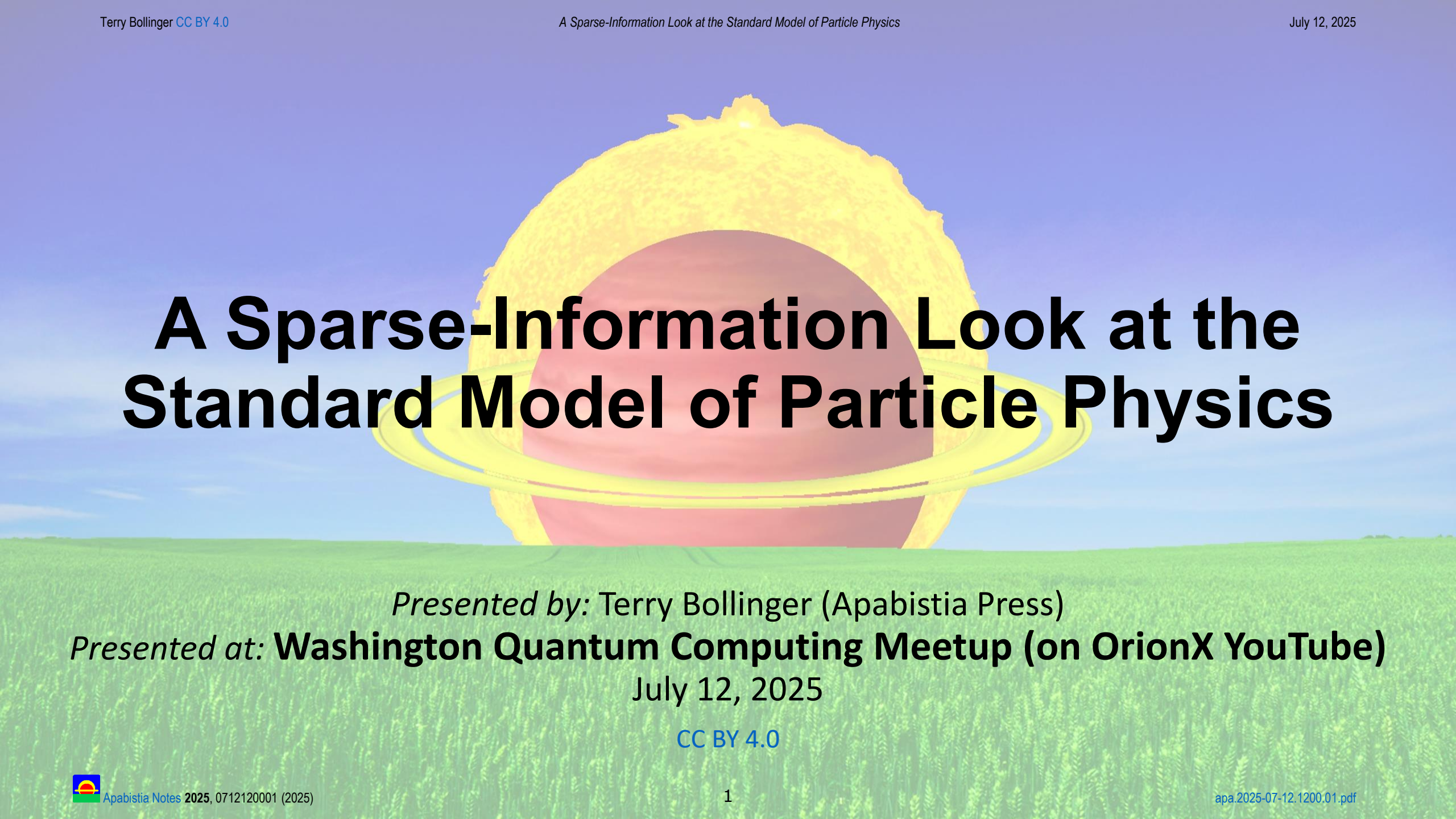


A Sparse-Information Look at the Standard Model of Particle Physics

Presented by: Terry Bollinger (Apabistia Press)

Presented at: **Washington Quantum Computing Meetup (on OrionX YouTube)**

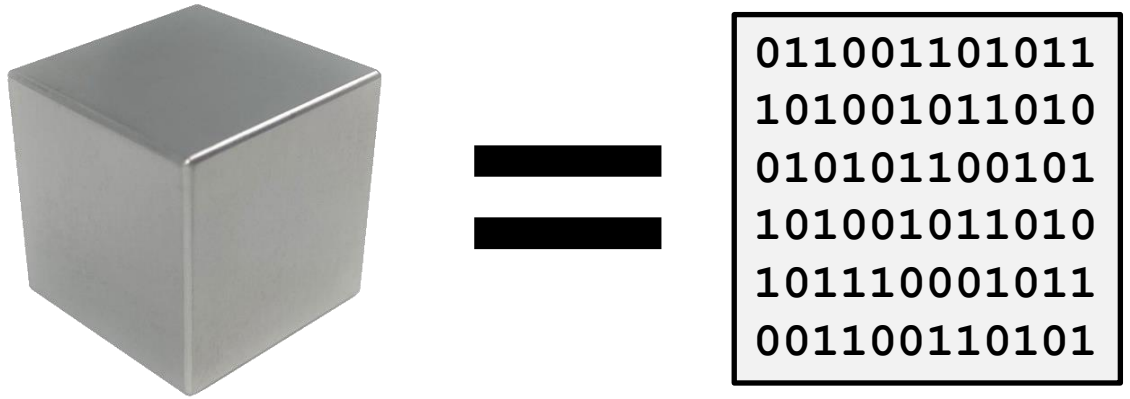
July 12, 2025

Overview

- First, a quick overview of my sparse universe interpretation
- Why folks need to stop treating "observation" as mysterious. It's just bumping, and it *enables* classical physics emergence.
- Mirrors! Reality is all about increasingly complex sets of mirrors
- What you believe about inertial frames is probably flatly wrong
- An overview (with minimal math) of the Standard Model
- An example of how to simplify Standard Model math
- Issues for some other time (e.g., a $1,000,000 Symmetry Prize)

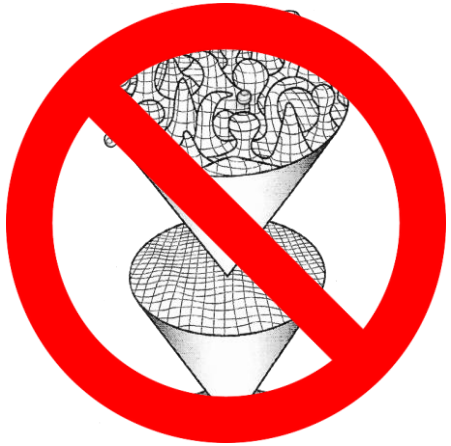
Sparse-Information Physics (1 of 2)

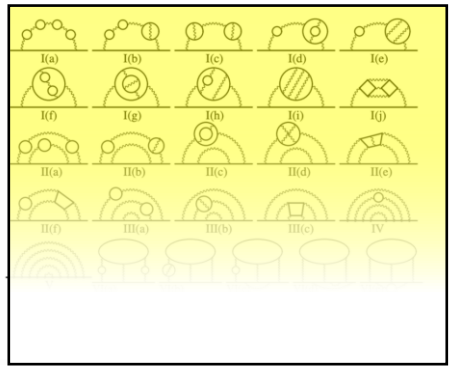
- Main premise: Information is a construct of the material universe
  - Mass and energy provide *data storage and transmission* to all of physics
  - Both time (memories of the past) and space (stable lengths) require data
  - Below certain minimums (e.g., one electron), *stable data ceases to exist*
  - Too few bits lead to loss of resolution ("pixelation"): Quantum uncertainty
  - Important corollary: *Mathematics* that assumes information invokes *mass*

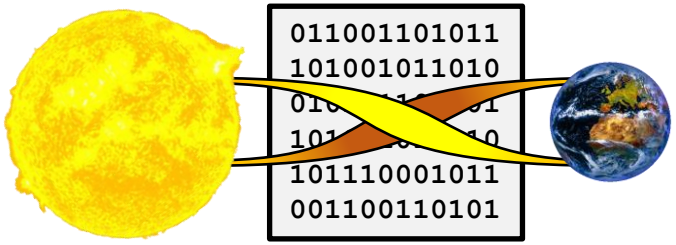


Sparse-Information Physics (2 of 2)

- Corollary: The vacuum becomes exactly that: Totally empty space
  - "Empty" is fully compatible with special relativity (and *centuries of thought*)
  - No Planck foam, no QCD fluctuations *except* when energized
  - Quantum fields become *localized* by inertial frames and "funded" by energy
  - No "effective" field theories (no cut-offs, no vacuum density issues)
  - Gravity and motion become *encodings* of relationships between objects

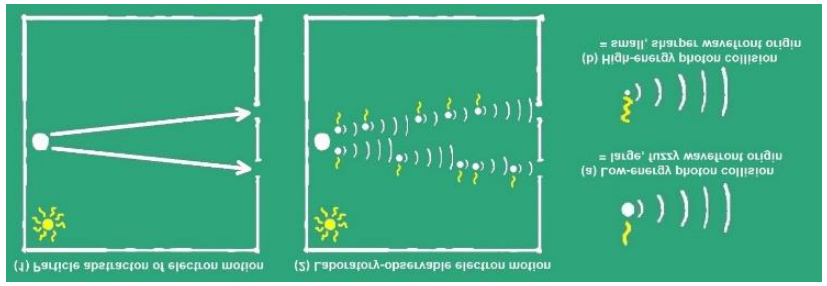


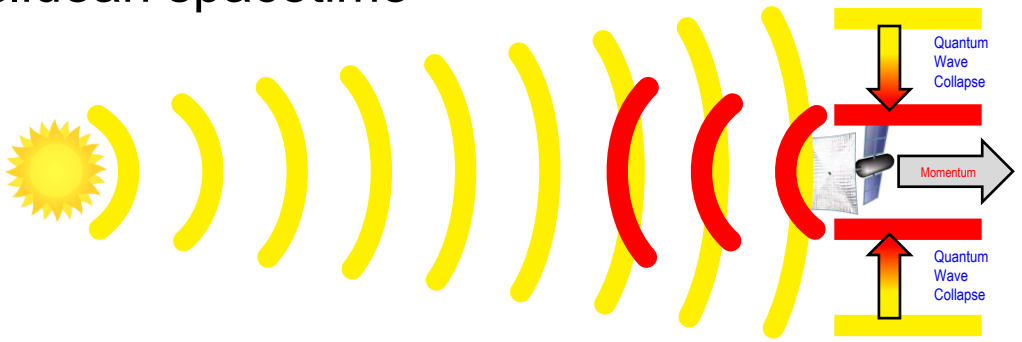




Needed: Ferocious Realism With No Observers

- *Any* math abstraction that goes to infinity mangles reality
  - Examples: Unguarded field theories, perfect Riemannian manifolds, MWI, true points
  - But why? Because…
- Wave collapse is real, *very* common, and *creates* classical physics
  - Linear momentum (which is not quantized) is the culprit: Every "bump" collapses waves
  - Collapse occurs in an infinite range of scales (e.g., human-scale mirrors collapse photons)
  - An electron orbital comes closest to point-like "continuous collapse" (angular acceleration)
  - Point-like particle paths do not exist; the closest is tight sequences of collapses
  - Interacting, multi-scale collapses create information (persistence, reality)
  - Gravity (equivalence principle) is the residual left after locally detectable accelerations finish constructing their "almost perfect" Euclidean spacetime





The Standard Model of Particle Physics

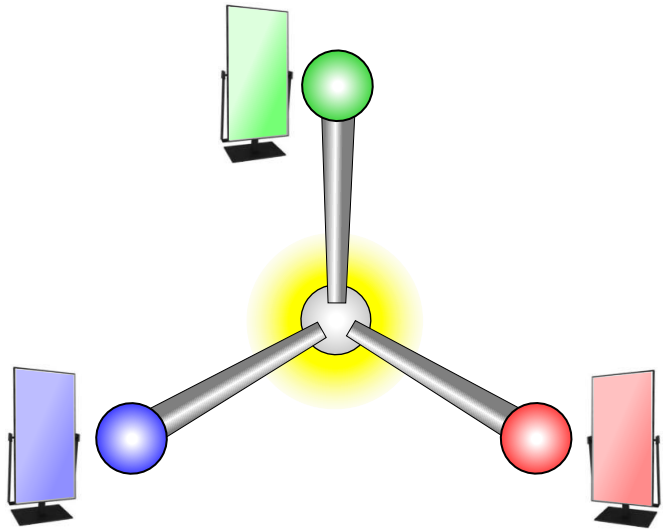
- The Standard Model is the theory of all particles seen in physics
- This astonishing work unified previously incomprehensible data
  - Once completed in the late 1970s, it predicted particles *never seen before*
  - The final predicted particle, the Higgs boson, was finally observed in 2012
  - While comprehensive, it remains a mix of predictive math and observations (e.g., its math does not explain why "matter particles" have three versions)
- Of the particles predicted, only four dominate everyday life: electrons (e^-), up (u) and down (d) quarks, and photons (γ, light)
- Quarks (plus binding gluons) only exist *inside* protons and neutrons
- Honorable mention: Neutrinos (ν) are *everywhere* (but *ghostly*)

The Role of Symmetries in Reality

- Particle physics (and reality) is like a delightfully complicated house of mirrors
- Hierarchies of reflections create the complex universe we think of as “classical” physics
- As long as images co-reside in the same local spacetime, they remain *equally* real
- Dirac was the first to use symmetries to predict a new particle: the *positron*
- Strange, hard-to-cancel combinations of images create persistent paradoxes: time
- Hydrogen atoms are one such paradox

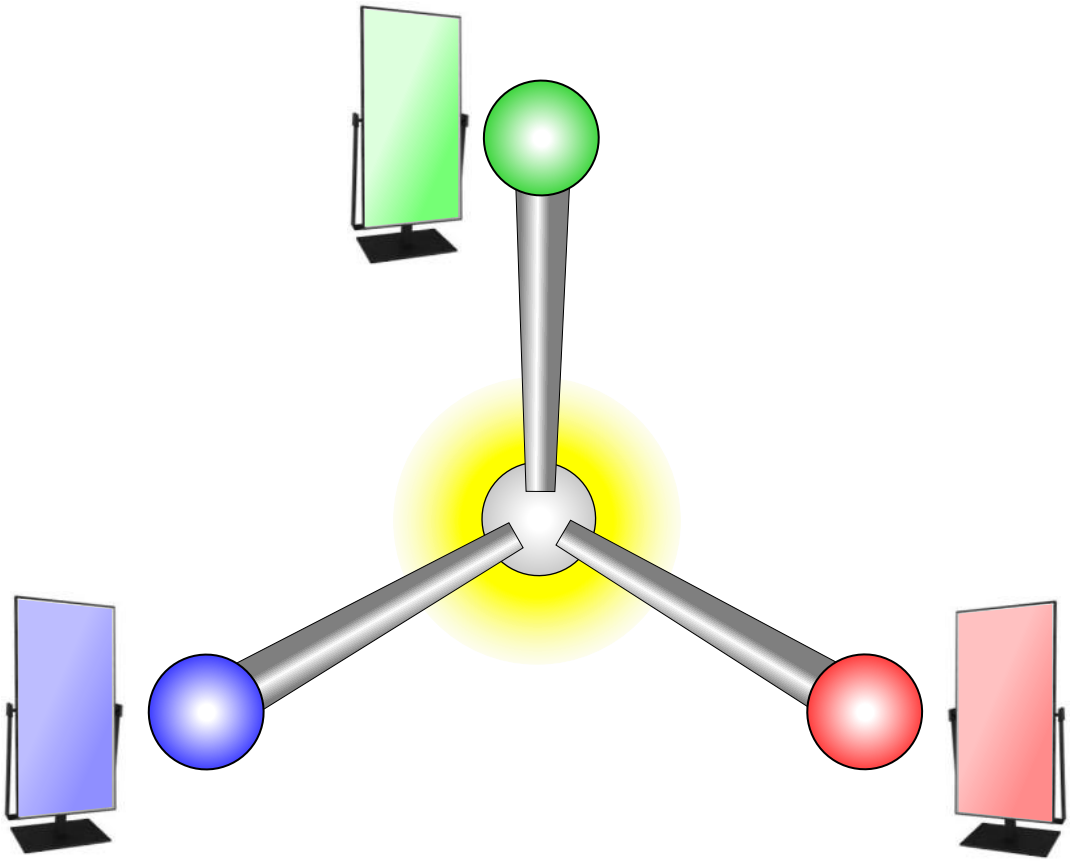
Building Complexity: Reflections of Reflections

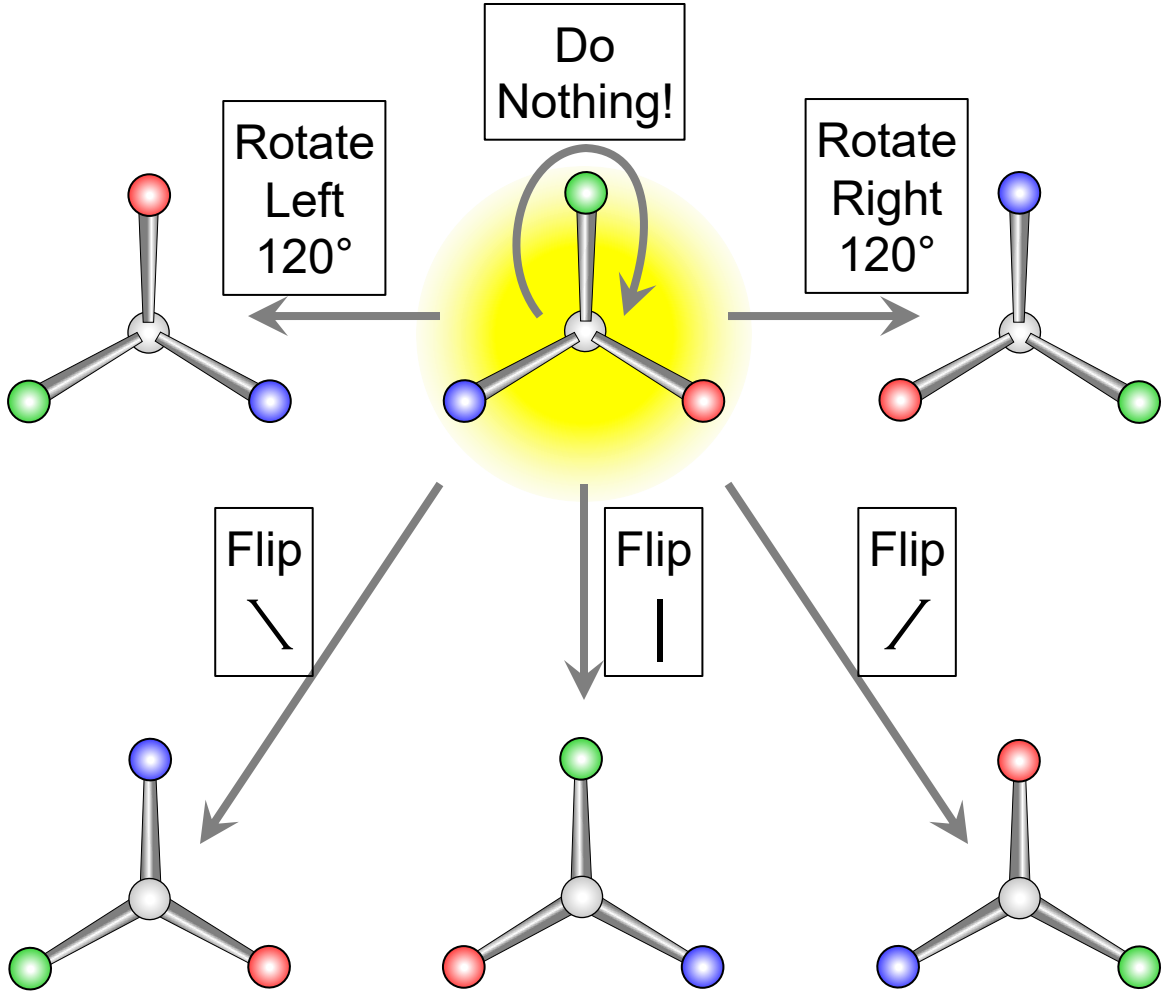
- The trick in describing symmetries is to find all the “mirrors” (operators) that return you the *original* image.
- Dirac’s positron — an antimatter electron — was the simplest example since it is literally an electron’s mirror reflection (almost)
- Collections of images form new objects that reflect in new ways:



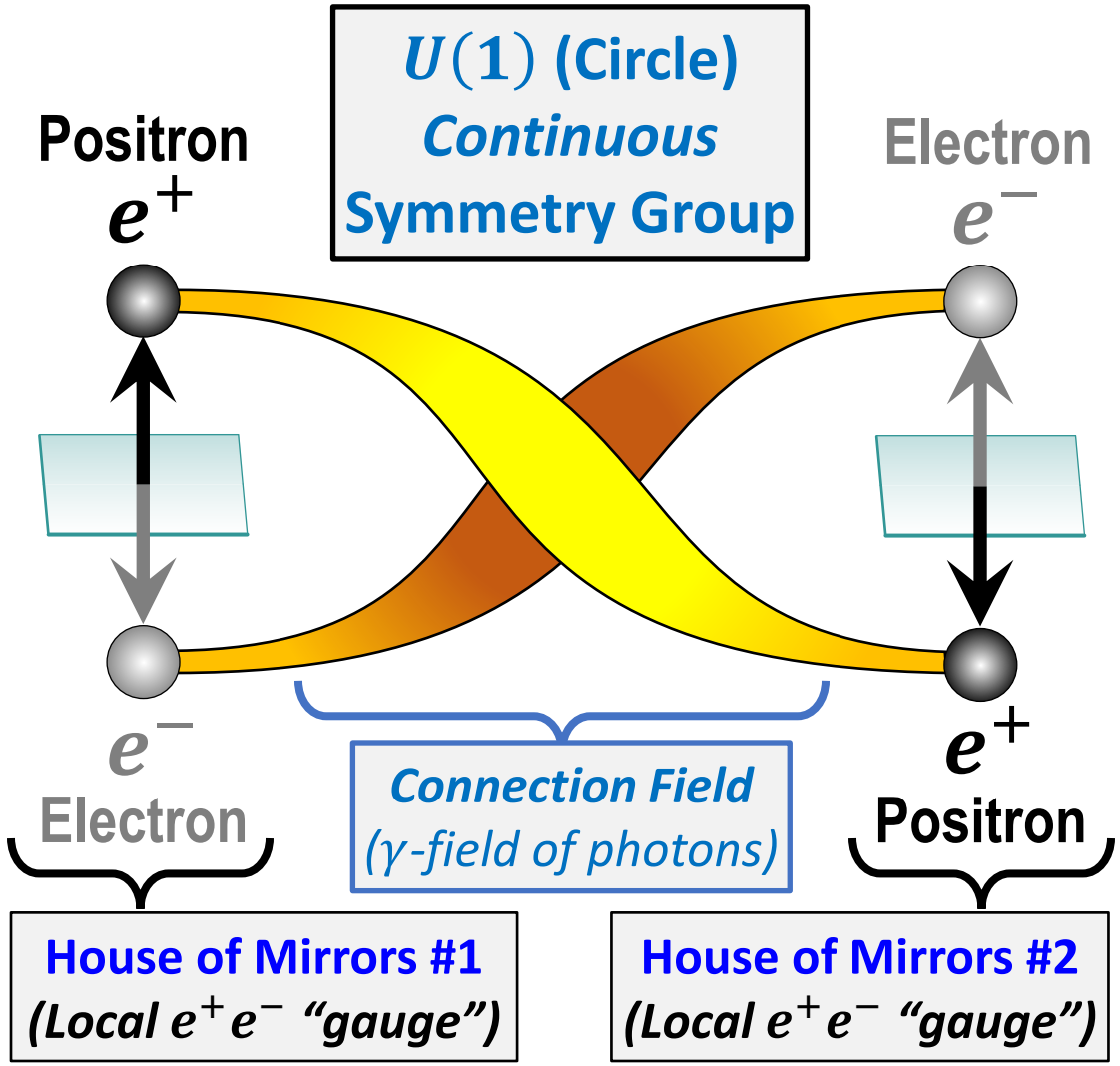
  - Imagine three images of one ball, created by arranging mirrors
  - Using colored mirrors on rigid rods helps distinguish the images. These distinctions have meaning only in relation to one another.
  - You have a new object! Notice how this new object subtly *assumes* concepts of dimensions, order, rigidity, and rigidity.
  - Next, use the new, more complex object as your starting object.
  - How many ways can you rotate or flip this rigid triplet of images?

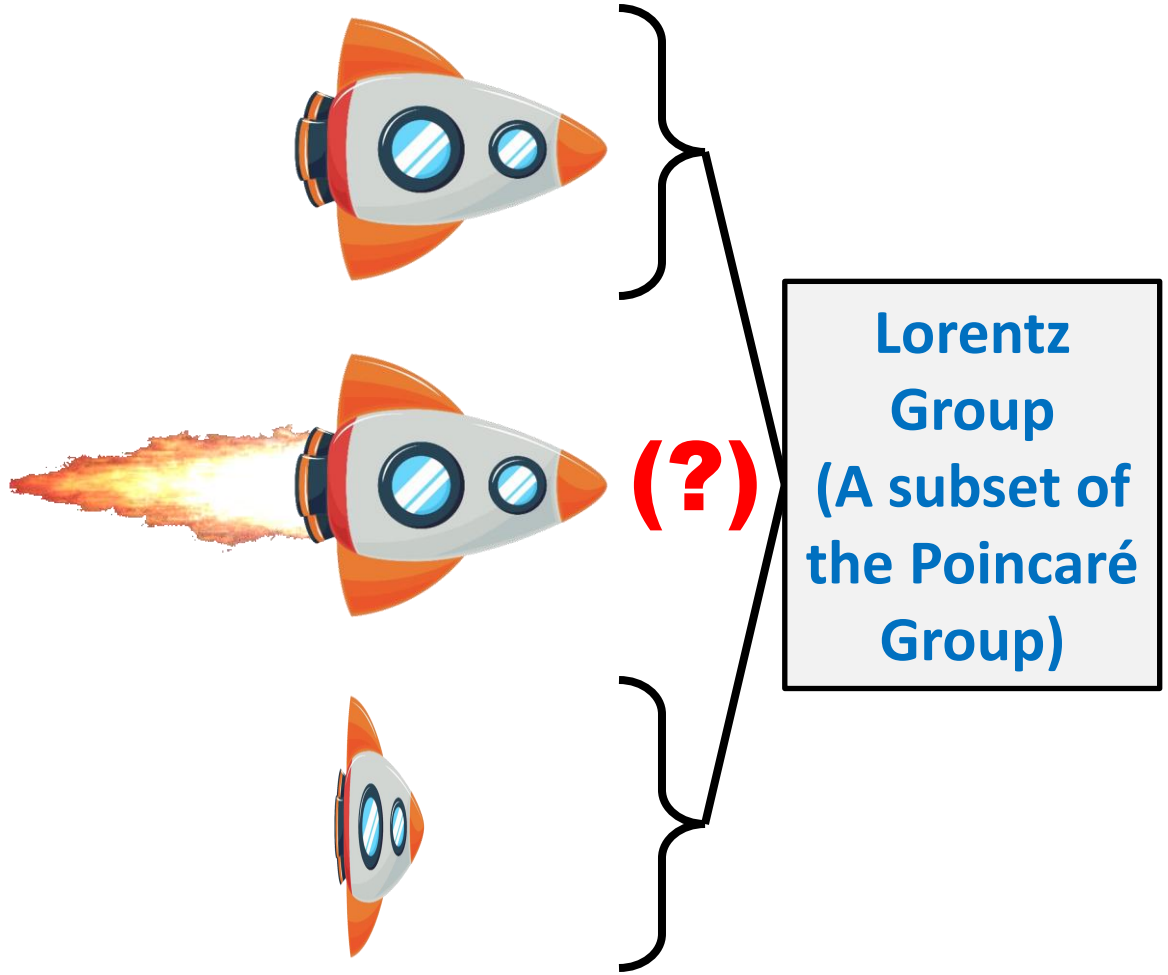
Reflection of Reflections: The Dihedral Group D_3



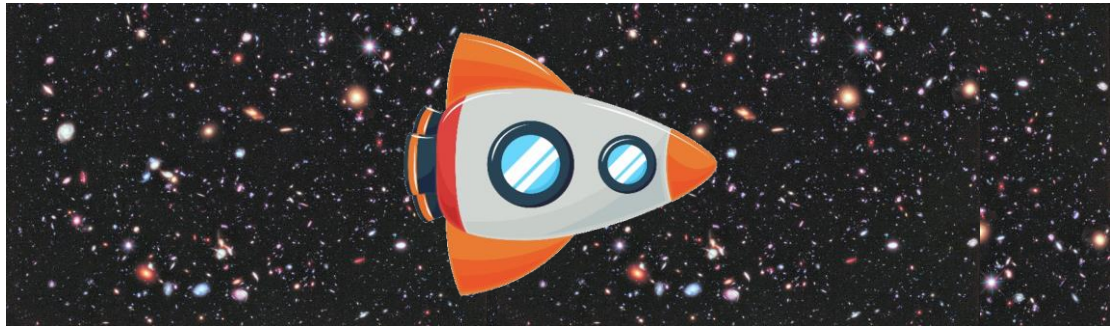


Symmetry Groups for Particles and Relativity

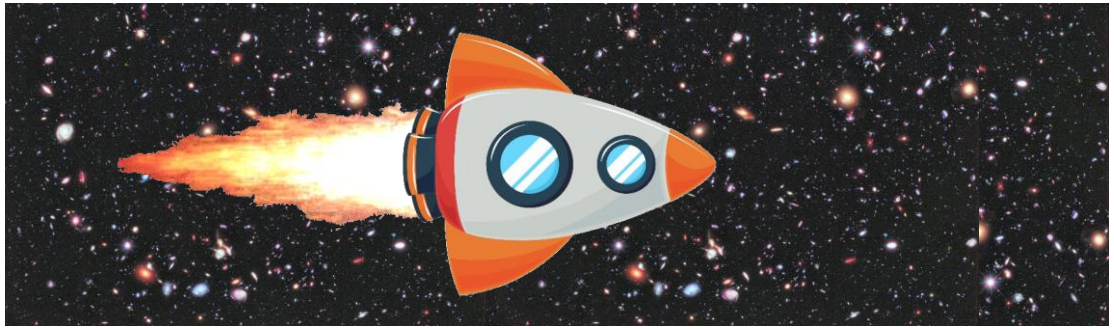




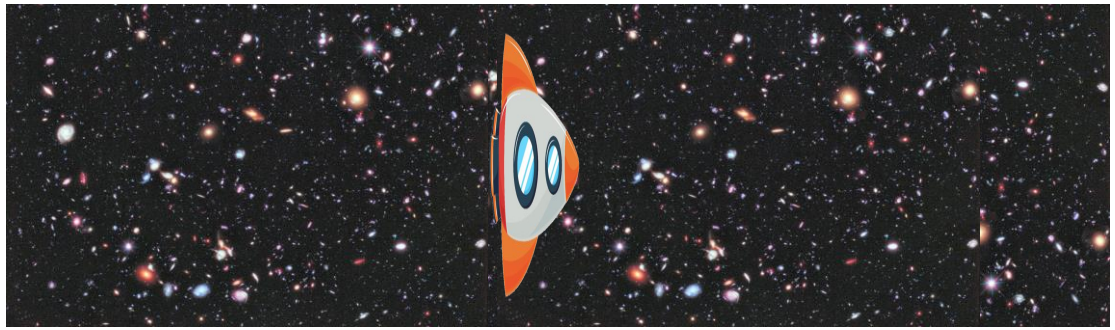
Special Relativity: "*All States of Motion Are Equal*"



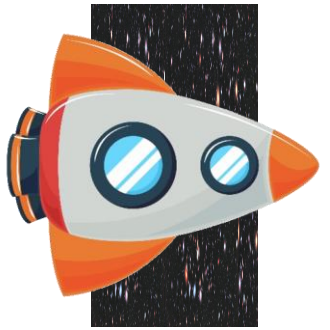
Lengths = *same*, clock ticks = *same*



The ship accelerates *fast*, then coasts



Universe's View:
The **ship** is **shorter**, and
all of its clocks tick **slower**



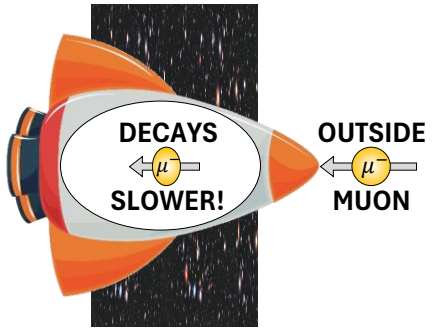
Ship's View (by *Poincaré Symmetry*):
Implication: The **universe** is **shorter**,
and all of its clocks tick **slower**

Does Fast Travel Freeze the *Entire* Universe?

(1)

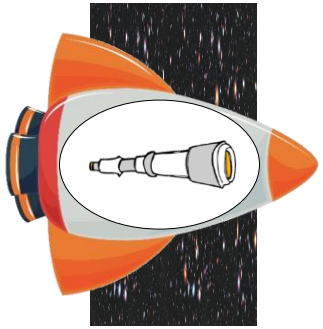
The Poincaré Symmetries say:
The **entire** universe must be shorter,
and all of its clocks must **tick more slowly**

(2)



*Experiments inside the ship **confirm** Poincaré!*
Muons entering from the outside universe
all decay more slowly inside the ship

(3)

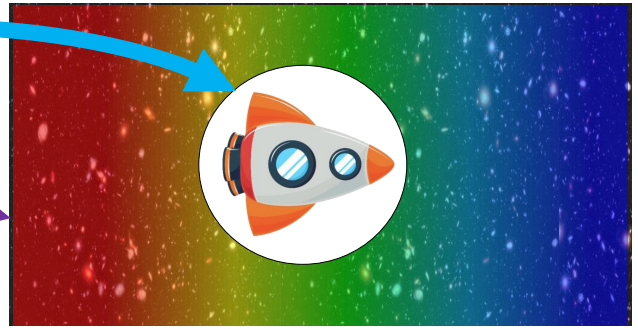


*Forward observations **contradict** Poincaré!*
Muons observed far in front of the ship
all decay much faster than normal (!)

(4)

(a) Mechanically created (!!) fully isotropic xyzt Poincaré bubble

(b) Relativistic Doppler symmetries (*only*) apply everywhere else

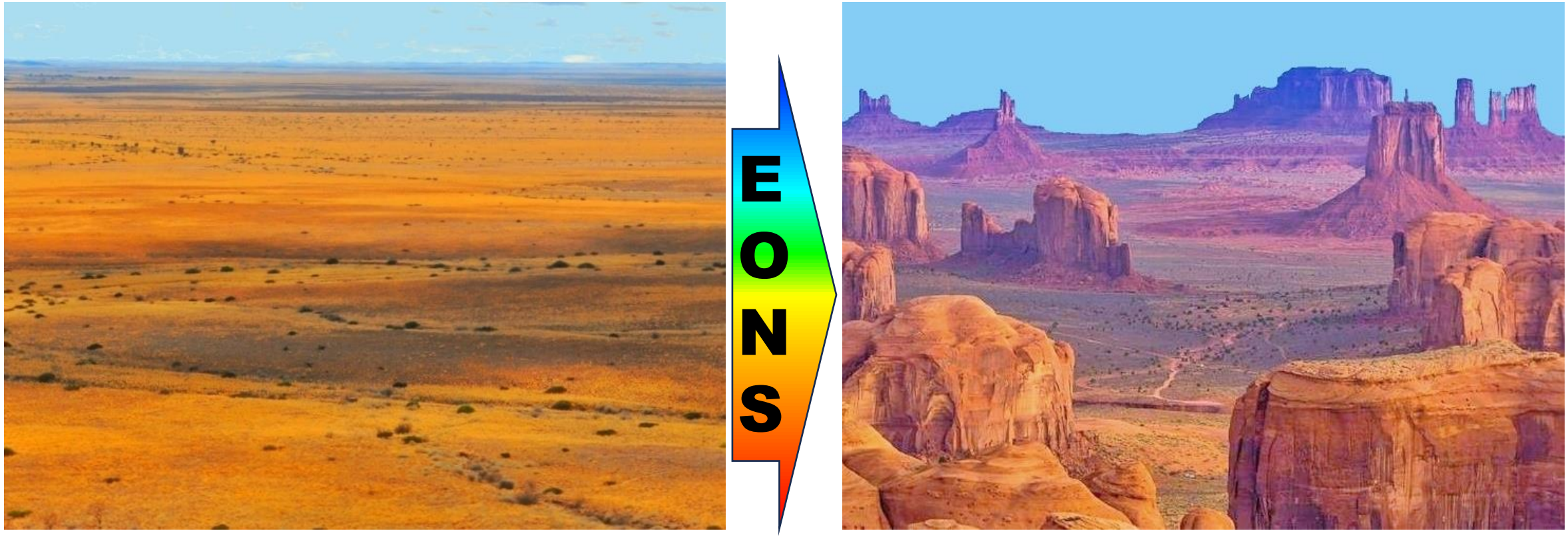


Resolution: Poincaré is a symmetry bubble
The Poincaré symmetries exist only as a tiny
isotropic bubble within **relativistic Doppler**

Modeling Implications of Symmetry Bubbles

- The problem of over-scoping Poincaré symmetries dates back to Einstein himself (multiple minor math errors in 1905, 1907)
- Excessive reverence caused the next century to brush off proper corrections (e.g., in *all* GPS satellites) as "engineering" details
- The formalist (Calvinist, really) Hilbert school of math aggravated the problem by overstating the universality of *all* symmetries.
- All physics symmetries — *not* just Poincaré — are *constructive*:
  - In all cases, the speed of light limits the scope of symmetry bubbles
  - Symmetries depend on *information* and thus are granular and use matter
- These limits apply even to Standard Model particle symmetries

The Impact of Symmetry Bubbles: A Dissected Universe



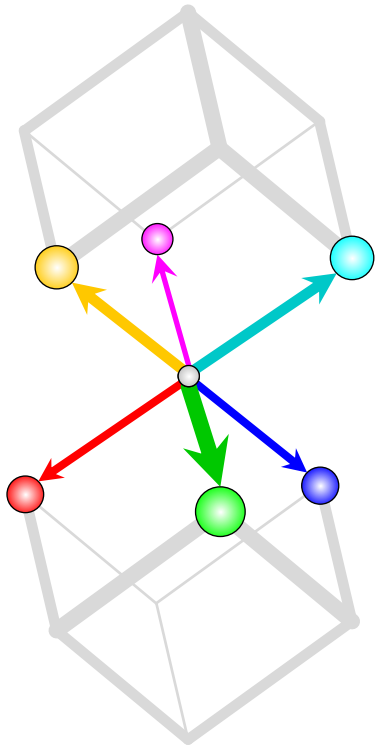
- Just as isolated mesas share “ground level” from an earlier shared plain, information breaks up shared global symmetries to create classical physics
- This earlier Compact Shared Universe (**CSU**) persists, e.g., in entanglement

What are the Mirrors of Reality?

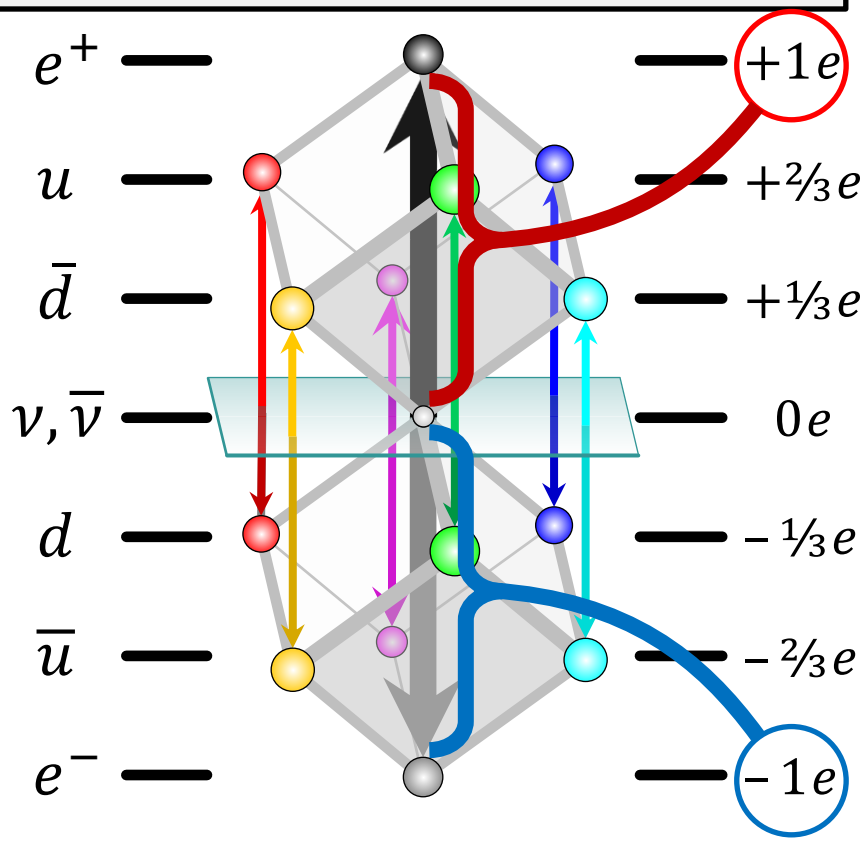
- If the symmetries (mirror groups) of reality are matter-dependent…
- … then it is *matter*, not spacetime, that defines all of reality
- The Standard Model thus is the (still incomplete) definition of reality
  - Look carefully, and you will see that every "vacuum excitation" uses matter
  - Space (ordered separation) and time (ordered change) emerge *from* matter
  - Information — a form of matter — is fundamental to creating mirrors
- No matter how oddly named, the symmetries of particle physics remain nothing more than increasingly complex mirror sets
- The main particle "mirror groups" are: $\boldsymbol{U(1)}$, $\boldsymbol{SU(2)}$, $\boldsymbol{SU(3)}$

Using Complexity to Build Simplicity

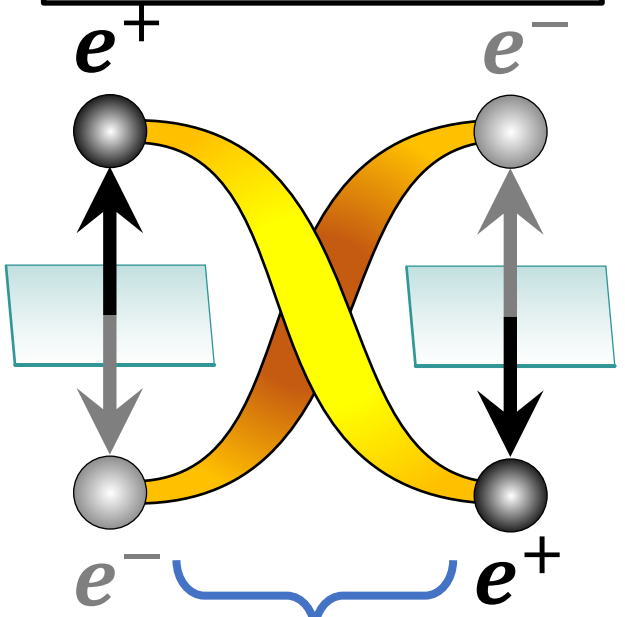
$SU(3)$ Symmetry Group (a 3-space of charges)



$SU(2)$ Symmetry Group (electric charges, and rest mass)



$U(1)$ (just a circle) Symmetry Group (the *most* complex)



Connection Field *(photons)*

Can Standard Model Math Be Simplified?

- Yes, for two reasons:
  - Not all historical choices made in the model were the simplest possible
  - The entire concept of finite-size symmetry bubbles is missing!
- Another subtler factor is the idea of complexity *creating* simplicity (The "good car" model: Internal complexity results in easy controls)
- Can the matrices used to express, say, $SU(3)$, be made simpler?

$$\boldsymbol{Ii} = \begin{pmatrix} \mathbf{1} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Ij} = \begin{pmatrix} 0 & \mathbf{1} & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Ik} = \begin{pmatrix} 0 & 0 & \mathbf{1} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

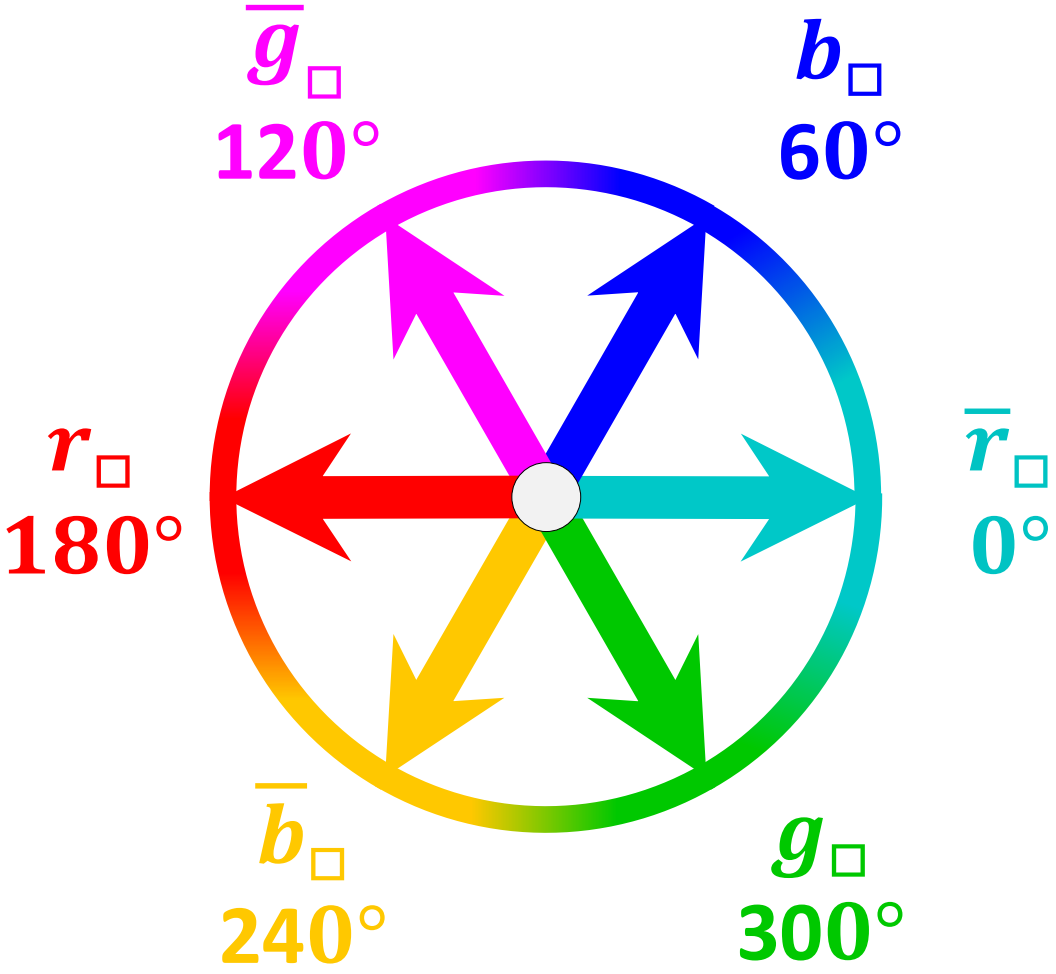
$$\boldsymbol{Ji} = \begin{pmatrix} 0 & 0 & 0 \\ \mathbf{1} & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Jj} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & \mathbf{1} & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Jk} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & \mathbf{1} \\ 0 & 0 & 0 \end{pmatrix}$$

$$\boldsymbol{Ki} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \mathbf{1} & 0 & 0 \end{pmatrix} \quad \boldsymbol{Kj} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & \mathbf{1} & 0 \end{pmatrix} \quad \boldsymbol{Kk} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \mathbf{1} \end{pmatrix}$$

$$\sqrt{1/3}\left[\boldsymbol{Ii} = \begin{pmatrix} \mathbf{1} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} + \boldsymbol{Jj} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & \mathbf{1} & 0 \\ 0 & 0 & 0 \end{pmatrix} + \boldsymbol{Kk} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \mathbf{1} \end{pmatrix}\right]$$

$$\boldsymbol{\gamma} = \sqrt{1/3}\begin{pmatrix} \mathbf{1} & 0 & 0 \\ 0 & \mathbf{1} & 0 \\ 0 & 0 & \mathbf{1} \end{pmatrix} = \begin{matrix} \boldsymbol{e}^{+} \\ \Updownarrow \\ \boldsymbol{e}^{-} \end{matrix}$$

$SU(3)$ Has Six Units of (Pro-Anti) "Color" Charge



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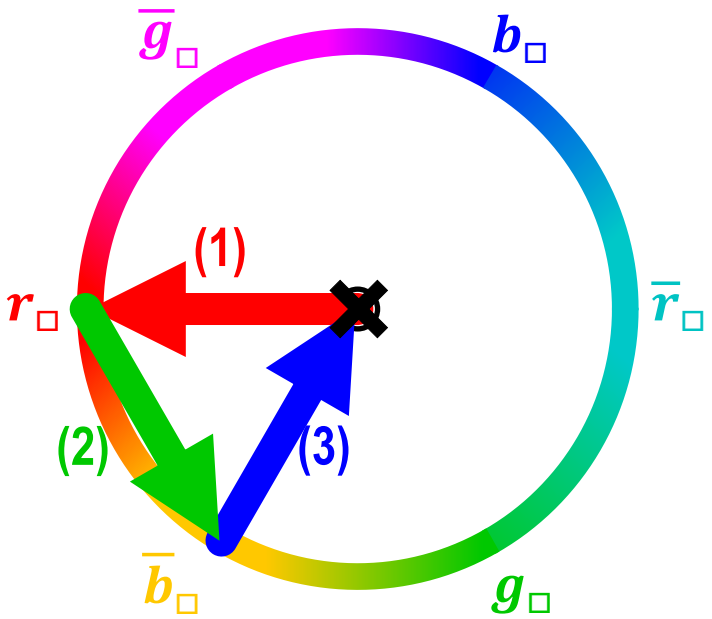
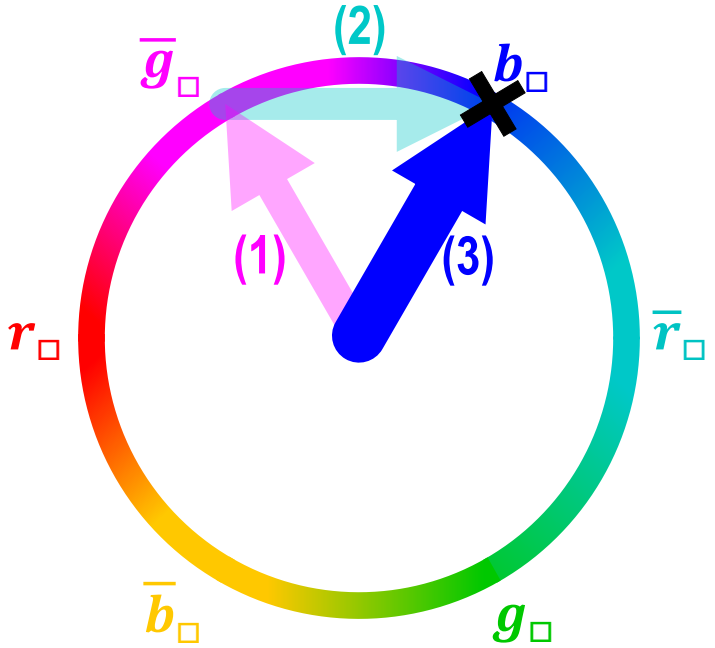
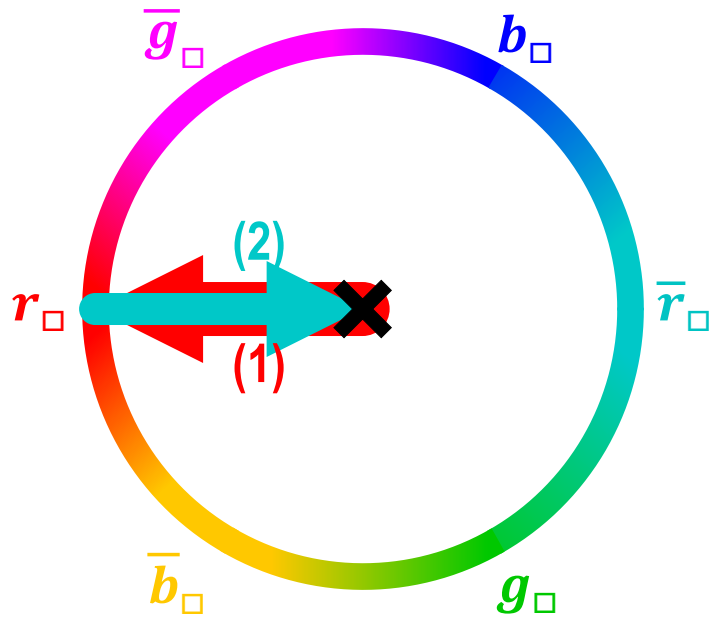
Color Addition in Strong Force Particles

$r_{\square} + g_{\square} + b_{\square} = \emptyset$	$\bar{r}_{\square} + \bar{g}_{\square} = b_{\square}$	$r_{\square} + \bar{r}_{\square} = \emptyset$
E.g., proton p, neutron n	E.g., blue up quark u_b	E.g., pions π^0, π^+, π^-
		
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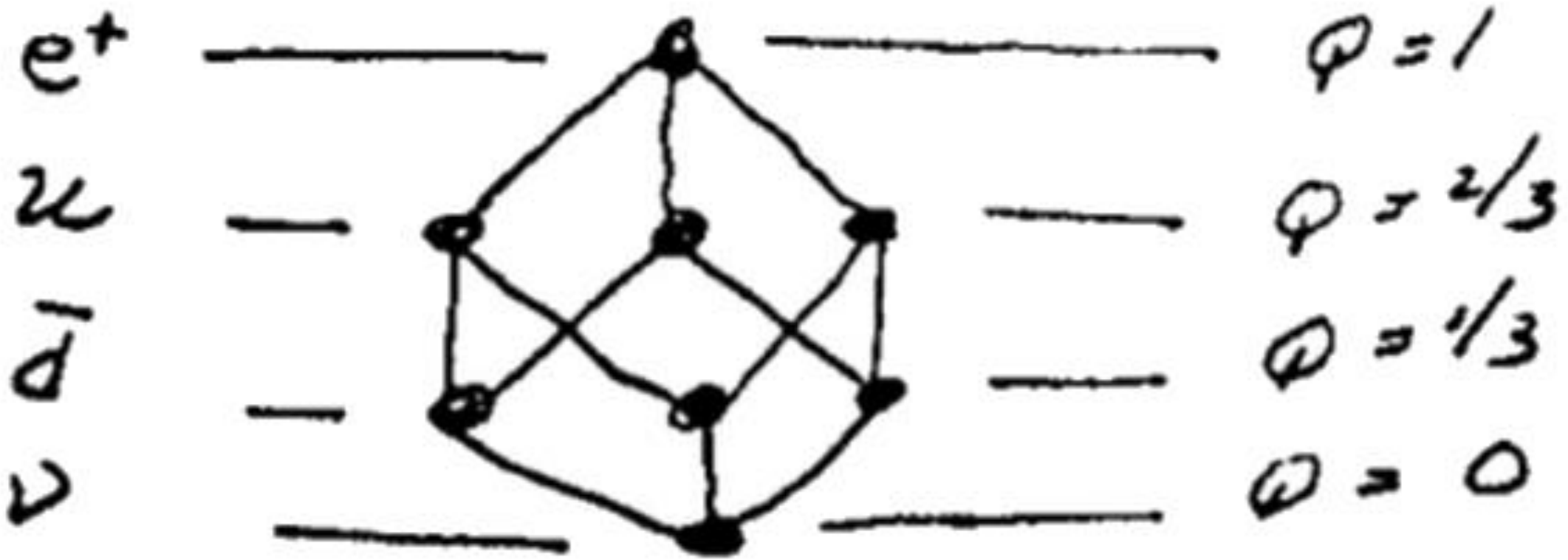
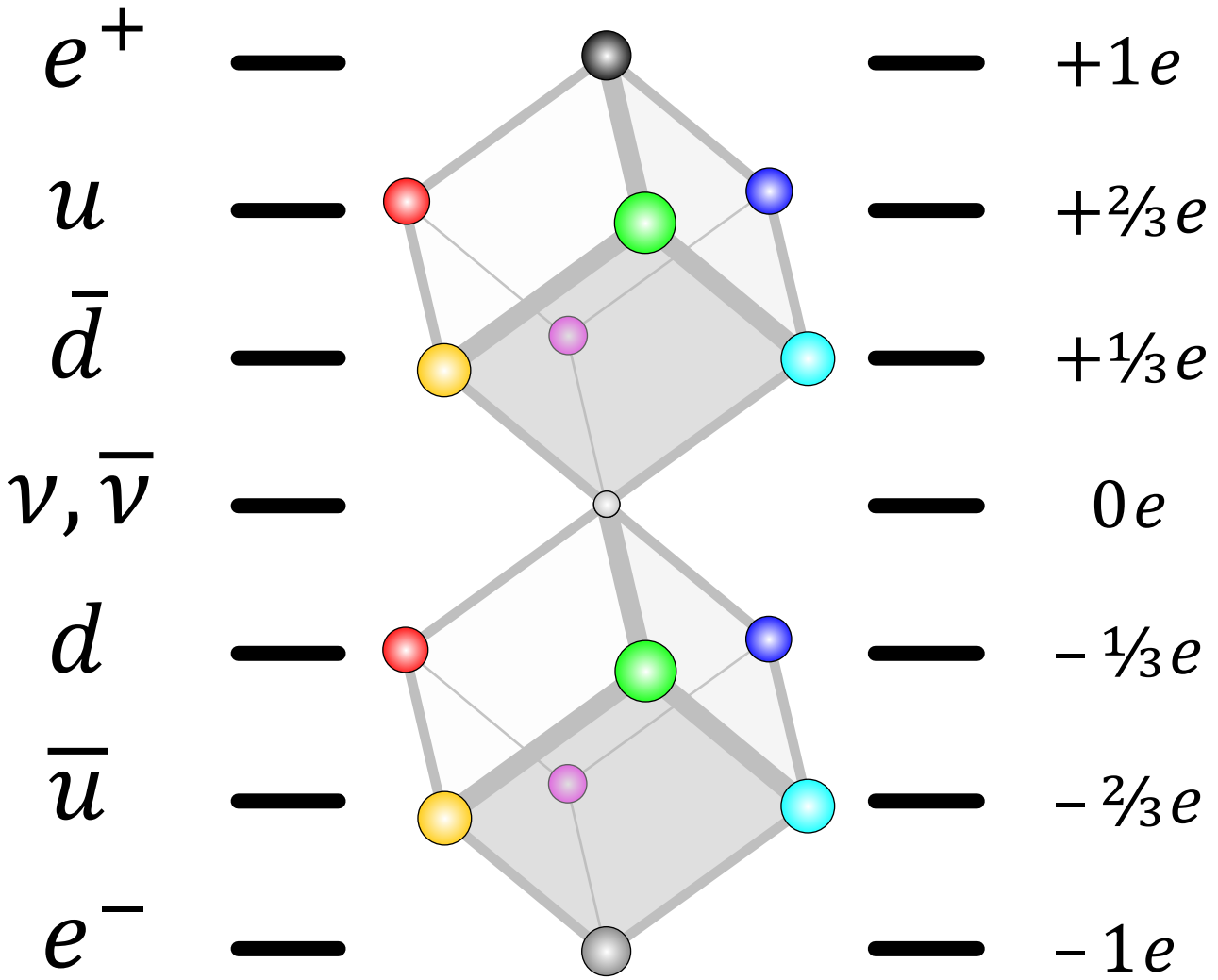
The Glashow Fermion Cube



S. L. Glashow, "The Future of Elementary Particle Physics [HUTP-79/A059]," *Harvard University Preprints*, Jul. 1979. Available: https://inspirehep.net/literature/144466. Page 29, Section III, *Let the Desert Bloom!* S. L. Glashow's original hand drawing.

Adding the Second Glashow Cube



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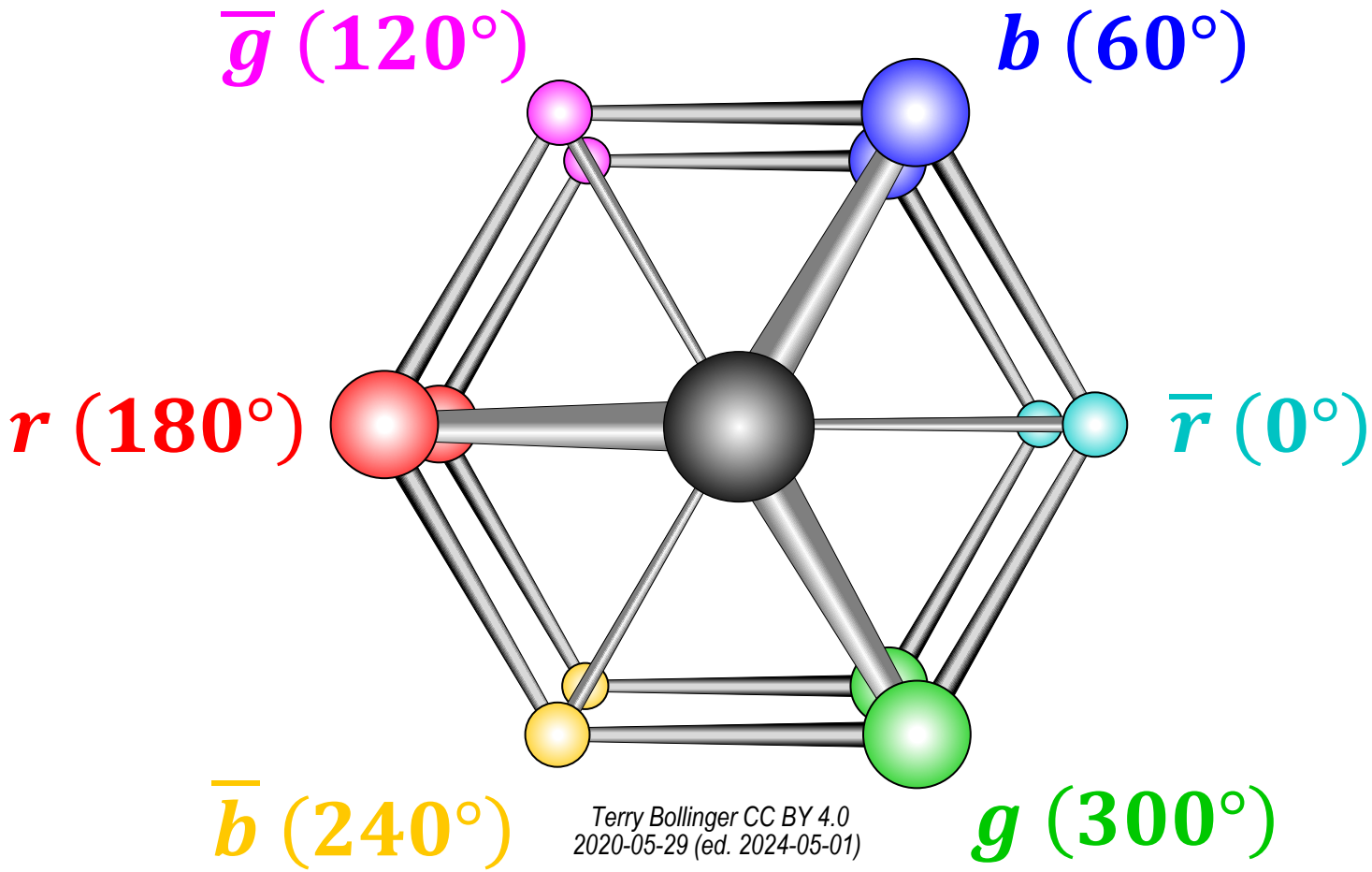
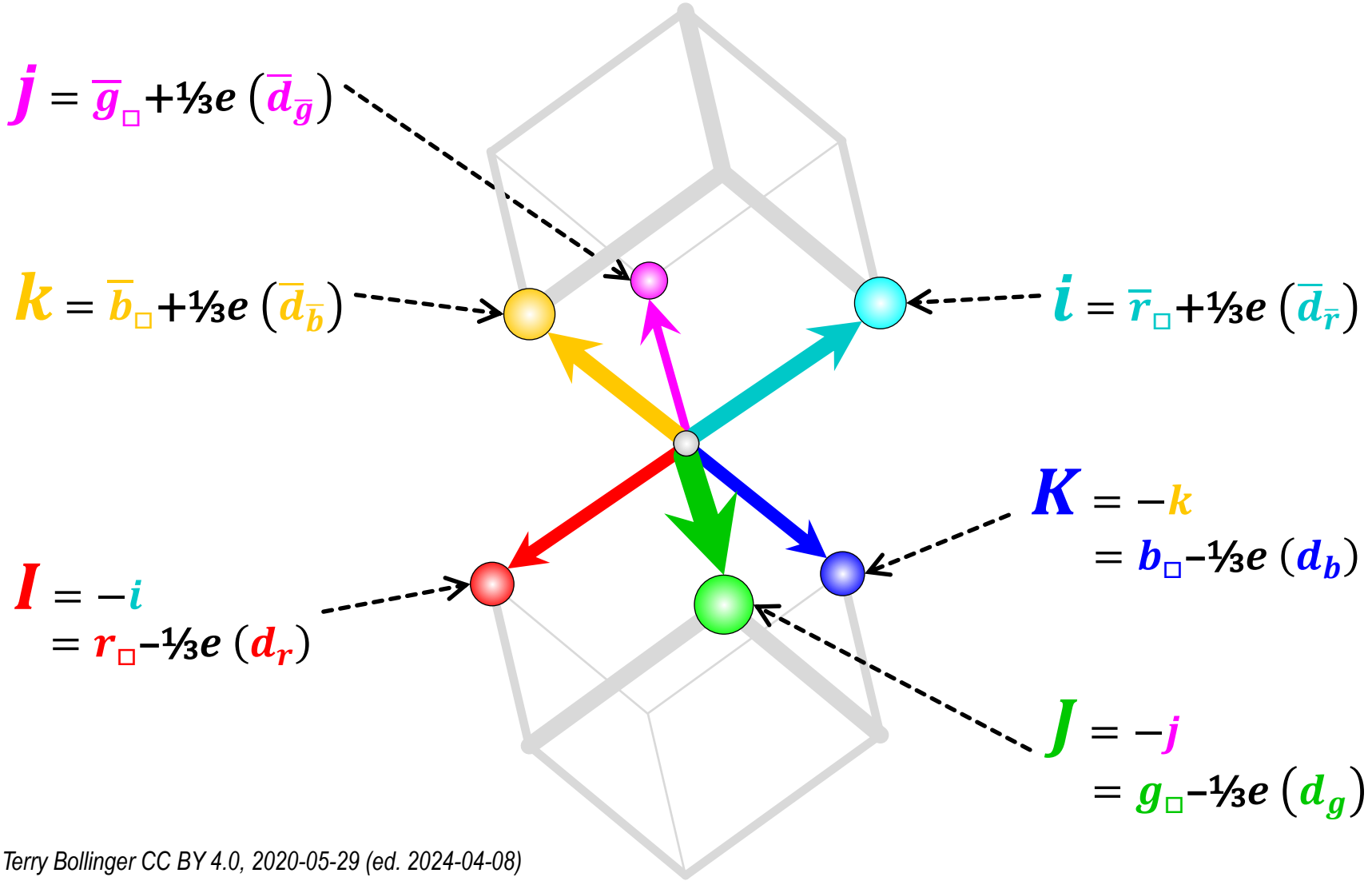
Top-Down View of Glashow Cube Colors



The Six Glashow Unit-Charge Vectors



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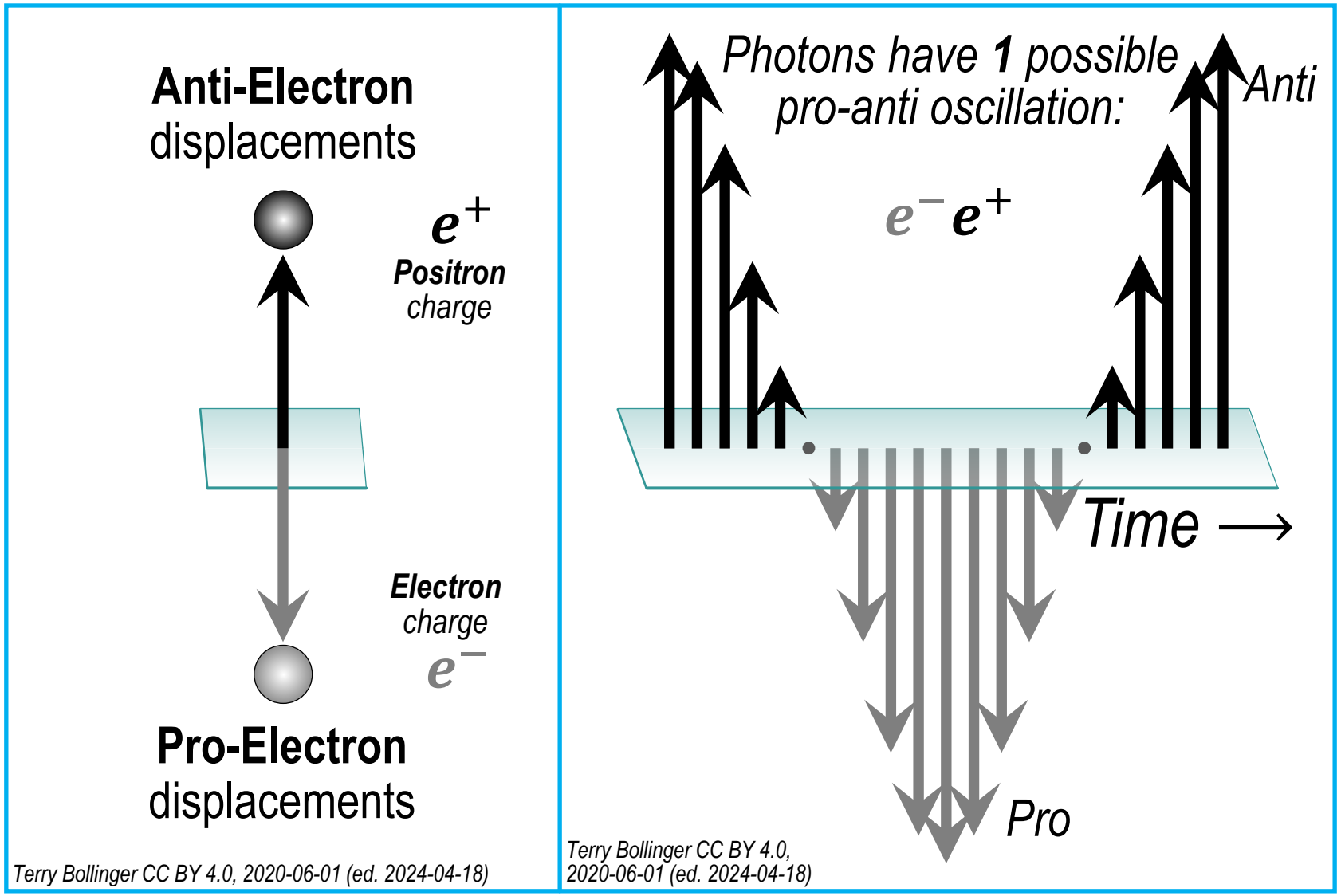
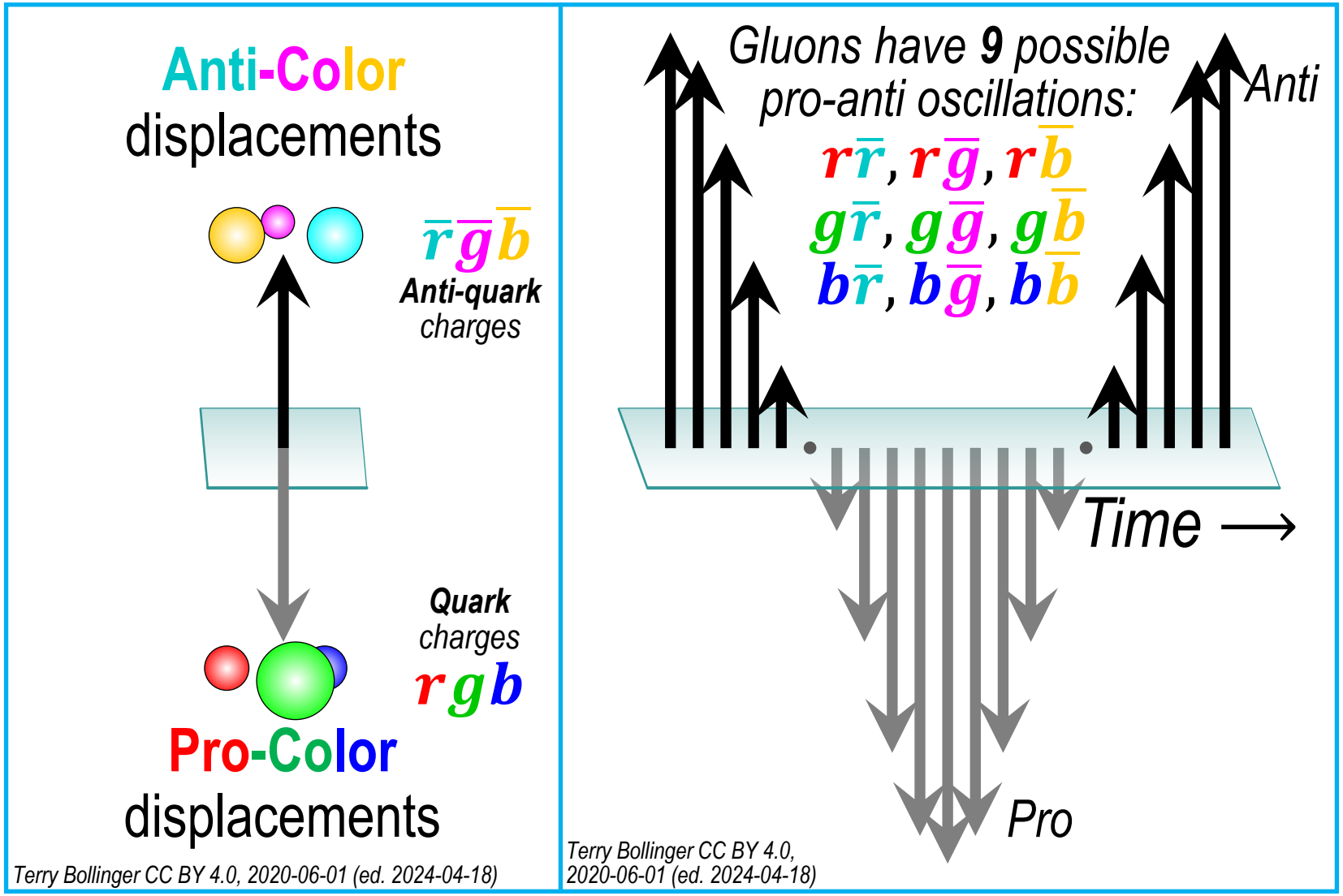
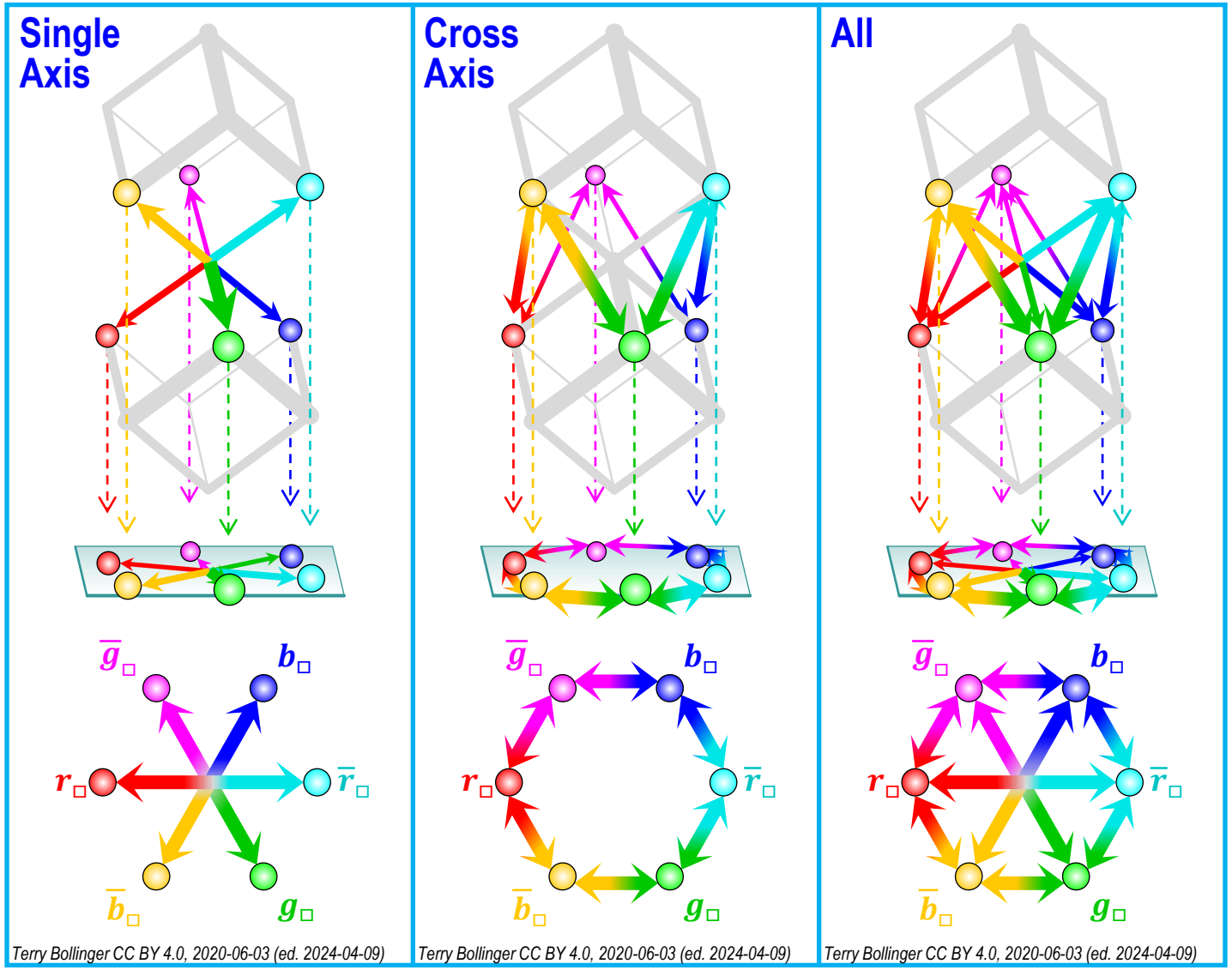
$U(1)$: Photons as Pro-Anti Electric Oscillations



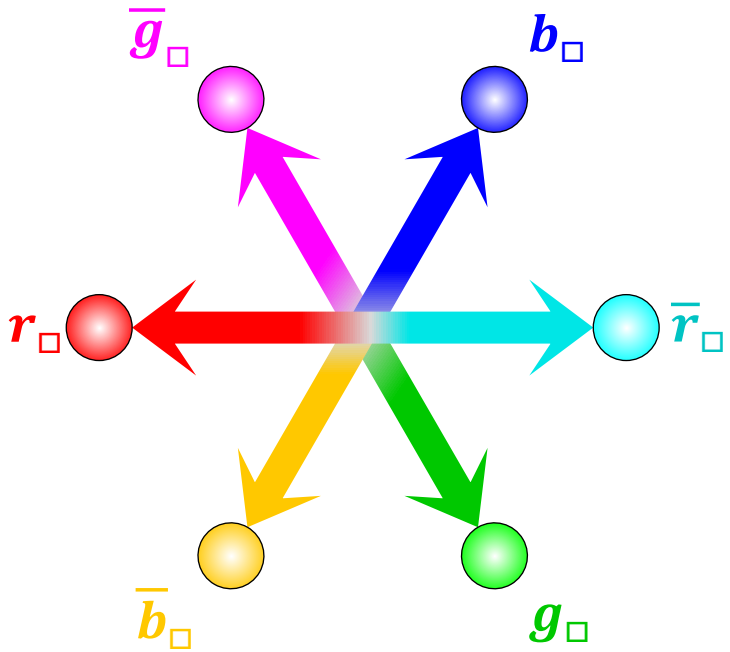
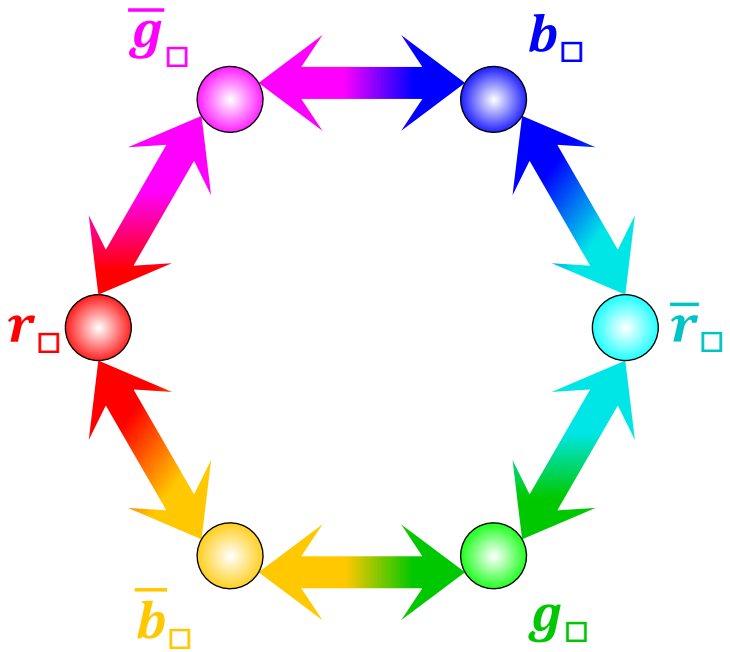
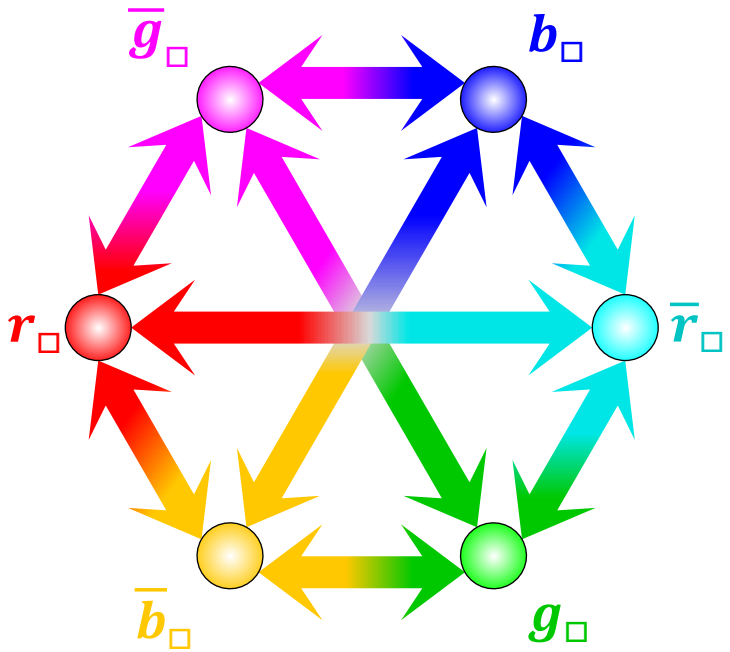
$SU(3)$: Gluons as Pro-Anti Color Oscillations



Color Oscillations in Glashow and Flat Coordinates



Mystery of the Missing Gluon

Same-axis charge point pairs result in **3 single-axis** gluon oscillations that, like photons, carry only energy & momentum.	Perimeter edge charge pairs result in **6 cross-axis** oscillations that carry color in addition to energy & momentum.	**3 energy-momentum** oscillations plus **6 color-carrying** oscillations gives **nine**. So why are there only **eight** gluons??
		
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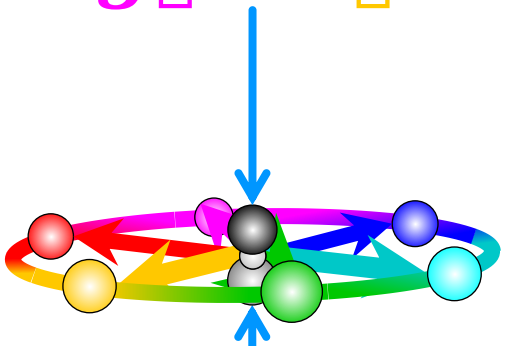
Standard Model Color Oscillation Space as a Donut

One combination of flat colors places "pro" and "anti" at the same location

$$\bar{r}_{\square} + \bar{g}_{\square} + \bar{b}_{\square} = \emptyset$$



$$r_{\square} + g_{\square} + b_{\square} = \emptyset$$

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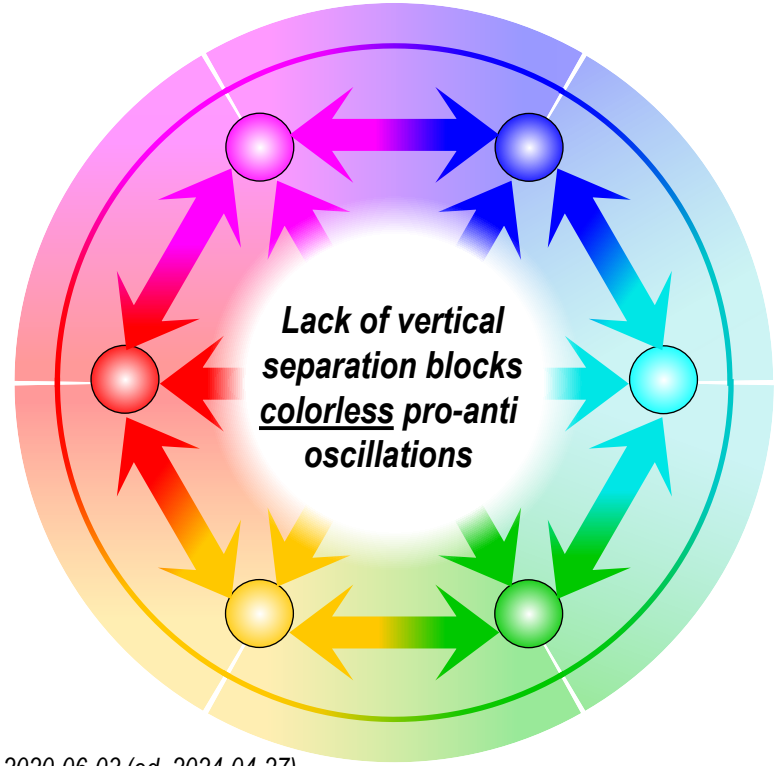
The Forbidden Oscillation: *With flat color there is a zero-amplitude "hole" in the vertical oscillation space — and thus, a missing gluon*



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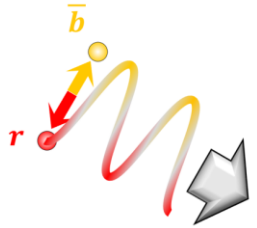
Standard $SU(3)$ Matrices Add More Dimensions to "Dodge" the Donut Hole

Matrices concisely define pro-anti oscillations:

$$r\bar{b} = \begin{array}{c|ccc} & \bar{r} & \bar{g} & \bar{b} \\ \hline r & & & 1 \\ g & & & \\ b & & & \end{array} =$$



The 9 expressible oscillations looks like this:

$$r\bar{r} = \begin{pmatrix} \mathbf{1} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad r\bar{g} = \begin{pmatrix} 0 & \mathbf{1} & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad r\bar{b} = \begin{pmatrix} 0 & 0 & \mathbf{1} \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$g\bar{r} = \begin{pmatrix} 0 & 0 & 0 \\ \mathbf{1} & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad g\bar{g} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & \mathbf{1} & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad g\bar{b} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & \mathbf{1} \\ 0 & 0 & 0 \end{pmatrix}$$

$$b\bar{r} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ \mathbf{1} & 0 & 0 \end{pmatrix} \quad b\bar{g} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & \mathbf{1} & 0 \end{pmatrix} \quad b\bar{b} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & \mathbf{1} \end{pmatrix}$$

Mixing the expressible oscillations and adding imaginary factors creates a new set of 8 finite-amplitude gluons that still result in real-quark charges of $r, \bar{r}, g, \bar{g}, b, \bar{b}$, but use higher dimensional topologies to navigate around the zero-amplitude donut hole in flat oscillation space

$$\lambda_1 = \begin{pmatrix} 0 & \mathbf{1} & 0 \\ \mathbf{1} & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \lambda_2 = \begin{pmatrix} 0 & -\boldsymbol{i} & 0 \\ \boldsymbol{i} & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \lambda_3 = \begin{pmatrix} \mathbf{1} & 0 & 0 \\ 0 & \mathbf{-1} & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$\lambda_4 = \begin{pmatrix} 0 & 0 & \mathbf{1} \\ 0 & 0 & 0 \\ \mathbf{1} & 0 & 0 \end{pmatrix} \quad \lambda_5 = \begin{pmatrix} 0 & 0 & -\boldsymbol{i} \\ 0 & 0 & 0 \\ \boldsymbol{i} & 0 & 0 \end{pmatrix}$$

$$\lambda_6 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & \mathbf{1} \\ 0 & \mathbf{1} & 0 \end{pmatrix} \quad \lambda_7 = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & -\boldsymbol{i} \\ 0 & \boldsymbol{i} & 0 \end{pmatrix} \quad \lambda_8 = \sqrt{1/3} \begin{pmatrix} \mathbf{1} & 0 & 0 \\ 0 & \mathbf{1} & 0 \\ 0 & 0 & \mathbf{-2} \end{pmatrix}$$

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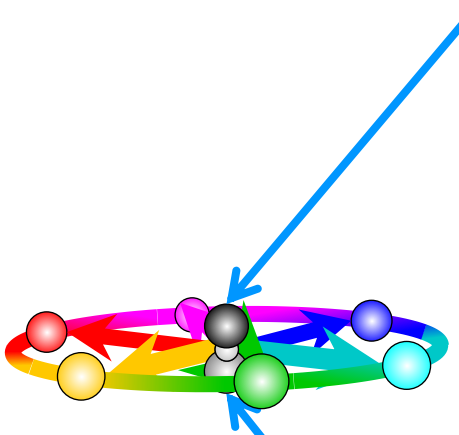
Why Glashow Space Has No Amplitude Hole

Flat-color amplitude hole

$$\bar{r}_{\square} + \bar{g}_{\square} + \bar{b}_{\square} = \emptyset$$



$$r_{\square} + g_{\square} + b_{\square} = \emptyset$$

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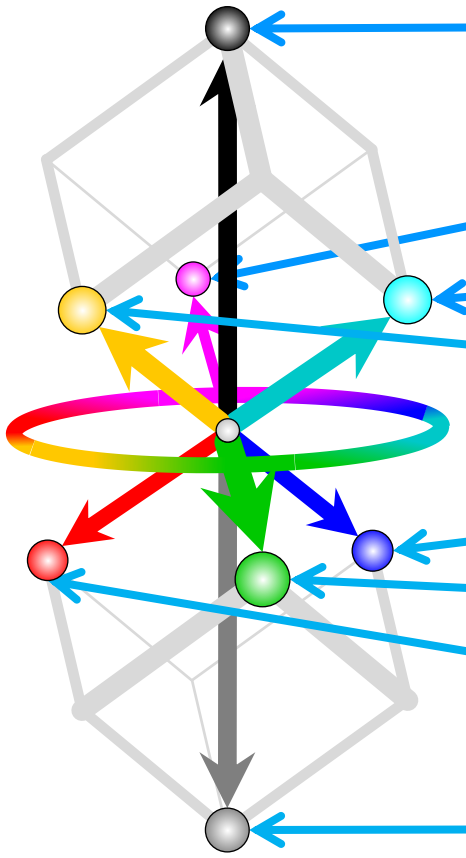
Adding electric-charge data removes the hole



$+1e = i+j+k$

$\bar{g}_{\square} + ⅓e = j$

$\bar{r}_{\square} + ⅓e = i$

$\bar{b}_{\square} + ⅓e = k$

$b_{\square} - ⅓e = K$

$g_{\square} - ⅓e = J$

$r_{\square} - ⅓e = I$

$-1e = I+J+K$

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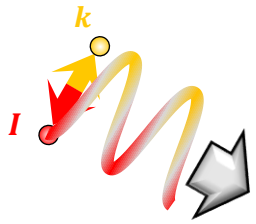
Chromoelectric (CE) Matrices Make Maxwell's Displacement into a 3-Space

All 9 pro-anti oscillations are force particles:

$$\boldsymbol{Ij} = \begin{array}{c|ccc} & i & j & k \\ I & & & 1 \\ J & & & \\ K & & & \end{array} =$$



The 9 expressible oscillations are the particles:

$$\boldsymbol{Ii} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Ij} = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Ik} = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}$$

$$\boldsymbol{Ji} = \begin{pmatrix} 0 & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Jj} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Jk} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{pmatrix}$$

$$\boldsymbol{Ki} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 1 & 0 & 0 \end{pmatrix} \quad \boldsymbol{Kj} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 1 & 0 \end{pmatrix} \quad \boldsymbol{Kk} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

An equal mix of the three momentum-and-energy-only chromoelectric diagonal particles gives rise to a particle not possible with flat color. This force particle has no net color when oscillating, but instead oscillates on Maxwell's vertical (electric) axis. It is better known as the ***photon****.*

$$\sqrt{1/3}\left[\boldsymbol{Ii} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix} + \boldsymbol{Jj} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 0 \end{pmatrix} + \boldsymbol{Kk} = \begin{pmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 1 \end{pmatrix}\right]$$

$$\boldsymbol{\gamma} = \sqrt{1/3}\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix} = \begin{matrix} \boldsymbol{e^+} \\ \Updownarrow \\ \boldsymbol{e^-} \end{matrix}$$

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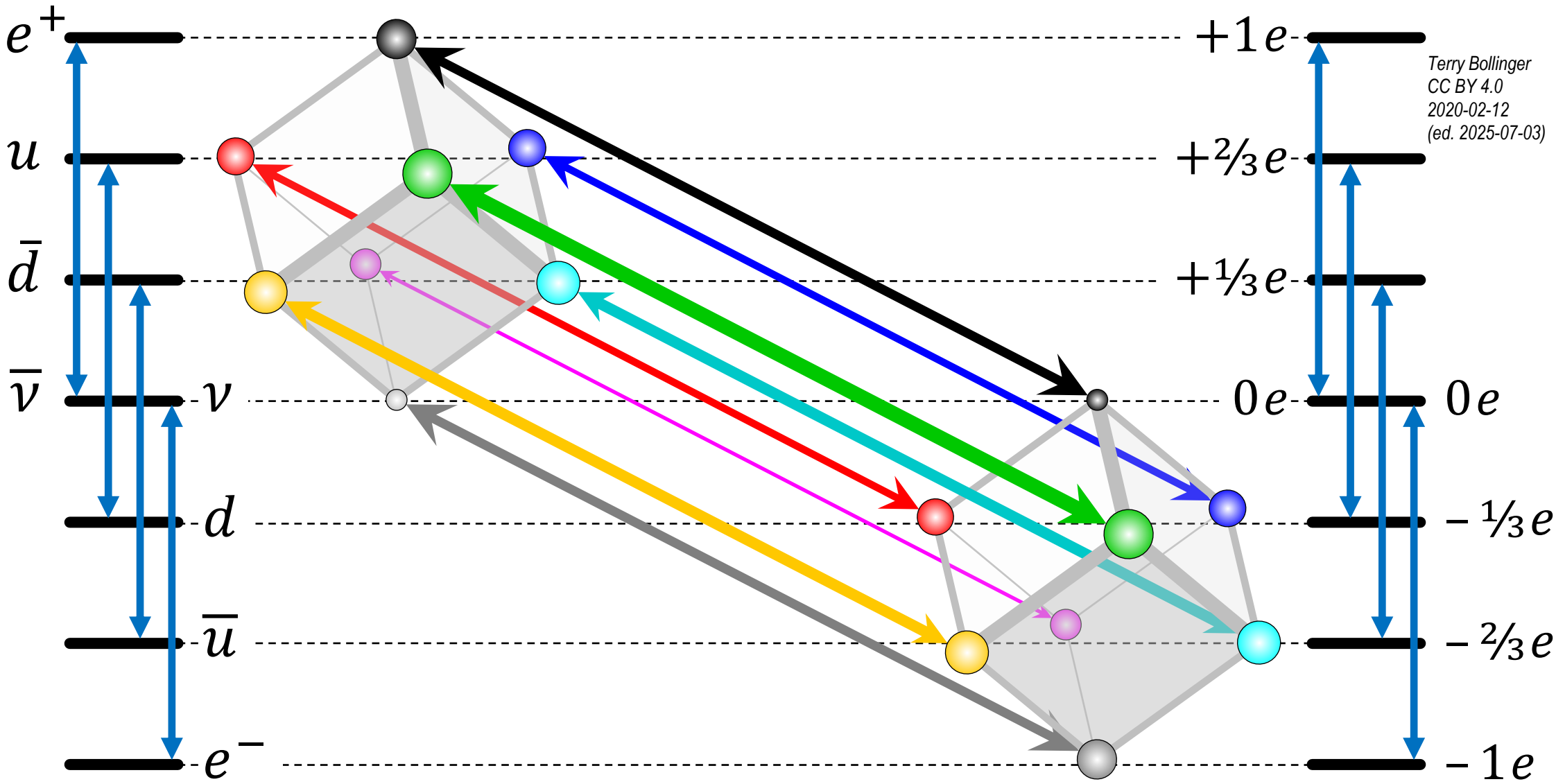
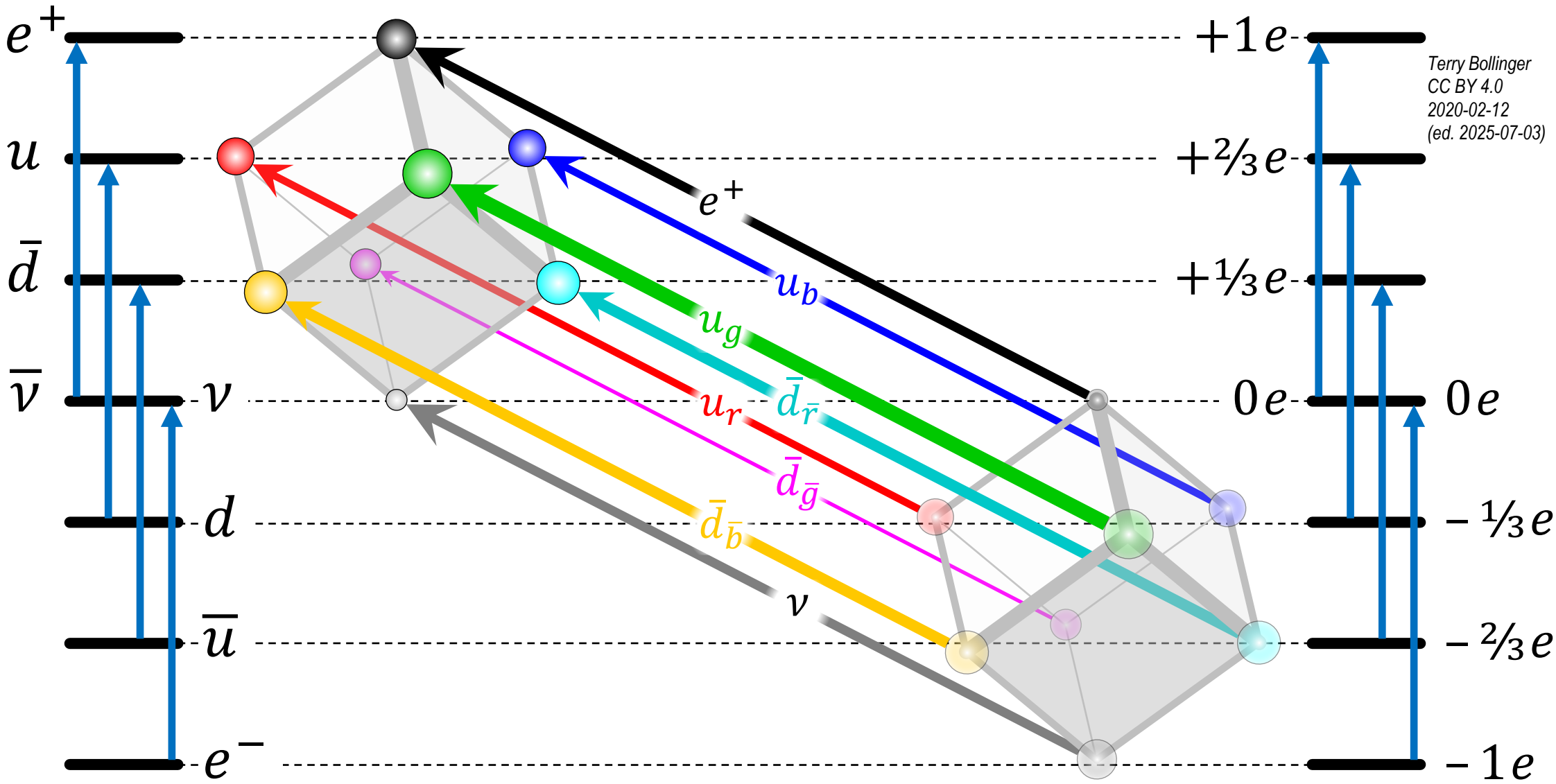
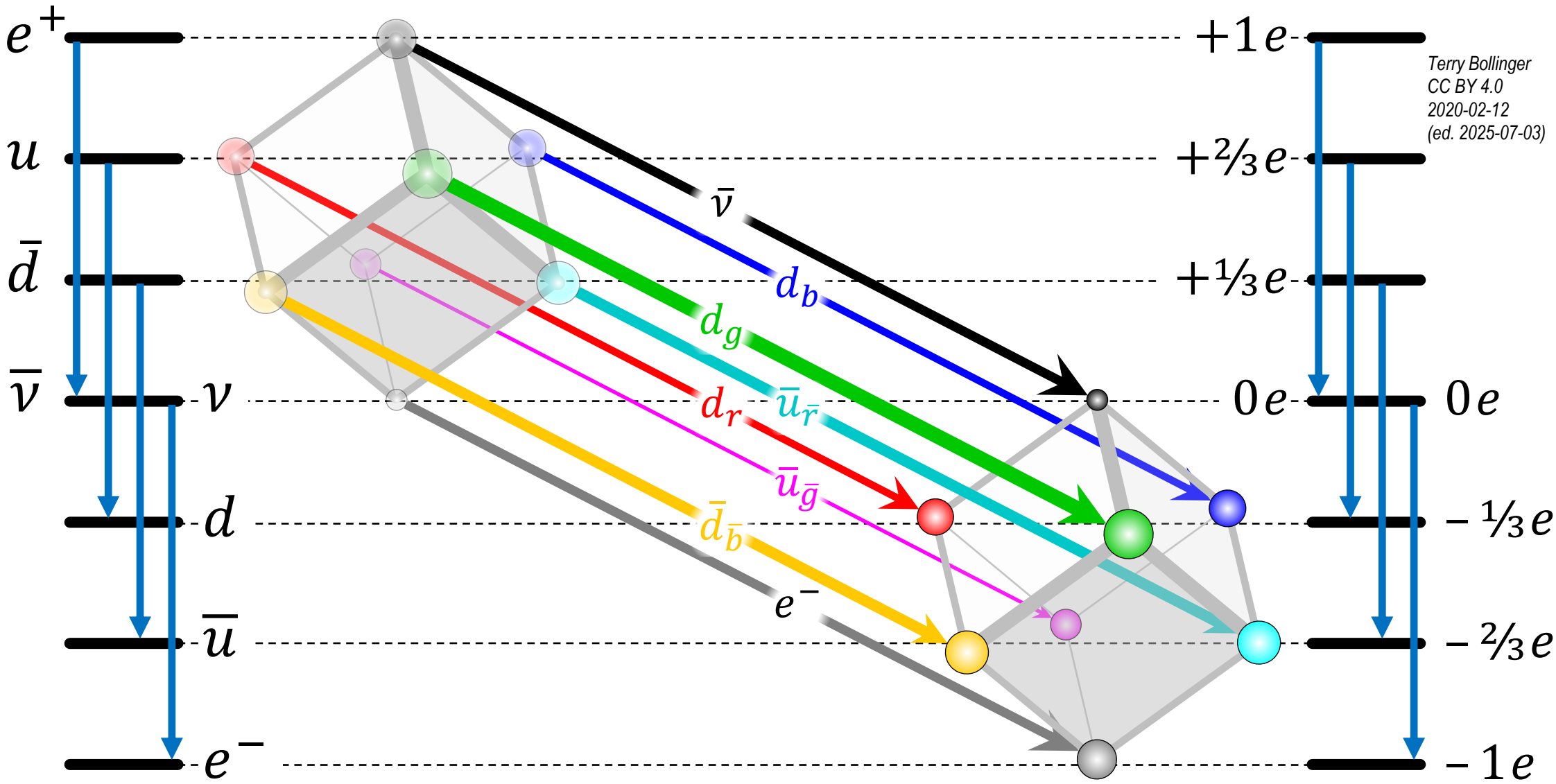
$SU(2)$: Gen-1 Fermions as T_3 Weak-Isospin Tesseract Bridge Vectors



Up Gen-1 Fermions as T_3 Weak-Isospin Tesseract Bridge Vectors



Down Gen-1 Fermions as T_3 Weak-Isospin Tesseract Bridge Vectors



Other Issues for Another Time

- All of these tesseract bridge figures are terribly naïve! But why?
- All fermions come in two forms: Left-handed and right-handed
- Experimentally, weak reactions occur only between pairs of left-handed fermions or right-handed anti-fermions
- More interesting: rest mass (and thus *time*) emerge from pro- and anti-fermion reactions… but *not necessarily* weak-respecting ones
- These issues are at the core of the Clay Math Institute's unsolved $1M Millennial Problem in symmetry: Yang-Mills & the Mass Gap

  https://www.claymath.org/millennium/yang-mills-the-maths-gap/

Summary

- Discarding unnecessary imaginary information in math results in a dramatic re-prioritization of physics issues: *Rest mass is the key*
- Symmetries are critical, but *cannot* be treated as infinite in size or capable of violating light speed. The light speed limit is *critical*.
- Reality is a complicated hierarchical hall of mirrors. The final outcome is an *approximation* of classical physics via *information*
- Wave collapse is real, very common (bumps), and *creates* reality
- Information *cannot exist* without mass and energy
- The non-classical strangeness of the universe comes from an ancient (and still existing) Compact Shared Universe (CSU)
- Bonus: What is gravity? The last visible traces of the CSU.