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The 7 Elementary Fields of Particle Physics

or

Just Too Many Particles!

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Summary

- The standard model includes ~ 60 particles, including antiparticles, flavors, and colors. That is too many to be truly fundamental.
- In a novel conceptual picture, these particles are composites of 7 elementary fields: the electric field and a conjugate charge field, the weak field and a conjugate lepton field, and 3 color fields (red, blue, and green).
- For example, the electron is a charge field bound to a lepton field; a quark is a charge field bound to a color field and a lepton field; and a gluon is two coupled color fields.
- This picture further envisions distributed mass, charge, spin, and color associated with rotation of real vector fields. Antiparticles and flavors follow simply within this picture.
- This is not yet a theory, but implications for development of a theory will be discussed.

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(from Wikipedia)

Too Many Particles in Standard Model

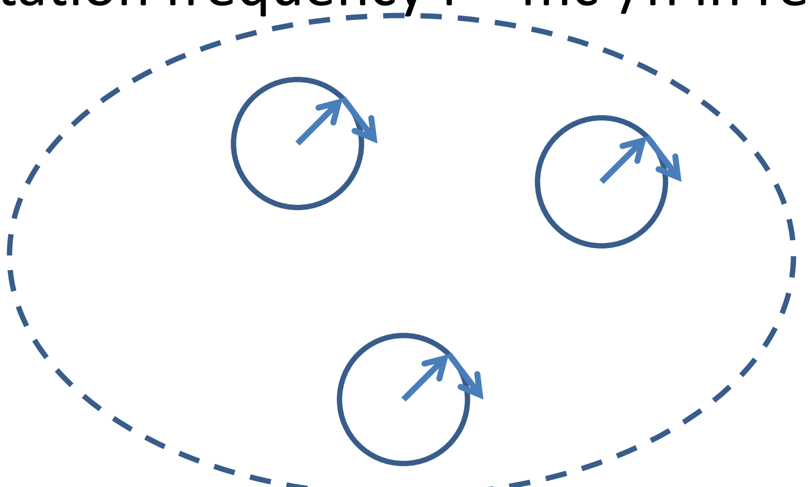
- But many more distinct particles than this chart indicates.
- 6 quarks, but each with antiparticles and 3 colors – 36 quarks total
- 8 independent varieties of gluons.
- 6 leptons each have antiparticles – 12 total.
- 2 W bosons (+ and -)
- 62 total particles in chart.
- Far too many for truly elementary particles!

Proposed Minimum Set of Fields

- EM Force: Photon (EM) field γ and Charge field C
- Weak Force: Weak field W and Lepton field L.
- Strong Force: Red, Green, & Blue Color fields R, G, B.
- 7 total fundamental fields
- Some “particles” composed of single field:
  - Photon is just γ field
  - Z boson is just W field
  - Neutrinos just L field (with excited states for heavier neutrinos).
- But other “particles” are composites of 2 or 3 fields.

Distributed Field Picture of "Particles"

- Particle really coherently rotating vector field distributed in space, NOT point particle or solid body.
  - Maps onto complex scalar quantum wave function $\Psi(r)$.
  - Soliton-like to prevent splitting or merging.
- Rotation about fixed axis corresponds to quantized total spin for either fermion or boson.
  - Rotation frequency $f = mc^2/h$ in rest frame.



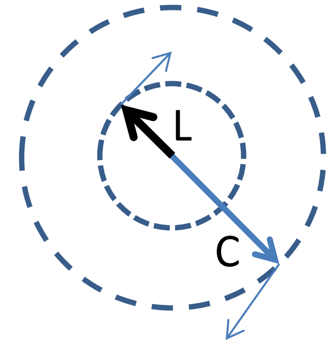
How to Strongly Couple Two Fields?

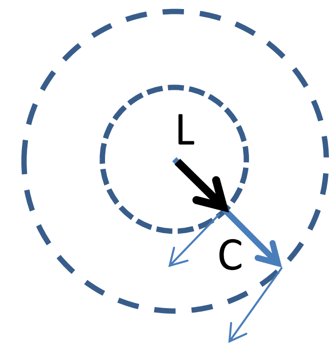
- They should both rotate together at same frequency.
  - They both contribute to same total spin and mass.
- They should both map onto same quantum wave function.
  - Same field ratio throughout volume.
- They should point along the same direction, either parallel or anti-parallel.
- *Proposal: Relative polarity is degree of freedom that encodes sign of a charge.*

Example: Electron & Positron

- Consider electron as L field coupled to C field
  - Electron is essentially charged neutrino, with both EM and weak forces.
  - Assume that L and C are anti-parallel aligned vectors that rotate together.
- Construct *positron* with same 2 vectors, now parallel instead of anti-parallel
  - Rotation frequency and spin are the same.
  - *Total static electric charge is determined by relative polarity of L and C fields.*

Electron





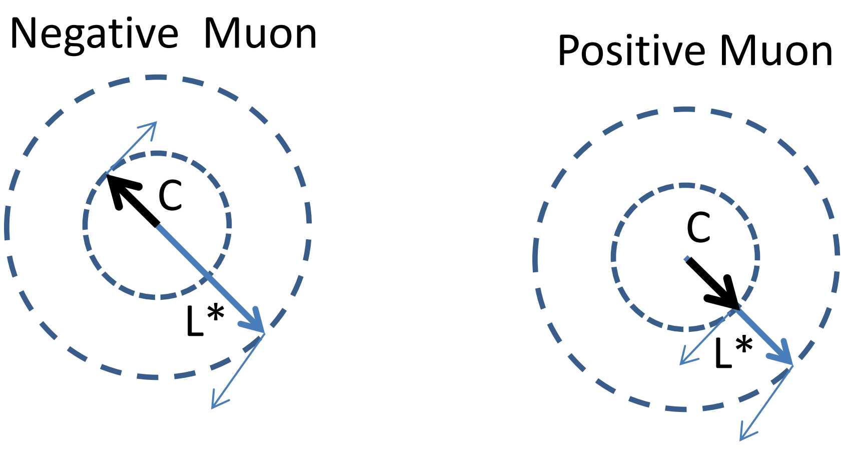
Positron

Neutrinos, antineutrinos, and generations

- Neutrinos are believed to exist in 3 generations:
  - Electron neutrinos, muon neutrinos, and tau neutrinos, with increasing mass (small but non-zero).
  - Spontaneous transitions between generations possible.
- Proposal: All neutrinos really just L field; heavy neutrinos are excited states of the same field: L* and L**.
  - Solutions with larger m (f), otherwise identical.
- Antineutrinos have opposite helicity, but are otherwise identical.
  - But in the rest frame both helicities are the same.
  - Antineutrinos can be represented by same fields L, L*, and L**.

Muons and Tauons

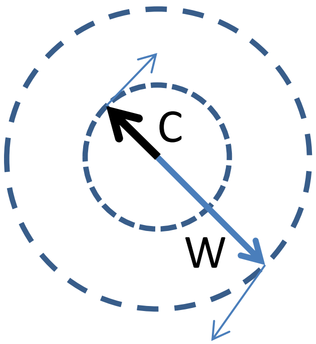
- Muons and Tauons act like heavy electrons.
- *Proposal: A muon is simply an electron with an excited L* field, and a tauon an electron with L**.*
  - In other words, these are just charged excited neutrinos.
  - Positive muons and tauons just positrons with L* and L**.



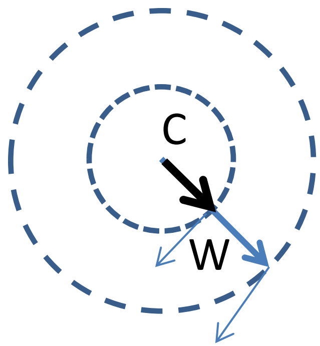
Weak Force Bosons

- The mediators of the weak force are the neutral Z and the charged W- and W+.
- *Proposal: Z is just W field, but W+ and W- are W field coupled to C field, either parallel or antiparallel as with electron and positron.*
    - Not clear why addition of C field *decreases* the mass.

Negative W



Positive W

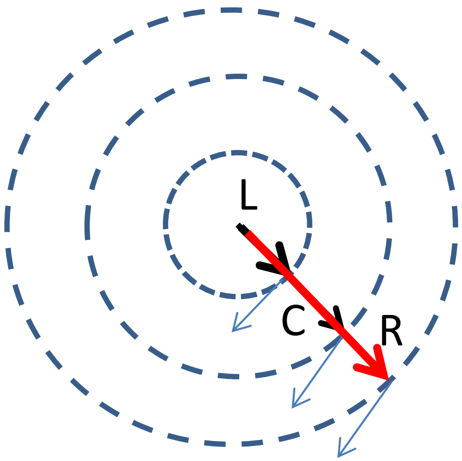


Quarks & Color Fields

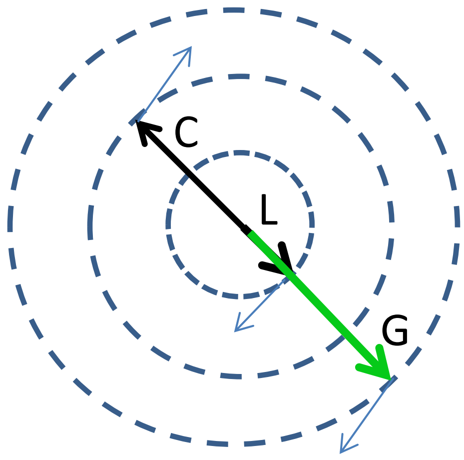
- Quarks are subject to all of strong, EM, and weak forces.
  - For example, beta decay of quark occurs via weak force.
- Each quark has a color: Red, Green, or Blue, or their anti-colors: Anti-Red, Anti-Green, or Anti-Blue.
- All metastable quark combinations must be color-neutral.
  - Either two quarks with color-anti-color combinations (pi meson)
  - Or 3 quarks with RGB (proton).
  - Or 3 quarks with anti-R, anti-G, anti-B (anti-proton).
- *Proposal: a quark is a color field (R,G, B) together with a charge field, and a lepton field.*
  - A quark is essentially an electron with a color field added.
  - Anti-quarks correspond to reversing L, so that both charge and color change sign.

Fractional Charges in Quarks

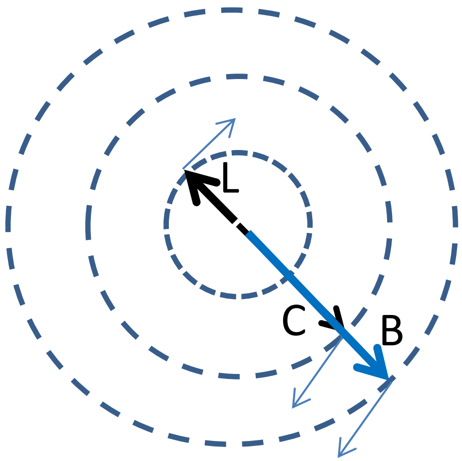
- Addition of color field to electron destabilizes charge ±e.
  - Now 2 solutions: e/3 and 2e/3.
- Quarks also have 3 generations that parallel those of leptons.
  - Correspond to L, L*, and L**.
- Red up quark is C(2/3)LR, with all 3 pointing parallel.
- Green down quark is C(-1/3)LG, with C opposite L and G.
- Anti-Blue up quark is C(-2/3)LB, with L opposite C and B.



Red Up Quark



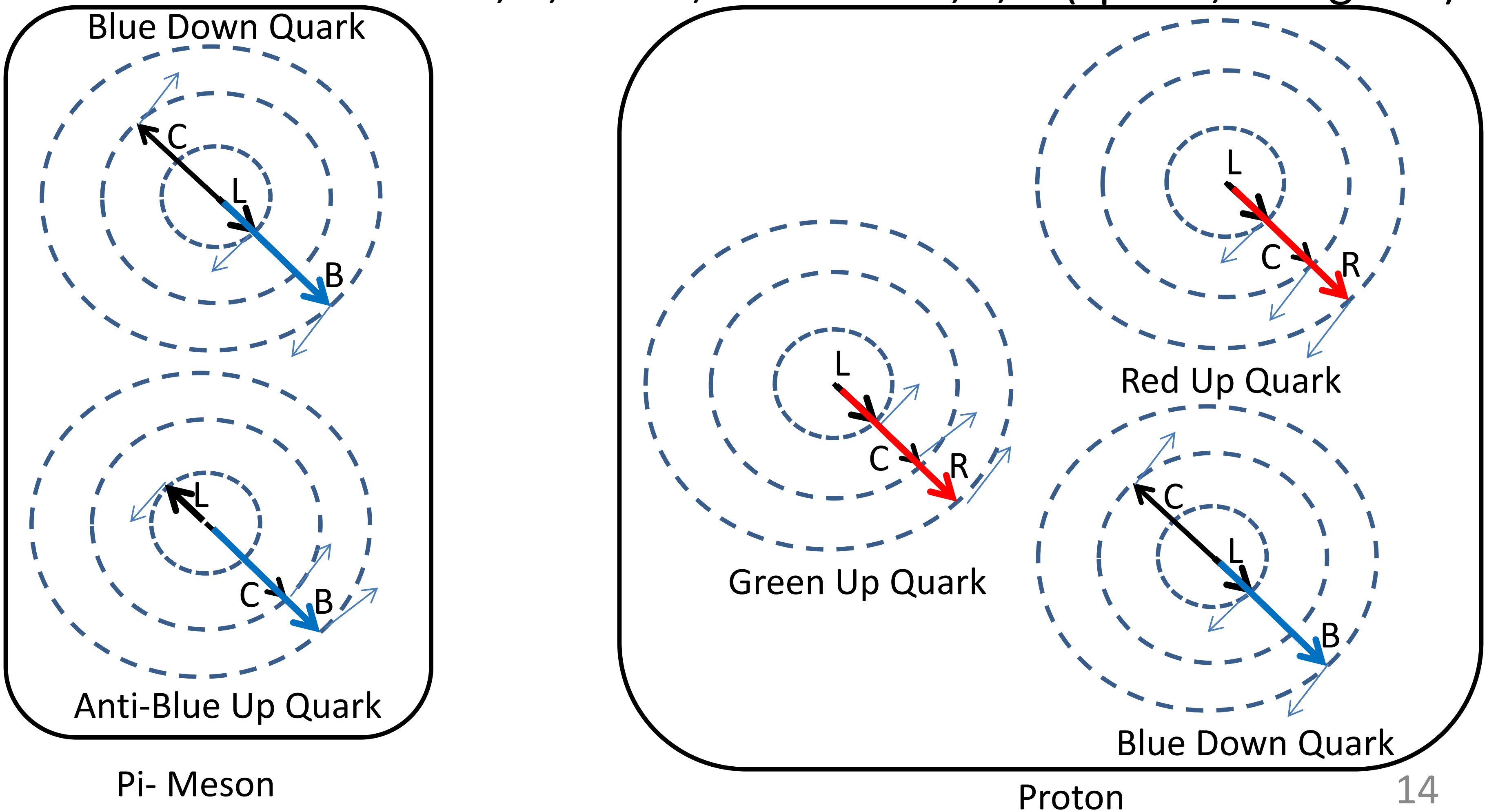
Green Down Quark



Anti-Blue Up Quark

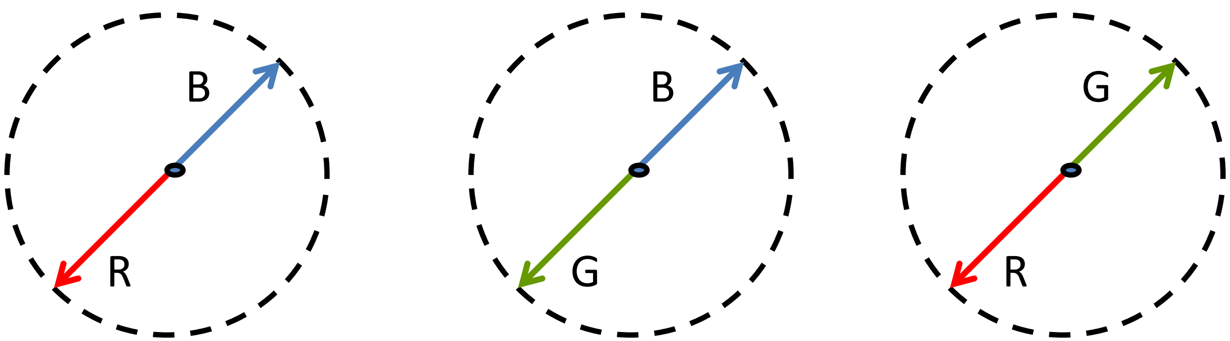
Examples of Proton and Pion

- Pi-meson consists of d and anti-u of same color (spin 0, charge -e).
- Proton consists of u, u, and d, 1 each of R,G, B (spin ½, charge +e).



Gluons and Composite Color Fields

- Gluons transmit color force, without any EM or weak force.
- Gluons convert one quark color to another.
  - Believed to consist of combination of color with anti-color.
- Proposal: Gluon consists of 2 anti-parallel color fields.
  - Corresponds to color-anti-color pairs.
- Example – red-anti-green gluon, same as green-anti-red.
- Gluons believed to have zero rest mass, so propagate at c.
- Can be circularly polarized like photons, with rotating fields.
- Not clear whether R-anti-R gluon would be stable in this picture; possibly if fields are displaced.



Gluon Examples

Implications of Coupled Field Picture

- This picture deals with rotating vector fields, so unclear basis for scalar Higgs boson.
- Not clear distinction between fermions and bosons.
- Picture assumes aligned bound fields, but possible decoupling during transitions.
- Possible implications of high-density unbound fields in early universe or gravitationally collapsed object.
- This picture does not specify equations, nor suggest unifying different forces.
- This picture says nothing about gravity, but suggests that rotating vector fields that give rise to charge, spin, and color could also generate gravitational field.

Summary Charts

Elementary Fields: Strong: R,G, B

EM: C, γ

Weak: L, W

New Standard Model

	Fermions I	**Fermions II**	**Fermions III**	**Bosons**
Quarks	Up C(2/3)LR	Charmed C(2/3)L*R	Top C(2/3)L**R	Gluon -RB,-RG,-BG
	Down -C(1/3)LR	Strange -C(1/3)L*R	Bottom -C(1/3)L**R	Photon γ
Leptons	Electron -CL	Muon -CL*	Tauon -CL**	Z-boson W
	El. Neutrino L	Mu Neutr. L*	Tau Neutr. L**	W-boson ±CW

Conclusions

- A new conceptual picture of 7 coupled vector fields may help organize the Standard Model.
  - This seems to be the simplest picture generally compatible with known particles.
- This suggests that fermions and bosons due to 1, 2, or 3 coupled fields rotating at $f = E/h$, carrying spin, charge, mass, and color.
- This picture further suggests that anti-particles are based on relative phases of rotating fields, and that particle generations are due to excited states of lepton field.
- Even if this is not correct, it may provide a simple basis for comparison of theories of fundamental particles.

References

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