NoteBook Setup

```
<< PhysicalConstants`
```

Set Constant Subscript Pattern Replacements

$\texttt{antiLPattern} : x\_{_R} := -\bar{x}_L$

$\texttt{antiRPattern} : x\_{_L} := -\bar{x}_R$

Std. MKS Dimensional Conversions

$$\text{JKC} := \text{Joule}\,\frac{1}{\text{Kilogram}}\left(\frac{\text{Second}}{\text{Meter}}\right)^2$$

$$\text{NKC} := \text{Newton}\,\frac{\text{Meter}}{\text{Joule}}\,\text{JKC}$$

$$\text{AKC} := \text{Ampere}\,\frac{\text{Second}}{\text{Kilogram}}\,\frac{\text{Second}}{\text{Meter}}$$

$$\text{CKC} := \text{Coulomb}\,\frac{1}{\text{Ampere Second}}\,\text{AKC}$$

$$\text{VKC} := \text{Volt}\,\frac{\text{Coulomb}}{\text{Joule}}\,\frac{\text{JKC}}{\text{CKC}}$$

$$\text{HKC} := \text{Henry}\,\frac{\text{Ampere}\,\hat{}\,2}{\text{Newton Meter}}\,\frac{\text{NKC}}{\text{AKC}^2}$$

Std. MKS Constants

Defined or Experimentally Measured MKS Constants

```
MKS`c = SpeedOfLight;

$Context = "MKS`";

α = FineStructureConstant;

μ0 = VacuumPermeability / HKC;

ϵ0 = VacuumPermittivity HKC;
```

$$\Omega 0 = \sqrt{(\text{FreeSpaceImpedance} / \text{HKC})^2};$$

```
el = ElectronCharge;
kCoul = CoulombConstant / HKC;

kBoltz = BoltzmannConstant;
```

$$\text{mel} = \sqrt{\left(\text{ElectronMass} / \text{HKC} \middle/ \text{CKC}^2\right)^2};$$

```
mp = ProtonMass;
```

```
h = Sqrt[(PlanckConstant / HKC / CKC^2)^2];

ℏ = h / (2 π);

GN = GravitationalConstant;

H0 = HubbleConstant;
Convert[H0, (Kilo Meter)/(Mega Parsec Second)]
```

$\frac{70.9711\ \text{Kilo Meter}}{\text{Mega Parsec Second}}$

```
a0 = BohrRadius;

R∞ = RydbergConstant;

xw = WeakMixingRatio;

θw = ArcSin[Sqrt[xw]] 180 / π;

αs = StrongCouplingConstant;

GF = FermiConstant;
Convert[%, 1 / (Giga eVperC2)^2]
```

$\frac{0.0000116639}{\text{eVperC2}^2\ \text{Giga}^2}$

```
mw = WeakBosonMass;
Convert[%, Mega eVperC2]
```

80 424.8 eVperC2 Mega

```
ParticleData[{"WBoson", 1}, "Mass"]
```

80 403.

```
mz = ZBosonMass;
Convert[%, Mega eVperC2]
```

91 187.3 eVperC2 Mega

```
ParticleData["ZBoson", "Mass"]
```

91 187.6

```
mμ = MuonMass;
Convert[%, Mega eVperC2]
```

105.658 eVperC2 Mega

```
ParticleData["Muon", "Mass"]
```

105.658369

```
TCMBR = CosmicMicrowaveBackgroundRadiationTemperature ;
```

New Unit Constants

```
$Context = "New`";
```

A More Natural Reference Model Integrating Relativity, Quantum Mechanics, and M Theory

J Gregory Moxness
http://www.TheoryOfEverything.org/TOE/JGM
jgmoxness@comcast.net

```
DateString[]
```

Sun 7 Oct 2007

Abstract

M Theory holds the promise of resolving the conflict between general relativity and quantum mechanics but lacks experimental connections to predictability in physics. This connection is made by questioning the value of the traditional Planck unit reference point for the scales at which M Theory operates. It also suggests a cosmological model which has acceleration as being fundamental. It provides for an intuitive understanding of the Standard Model and its relationship to particle masses and the structure of the atom. The prediction of particle mass and lifetimes is a good indicator for its validity.

PACS numbers: 03.65, 04.20.-q, 11.25.-w, 11.27.+d, 12.10.-g,12.60.-i, 95.30. 95.35.+d, 95.75.Wx, 98.80-k

Keywords: M Theory, Quantum Mechanics, Relativity, Cosmology, Standard Model, CKM, Nuclear Physics

Introduction

This paper will present a new "more natural" reference model for integrating General Relativity (GR) and Quantum Mechanics (QM) by contrasting it with the development of a reference model based on the more traditional Planck units. The new unit-of-measure (UoM) is based on the non-linear expansion or acceleration of the universe [1]. It provides a testable framework for particle mass prediction in support of the Standard Model (SM) as well as M Theory (MT).

The fact that the universe is found to be accelerating indicates that an exponential model which accommodates this acceleration could be more natural than the traditional linear model. The key to defining this new model relies on deriving "unity" as the center of scales for length (L), time (T), mass (M), and charge (Q) that are exponentially expanding.

Grand Unified Theories (GUTs) hold in high regard the Planck scale for its natural proximity to the unification energies. This scale is set by setting the fundamental parameters of the velocity of light (c), Planck's constant ($\hbar$), and Newton's Constant (G_N) to unity. Planck units are derived by combining powers of these constants into their dimensions of L, T, M, and Q. In terms of space-time, it seems to identify a possible lower limit to the length scale at one unit Planck length ($l_P = \sqrt{G_N \hbar / c^3}$).

$$l_P = \sqrt{\frac{\hbar}{c}\frac{G_N}{c^2}}$$

$$\sqrt{\frac{\hbar G_N}{c^3}}$$

Cosmological models logically define an upper limit based on the age and extent of the universe. In addition to an upper and lower limit (e.g. infinity (∞) and zero=1/∞ respectively), an exponential model should identify a center (unity) in order to be well defined.

In physics, the upper limit is naturally thought to be indicated by the macro world of G_N and GR. The lower limit is the micro world of $\hbar$ and QM. Fortunately, c is at home in both the micro and macro worlds. In the Planck unit model, the expanse between unity and zero is where GR and QM require the"new physics" beyond SM. As a reference model for scaling the universe, it offers no direct prescription for phenomena associated with atomic scales; therefore, using Planck units as a reference frame for the"center" of an exponentially scaling model seems counter-intuitive.

A new model is offered that uses this same general approach in defining natural dimensions but with interesting results achieved by associating with it two more fundamental parameters - the macro Hubble (H_0) and the micro fine structure (α). This approach does not detract from the significance of the Planck scale and its associated theoretical frameworks; however, it adds a point of view that puts it properly at the micro edge of an accelerating universal expansion.

Defining The New Model

```
MKS`α^-8
```

1.24359×10^{17}

Except for the Hubble parameter, the fundamental parameters of $\hbar$, c, G_N, and α are typically thought to be constant. A new model based on an accelerating universe is achieved by considering that all of these fundamental parameters vary with time \footnotetext[2]{Measuring synchronous time variation of multiple fundamental constants is problematic due to the principle of covariance. Time variation per t_{Unit} is 1 in α^{-8}=1.24359×10^{17}.}. It is also necessary to redefine the relationships between the measurable aspects or dimensions of our reality.

Relating Length to Time

In Planck units, c sets up the relationship between space and time by being driven to an effective dimensionless unity (a.k.a. geometrized units). This is done by setting unit (Planck) time as that taken by a photon to traverse 1 unit l_P, such that $t_P = l_P / c$. In terms of experimental precision, c is a "defined measurement" with no standard error. That is, its value is used to define length and time by counting its particle/wave oscillations or pulses.

$$t_P = \sqrt{(l_P / c)^2}$$

$$\sqrt{\frac{\hbar G_N}{c^5}}$$

$$m_P = \sqrt{\left(\frac{\hbar}{c}\frac{1}{l_P}\right)^2}$$

$$\sqrt{\frac{c\hbar}{G_N}}$$

The concept of using c to drive the relationship of space and time is also used in the new model with the difference focusing on the fact that the universe is found to be accelerating. This new model creates a relationship between the fundamental constants which provides an opportunity to normalize them to that universal acceleration. It does this by defining their magnitudes to be varying with time. For consistency, it also modifies the traditional understanding of the relationship between the dimensionality of L and T. The fundamental "constants" are now more properly referred to as fundamental "parameters".

For the assumptions in this new model, acceleration becomes a "dimensionless unity" and requires setting L to be equivalent to the square of the time dimension \footnotetext[3]{Procedural note: in terms of the traditional dimensionality of L, T, M, Q, the extra time dimensions found are associated with the complex plane.}:

```
LTC := LengthUnit 1/TimeUnit^2
```

$$L = T^2 \tag{1}$$

```
TimeUnit == 1/2 ∂_TimeUnit LengthUnit/LTC
```

True

```
Sqrt[-∂_TimeUnit TimeUnit]
```

i

or alternatively T=$\dot{L}/2$ and I=$\sqrt{-1}=\sqrt{-\dot{T}}$.

With c as the indicator for the expansion of space-time through its integral relationship with the impedance of free space (Ω_0) derived from permittivity (ϵ_0) and permeability (μ_0), it is natural to be defined as covariant with an accelerating universe. Since LT^{-1}=T, c can also be directly associated with the age of the universe instead of Planck's (dimensionless) unity. Of course, since H_0 of dimension T^{-1} is directly related to the age of the universe, it can be incorporated into the new model as well with \footnotetext[4]{This is an explicit acceleration in terms of dimension and does not rely on the modified relationship between L and T.}:

```
μ0 := 1 / Sqrt[c]

ϵ0 := μ0

Ω0 := Sqrt[μ0 / ϵ0]

aU = MKS`c 4 π MKS`H0;
Convert[%, Nano Meter / Second^2]
```

$\frac{8.6648 \text{ Meter Nano}}{\text{Second}^2}$

$$a_U = c\, 4\, \pi\, H_0 = 1 \text{ Unit Accleration} = 1 \text{ Dimensionless Unit} = 8.66\, \text{nm} / s^2 \tag{2}$$

where:

```
c[t_] := ∫_0^t 1 ⅆt

c'
```

1 &

```
a[l_] := l
a'
```

1 &

```
H[a_] := 1 & / a
H[a = t]
```

$\frac{1\,\&}{t}$

```
-H'[1]
```

1 & – (0 &)

$$\dot{c} = -\dot{H}_0 = 1 \text{ Dimensionless Unit} \tag{3}$$

H_0 is defined using the space metric (a) which is a function of time. It can also be defined as a function redshift factor (z) as a(z). Depending on cosmological model, this can give the age of the universe:

$$t_U = \frac{a(0)}{H_0} \tag{4}$$

The normalization is made possible by (2) and this model's definition of:

```
c := α^-8 LengthUnit / TimeUnit
Solve[Convert[MKS`c, LengthUnit / TimeUnit] == c, α][[8]];
1 / α /. %
```

137.036

```
α = 1 / 137.0359997094;
Convert[c, Meter / Second]
```

$\frac{2.99792\times10^{8}\ \text{Meter}}{\text{Second}}$

```
H0 := LTC / (4 π c)
Convert[H0, Kilo Meter / (Mega Parsec Second)]
```

$\frac{71.5812\ \text{Kilo Meter}}{\text{Mega Parsec Second}}$

$$H_0 = \frac{\alpha^8}{4\,\pi\,t_{\text{unit}}} \tag{5}$$

```
c / LTC == LengthUnit / (α^8 TimeUnit) 1 / LTC == 1 / (4 π H0) == α^-8 TimeUnit
```

True

$$c = \frac{l_{\text{unit}}}{\alpha^8\, t_{\text{unit}}} = \frac{1}{4\,\pi\, H_0} = \alpha^{-8}\, t_{\text{unit}} \tag{6}$$

For the purposes of this work, the assumption is that this relationship is correct and that the analysis of experimental evidence for the constraints on multiple time varying fundamental parameters will corroborate this.

A less dramatic alternative is also offered by defining L=T and a dimensionless $c = 1/4\,\pi\, H_0\, t_{\text{unit}} = \alpha^{-8}$. There is evidence from the relationships defined below that this is just as reasonable. This alternative has similar dimensionality to that of the traditional Planck UoM, along with its constant fundamental parameters. Unfortunately, it negates several interesting results related to this model's tie to MT. Some of these results can be recovered by instead relating the 11 MT charge dimensions to Degrees of Freedom (DoF). It leaves open the interpretation for the value of α.

The Constancy of Constants

An analysis of the possible time dependence of c, G_N, the cosmological constant (Λ), and the "dark energy" density (ρ_Λ) has determined [2] that if:

$$\frac{\dot{\rho}_\Lambda}{\rho_\Lambda} = 2\,\frac{\dot{c}}{c} - \frac{\dot{G}_N}{G_N} \tag{7}$$

then Λ is constant. The new model has:

$$\frac{\dot{c}}{c} = -\frac{\dot{G}_N}{G_N} = -\frac{\dot{\rho}_\Lambda}{\rho_\Lambda} = \frac{1}{t_U} \tag{8}$$

implying that Λ is not constant.

Current experimental evidence for (and constraints on) the magnitude of the time variation in the fundamental parameters is on the order of 1 part in 10^{14} per year for G_N (from type Ia supernova data [3] and 1 part in 10^{16} per year for α (from quasar dust cloud and Oklo reactor data [4]. Of course, these calculations assumed that the other fundamental parameters were constant. This assumption could account for the discrepancy in this model's G_N and α varying at 1 part in 10^9 per year, which is too large by a factor of 10^5 for G_N and 10^7 for α.

In the case where these fundamental parameters are considered unity and constant, as in Natural and Planck UoM, their scaling may be accounted for in the scaling of other related parameters, such as in gauge theories and/or Running Coupling Constants (RCC).

Relating Length to Mass

Typically, equating dimensions of L to M in Planck units uses the QM based Compton effect. Setting Planck's constant (h or $\hbar = \frac{h\,\pi}{2}$) and c to unity effectively associates a Compton (wave) length to be the inverse of mass or L=M^{-1}. The association of L to M can also be accomplished in GR by associating mass to its gravitational radius. This method establishes L=M at odds with the Compton method. While this GR approach removes the dimensionality of G_N, it leaves a dimensionality to $\hbar$ of L^2, which is used by Veneziano [5] to link GR to MT by setting $\hbar$ to the square of string length (l_P). Another motivation for Planck units is derived from the fact that it is only at l_P that these two methods for relating length to mass converge.

$$\mathbf{h := (4\,\pi\, c)\ MassUnit\ \frac{LengthUnit}{2}}$$

$$\mathbf{\hbar := \frac{h}{2\,\pi}}$$

```
Convert[ℏ, Kilogram Meter^2 / Second]
```

$$\frac{1.05457\times 10^{-34}\text{ Kilogram Meter}^2}{\text{Second}}$$

In the new UoM model, as in Planck units, it uses the Compton effect to set $\hbar = c\, l_{\text{unit}}\, m_{\text{unit}}$ while giving significantly different results due to c being associated with time and not (dimensionless) unity. This begs the question of whether to simply take the Compton effect as nature's indicator of the dimensional relationship between length and mass. Compton relates mass to a 1D wavelength. In 4D GR space-time, the inter-relationship between mass and gravity is spherically symmetric. The ability to link GR and QM in an intuitive way becomes problematic.

A more natural alternative to rationalizing this problem is offered. The Compton effect is the indicator of the inter-dependence between a particle's rest mass and the corresponding quantized wavelength and angle of its emissions. It is merely one aspect of how mass relates to length given the wave-particle duality of nature. **It is reasonable to understand a particle's rest mass in terms of both a QM-like linear wave from the Compton effect (L=M^{-1}) and a GR-like point particle from a spherically symmetric volume compression (or deceleration) of space for some period of time.** That is:

```
MTC = MassUnit TimeUnit/LengthUnit^3 LTC^3
```

$$\frac{\text{MassUnit}}{\text{TimeUnit}^5}$$

```
MassUnit/MTC == 1/6 ∂_TimeUnit LengthUnit^3/LTC^3
```

True

$$M = \frac{L^3}{T} = T^5 \tag{9}$$

or in terms of a volume of space (V) simply $M = \dot{V}/6$. This implies that the transformation of GR space-time into a particle's rest mass is a separate transformation from that of QM transformations to the massless photon (γ). This idea is the key to particle mass prediction of the new model.

Since $\hbar$ is a quantized angular momentum (mvr or spin), its particle dimensionality in the new model is:

```
MassUnit/MTC LengthUnit/(TimeUnit LTC) LengthUnit/LTC
```

TimeUnit^8

$$\text{ML}^2\, T^{-1} = T^8 \tag{10}$$

which indicates a linkage between QM, GR and an 11D MT space-time with 3 real dimensions of space and 8 dimensions associated with time, but allocated to complex imaginary space.

The model identifies a very natural unit length which is precisely related to the inverse of the Rydberg Constant (R_∞):

```
MKS`α/MKS`R∞
```

6.64984×10^{-10} Meter

```
MKS`α / MKS`R∞ == 4 π MKS`a0 == SetAccuracy[MKS[LengthUnit], 20]
```

True

$$l_{\text{unit}} = \frac{\alpha}{R_\infty} = \frac{2\,h}{\alpha\,c\,m_e} = \frac{4\,\pi}{\alpha\,c\,m_e} = 4\,\pi\,a_0 \tag{11}$$

This is twice the circumference of the Bohr model of the atom ($2\,\pi\,a_0$). If this l_{unit} is related to spin ($\hbar$), it is clear that a fermion of spin $\pm\hbar/2$ would then be precisely the circumference of the Bohr atom. It should be noted that l_{unit} is being defined using the most accurately measured parameters [6], where $\hbar$ and m_e are calculated using R_∞ known to a standard error of 6.6 ppt or 6.6 10^{-12} and α at 0.7 ppb or 7.0 10^{-10}. This is accomplished using the definition of α and the electron or elementary charge (e) less accurately known to 85 ppb:

```
MKS`ℏ^2 == (MKS`el^2 MKS`Ω0 / (CKC^2 4 π MKS`α))^2
```

True

$$\hbar = \frac{e^2\,\Omega_0}{4\,\pi\,\alpha} \tag{12}$$

So from (11) and (12) with an error twice that of e's giving 170 ppb accuracy to:

```
MKS`mel^2 == (MKS`el^2 MKS`R∞ MKS`Ω0 / (CKC^2 MKS`α^3 MKS`c))^2
```

True

$$m_e = \frac{4\,\pi\,\hbar\,R_\infty}{\alpha^2\,c} = \frac{e^2\,R_\infty\,\Omega_0}{\alpha^3\,c} = \frac{e^2\,R_\infty\,\mu_0}{\alpha^3} \tag{13}$$

It is also interesting to note that R_∞ is theoretically derived by finding the smallest electron radius of a classical (Bohr orbital) model allowed when incorporating the quantum model using the Hiesenberg uncertainty principle. This may support the idea that the $R_\infty=\alpha/l_{\text{unit}}$ is more deeply connected to the boundary of both classical-relativistic (macro) and quantum (micro) models of the universe than l_P.

The New Model and Special Relativity (SR)

It is instructive to visualize the new model using the concepts of SR. Normalizing c to a_U allows for an explicit description of the mechanism for changing a particle's velocity (v). It is done by constraining a_U in one or more dimensions. The velocity increases orthogonally to the constraint of a_U. The explanation for Lorentz length contraction (l'), time dilation (t'), and increase in mass (m') are a natural result of constraining a_U. See Fig. 1.

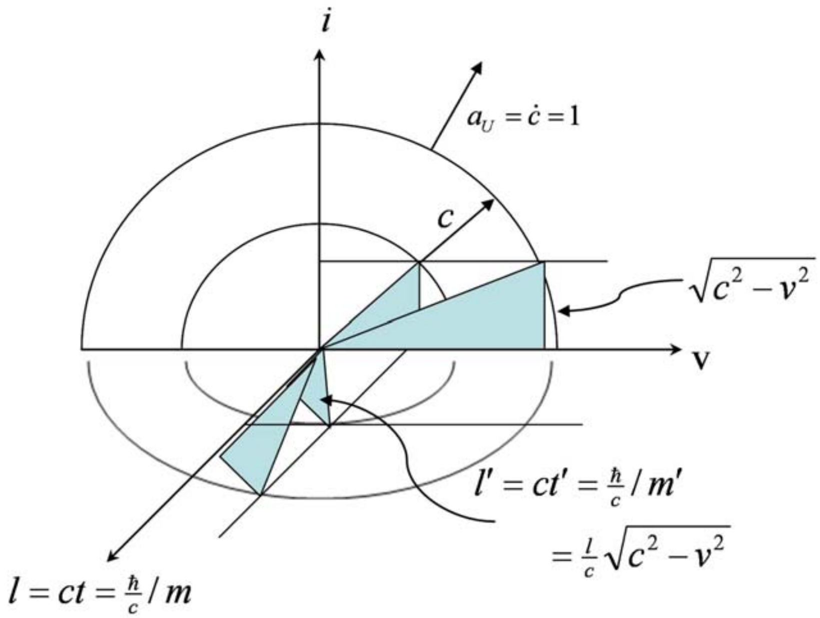

Fig 1 Visualizing the New Model

Defining Mass' Magnitude

Completing a minimally constrained definition in Planck units is accomplished by locking in a specific unit of mass by the free selection of the magnitude for $G_N = 1$. For the most part this affords a pleasing result. Unfortunately, it also results in a unit mass that is significantly larger than the particles of the SM. This large unit mass is rationalized with the hope that it will be the harbinger of particles in a GUT. This indeed may be the case and is not precluded in the definition of the new model.

Since the new UoM-based model is already over-constrained, the ad hoc selection of the magnitude of G_N is not possible. The new relationships between L, T, and M give G_N a dimension of T^{-1}, and a new relationship with H_0 is possible:

$$G_N = 4\pi H_0 \tag{14}$$

in terms of both magnitude and dimension. Given accurate current measure of Newton's Constant at 14 ppm [7]:

```
MKS`GN
```

$$\frac{6.67422 \times 10^{-11}\ \text{Meter}^3}{\text{Kilogram Second}^2}$$

$$G_N = 6.67422\times 10^{-11}\ \frac{m^3}{\text{kg}\ s^2} \tag{15}$$

the Hubble parameter can be calculated very precisely in terms of velocity per mega parsec (Mpc) as:

```
Clear[α]
```

```
Solve[Convert[MKS`GN, LengthUnit^3/(TimeUnit^2 MassUnit)] MTC/LTC^3 == 4 π H0, α][[1]];
Convert[H0 /. %, (Kilo Meter)/(Mega Parsec Second)]
```

$$\frac{81.3248\ \text{Kilo Meter}}{\text{Mega Parsec Second}}$$

$$H_0 = \frac{81.3248\, k\, m}{\text{Mpc}\, s} \tag{16}$$

```
Abs[Convert[%, 1 / Second]/MKS`H0 - 1] / HubbleConstantError
```

2.91773

```
α = 1 / 137.0359997094;
```

This preliminary value is outside a rather large standard uncertainty of 5% by a factor of 3 [8], but will be elegantly adjusted in a later section. More detailed significance of an interestingly small particle size m_{unit}=296.7397 eV/c^2 \footnotetext[6]{Representing mass as (eV/c^2) is less common than simply (eV). Natural UoM facilitates ignoring fundamental parameters set to unity ($\hbar$, c, G_N) and equates mass, energy, length and time. This paper exposes the risks of this habit based on UoM assumptions, and attempts to clarify and maintain complete and accurate representations.} and a rather large t_{unit}=0.2758466 s will also be discussed in a later section.

Defining Charge

The magnitude and dimensionality for a unit of charge still needs to be defined explicitly. It has implications for Quantum Field Theory (QFT) linking Quantum ElectroDynamics (QED) to Quantum ChromoDynamics (QCD), particle mass prediction, as well as a more general linkage between GR, QM and MT. In Planck units, charge is essentially a dimensionless parameter. It sets e(Q) to the small fraction $\sqrt{4\pi\alpha}$. Since the dimensionality of M has been redefined in terms of L and T, an alternate definition to the dimensionality of Q is offered with possible implications for Higgs mass prediction.

```
Ω0 == 1
```

True

Holding Ω_0 to dimensionless unity and using the new model's dimensional definition for M sets the magnitude of $e^2[Q] = 4\pi\alpha\,\hbar$ and the dimensionality to:

```
CTC = ChargeUnit TimeUnit/MassUnit MTC
```

$$\frac{\text{ChargeUnit}}{\text{TimeUnit}^4}$$

```
ChargeUnit/CTC == 1/5 ∂_TimeUnit MassUnit/MTC == 1/5 1/6 ∂_TimeUnit (∂_TimeUnit LengthUnit^3/LTC^3)
```

True

$$Q = \text{ML}^{-1/2} = \text{MT}^{-1} = L^2 = T^4 \tag{17}$$

Charge can now be visualized as a measure of the quantum change in particle mass per unit time. In terms of an area (A): $Q = \dot{M}/5 = \ddot{V}/30 = A$. In this model, with the possibility for complex space-time, the quantization of charge seems necessary for the mass transformation between the real spatial dimensions of a 3D GR particle-like volume compression and its dual 1D QM linear wave-like Compton effect. That is: M(3D)/M(1D)=Q(2D)=A=±1 \footnotetext[7]{Obviously, in this context, dimension D=Re[L]=T, or equivalently $D = L = T^2$ if $M(3D) = T \cdot M(T^5)$.}.

The significance of an intuitive choice for the magnitude of the charge's mass gives a testable prediction for what may be the mass of the Higgs boson (m_H). This can be shown to have new more natural relationships in the definitions of the Fermi Constant (G_F), ElectroWeak (EW) mixing angle (θ_w), the Vacuum Expectation Value (VEV or v, and <ϕ^0>_0) [9], and Zero Point Field (ZPF):

```
mH := √(2 ħ LengthUnit MTC / LTC^3) ;
Convert[mH, Giga √(eVperC2^2)]
```

147.989 $\sqrt{\text{eVperC2}^2}$ Giga

$$m_H = \sqrt{2\,\alpha\,\hbar\,l_{\text{unit}}} = \sqrt{\frac{2\,\hbar\alpha}{R_\infty}} = \hbar\sqrt{\frac{8\,\pi}{\alpha\,m_e\,c}} = \frac{\hbar}{\sqrt{c\,m_{\text{unit}}/2}} = 147.989\,\text{GeV}/c^2 \approx \frac{1}{2\sqrt{G_F}} \tag{18}$$

and:

```
el := √(4 π α^-7) ChargeUnit;
Convert[el, Coulomb]
```

1.60218×10^{-19} Coulomb

This leaves the possibility of a new interpretation for the parameter ($4\,\pi\alpha$) traditionally equated in a Planck unit model to e^2 where $\hbar$=1.

$$q_{\text{unit}} = e = m_H\sqrt{\frac{4\,\pi\,\alpha}{2\,l_{\text{unit}}}} = m_H\sqrt{2\,\pi\,R_\infty} = m_H\,\alpha\sqrt{\frac{m_e\,c}{2\,\hbar}} = \sqrt{4\,\pi\alpha\,\hbar} = \sqrt{2\,\alpha\,h} \tag{19}$$

■

EW Mixing Angle (θ_w)

The EW ratio ($4\pi\alpha$) from (12) is used to define a weak mixing or Weinberg angle of:

```
∛(α π / 2)
```

0.225473

```
θW = ArcSin[√%]
```

0.494783

```
θW 180 / π
```

28.3489

$$\theta_w = \text{Sin}^{-1}\sqrt{x_w} = 28.3489\,°\tag{20}$$

where:

$$x_w = \sqrt{\alpha\pi/2} = 0.225473\tag{21}$$

Surprisingly, this value is easily derived from the standard EW model [9] with a bit of algebraic manipulation, where:

```
Clear[α]
```

$$\texttt{g := }\sqrt{\left(\texttt{el}\Big/\sqrt{\texttt{x}_\texttt{w}}\Big/\texttt{CTC}\right)^2}$$

$$g = \frac{e}{\sqrt{x_w}}\tag{22}$$

$$\texttt{gPrime := }\sqrt{\left(\texttt{el}\Big/\sqrt{\texttt{1 - x}_\texttt{w}}\Big/\texttt{CTC}\right)^2}$$

$$g' = \frac{e}{\sqrt{1 - x_w}}\tag{23}$$

using a typical EW SM constraint:

$$\texttt{Solve}\left[\texttt{g == x}_\texttt{w}\sqrt{8\,\frac{\hbar}{\Omega_0}\,\frac{1}{\texttt{LTC}^2\,\texttt{MTC}}}\texttt{, x}_\texttt{w}\right]\texttt{[[2]]}$$

$$\left\{x_w \to \sqrt[3]{\frac{\pi}{2}}\,\sqrt[3]{\alpha}\right\}$$

$$\texttt{x}_\texttt{w}\texttt{ := }\sqrt[3]{\alpha\,\pi\,/\,2}$$

$$g = x_w\sqrt{8\,\frac{\hbar}{\Omega_0}}\tag{24}$$

Of course, this also agrees with EW SM predictions:

```
α = 1 / 137.0359997094;
```

$$\texttt{(el / CTC)}^2 \texttt{ == }\left(\frac{\texttt{g gPrime}}{\sqrt{\texttt{g}^2 + \texttt{gPrime}^2}}\right)^2 \texttt{ == (g Sin[}\theta_\texttt{W}\texttt{])}^2 \texttt{ == (gPrime Cos[}\theta_\texttt{W}\texttt{])}^2$$

True

$$e = \frac{\text{gg}'}{\sqrt{g^2 + g'^2}} = g\,\text{Sin}\,\theta_w = g'\,\text{Cos}\,\theta_w\tag{25}$$

$$\texttt{Abs}\left[\frac{\texttt{x}_\texttt{w}}{\texttt{MKS`xw}} - 1\right]\Big/\texttt{WeakMixingRatioError}$$

3.86334

```
Abs[3 xw / (0.22215 + MKS`xw + 0.23124) - 1] / WeakMixingRatioError
```

0.20878

This prescription for the input parameters of the EW model is within the experimental standard error [6] of 3.4 ppk when averaged with x_w[OnShell]=0.22215 and $x_w[\overline{\text{MS}}]$=0.23124. Taking the average of the two x_w schemes might be linked to RCC.

Completing the Model

Combining the discussion of magnitude and dimension above into a single equation, gives:

```
Clear[α]
```

```
GN := α^8 gc2 (LengthUnit/TimeUnit)^2 LengthUnit/MassUnit
```

```
c / LTC == ħ/(MassUnit LengthUnit) 1/LTC == gc2/GN LTC^3/MTC == 1/(4 π H0) == α^-8 TimeUnit
```

True

```
Solve[Convert[MKS`GN, LengthUnit^3/(TimeUnit^2 MassUnit)] MTC/LTC^3 == 4 π H0, α][[8]];
1 / α /. %
```

134.867

```
α = 1 / 137.0359997094;
```

$$\frac{h(T^8)}{l_{\text{unit}}\, m_{\text{unit}}} = c = \frac{1}{G_N} = \frac{1}{4\,\pi\, H_0} = 134.867^8\, t_{\text{unit}} \approx \alpha^{-8}\, t_{\text{unit}} \quad (26)$$

The inverse relationships between the fundamental parameters and a more natural connection between gravitational attraction and Hubble expansion may suggest the duality of MT relating the micro and macro worlds defined above. The proximity of the magnitudes to $\alpha^{-8}\, t_{\text{unit}}$ may extend the model even further. This exponent seems to support the 8D time construct previously noted in the dimensionality of implying that fine structure is a fractional dimension (fractal) of time.

Linking G_N and θ_w

It is possible to adjust the Newtonian or GR value of $G_N^{D=3+1=4}$ to the MT value of $G_N^{D=3+8=11}$ using the dimensionless gravitational coupling factor for open (g_o) and closed (g_c) strings [11] where g_c=g_o^2 and $G_N = \alpha^8\, g_c^2 / t_{\text{unit}}$. A value of:

```
gc2 := Sqrt[1 - 2 (α π / 2)^2] / Sqrt[1 - xw]
gc2
```

1.13612

$$g_c^2 = \frac{\sqrt{1 - 2\left(a \cdot \frac{\pi}{2}\right)^2}}{\text{Cos }\theta_w} = \sqrt{\frac{1 - 2\left(a \cdot \frac{\pi}{2}\right)^2}{1 - \sqrt[3]{a \cdot \frac{\pi}{2}}}} = 1.13612135987 \tag{27}$$

```
Clear[α]
```

$$\text{Solve}\left[\text{Convert}\left[\frac{\text{MKS`GN}}{\text{gc2 /. }\alpha \to \text{FineStructureConstant}}, \frac{\text{LengthUnit}^3}{\text{TimeUnit}^2\ \text{MassUnit}}\right] \frac{\text{MTC}}{\text{LTC}^3} == 4\,\pi\,\text{H}_0, \alpha\right][[8]];$$

```
1 / α /. %
```

137.036

$$\text{Convert}\left[\text{H}_0 \text{ /. \%\%}, \frac{\text{Kilo Meter}}{\text{Mega Parsec Second}}\right]$$

$$\frac{71.5811\ \text{Kilo Meter}}{\text{Mega Parsec Second}}$$

$$\text{Abs}\left[\frac{\%}{\text{Convert}\left[\text{MKS`H0}, \frac{\text{Kilo Meter}}{\text{Mega Parsec Second}}\right]} - 1\right] \Big/ \text{HubbleConstantError}$$

0.171902

$$\text{c / LTC} == \frac{\hbar}{\text{MassUnit LengthUnit}} \frac{1}{\text{LTC}} == \frac{\text{gc2}}{\text{G}_\text{N}} \frac{\text{LTC}^3}{\text{MTC}} == \frac{1}{4\,\pi\ \text{H}_0} == \alpha^{-8}\ \text{TimeUnit}$$

True

$$\text{Abs}\left[\sqrt{\left(\frac{\text{Convert}\left[\hbar, \text{Kilogram Meter}^2 \big/ \text{Second}\right]}{\text{MKS`}\hbar}\right)^2} - 1\right] \Big/ \text{PlanckConstantError}$$

$$5.88235 \times 10^6 \left| 8.04123 \times 10^{-18} \sqrt{\frac{1}{\alpha^{16}}} - 1 \right|$$

$$\text{Abs}\left[\frac{\text{Convert[el, Coulomb]}}{\text{MKS`el}} - 1\right] \Big/ \text{ElementaryChargeError}$$

$$1.17647 \times 10^7 \left| \frac{3.31955 \times 10^{-8}}{\alpha^{7/2}} - 1 \right|$$

```
Abs[Convert[G_N, Meter^3/Second^2/Kilogram]/MKS`GN - 1]/GravitationalConstantError
```

$$71\,428.6\left|\frac{1.09459\times 10^{17}\,\alpha^{8}\sqrt{1-\frac{\pi^{2}\alpha^{2}}{2}}}{\sqrt{1-\sqrt[3]{\frac{\pi}{2}}\,\sqrt[3]{\alpha}}}-1\right|$$

which alters (21) and **shifts the values for H_0=71.5811688427 km/s/Mpc and α=1/137.0359997094 in precise alignment with the center of all current experimental values [12]!** SM can now be directly linked to GR and MT giving G_N=6.67422093862 x 10^{-11} m^3/kg s.}

Model Detail and Predictions

Combining these discussions of dimensions and magnitude of the fundamental parameters results in an ability to associate the results to familiar arguments as well as predict new relationships in physics.

Charge Predictions

The complexity of charge in the SM involves RCC, perturbation theory, Axial-Vector (A-V) currents, quark Cabibbo-Kobayashi-Maskawa (CKM) and neutrino Maki-Nakagawa-Sakata (MNS) phased mixing matrices, Noether's theorem linking conservation rules and CPT symmetry (and its violations), the Unitary Triangle, a dual Standard Model (dSM), and $SU(5)\to SU(3)_C\times SU(2)_I\times(U\,(1))_Y/\mathbb{Z}_6$ group theory. The new model builds on this by introducing a simplifying "self dual" Standard Model (sdSM) while predicting and retro or post-dicting the parameters in the theories just mentioned. It solves the hierarchy problem and explains fine tuning of the fundamental parameters.

Linking RCC and x_W

```
Clear[α]

Solve[x_w == 0.23124, α];
1 / α /. %
```

{127.037}

```
α = 1 / 137.0359997094;
```

RCC, with its varying of α at different energies or masses, is a method that accommodates experimental results and provides for the idea of "grand unification" at (or near) the Planck mass ($m_P=\frac{\hbar}{c}\frac{1}{l_P}=\sqrt{\frac{c\,\hbar}{G_N}}$) scale. If RCC is viewed as an accommodation of the effect that the accelerating universe has on the fundamental parameters, then by (21), x_w and θ_w will vary with different α. Using this as a guide to understanding the difference between $x_w(\alpha)[\overline{\text{MS}}]$ and $x_w(\alpha)$[OnShell], calculating $x_w(\alpha)[\overline{\text{MS}}]$ gives consistent results with $\alpha(M_Z)$=1/127.037.

```
α_s := x_w / 2
α_s
```

0.112737

```
Abs[αs/MKS`αs - 1] / StrongCouplingConstantError
```

4.21696

It will be interesting to see whether the strong coupling constant in the modified-minimal-subtraction scheme $\alpha_s(m_Z)[\overline{\text{MS}}]$=0.1177(13) might also relate to $\alpha_s(m_Z)[\overline{\text{MS}}]=x_w/2$=0.1127. The modification of RCC using (21) as an indicator to the path to grand unification is an interesting alternative to current thinking.

Linking CKM and x_W

```
VCKM = {
  {Vud, Vus, Vub},
  {Vcd, Vcs, Vcb},
  {Vtd, Vts, Vtb}
 }
```

$$\begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix}$$

```
A = KMScale
```

0.85

```
λ = KMValues[[1, 2]]
```

0.221

```
VCKM-λAρη := {
  {1 - λ^2/2, λ, A λ^3 (ρ - ⅈ η)},
  {-λ, 1 - λ^2/2, A λ^2},
  {A λ^3 (1 - (ρ + ⅈ η)), -A λ^2, 1}
 }
VCKM-λAρη
```

$$\begin{pmatrix} 0.97558 & 0.221 & 0.00917478\,(\rho - i\,\eta) \\ -0.221 & 0.97558 & 0.0415149 \\ 0.00917478\,(-i\,\eta - \rho + 1) & -0.0415149 & 1 \end{pmatrix}$$

It is also found that x_w may relate to the Cabibbo angle (θ_c) in the Wolfenstein parameterization of the CKM matrix [13] where $\lambda = |V_{us}| = \text{Sin}\,\theta_c$. More recent data suggests that $\lambda = x_w$ may not be outside a rather large standard error of >1% for θ_c [14]. With $\delta = \pi/3 = 60°$, $\sigma = \frac{1}{A} = \frac{2}{3}$, $\rho = \frac{\sigma}{2}$, and $\eta=1/(\sqrt{3}\,\sigma)$ gives:

```
(* Cabbibo and Wienberg Angle relationship xw=SinθC=Sin^2θW *)
λ := xw

(* a conjecture about the Unitary Triangle *)
```

$\delta := \frac{\pi}{3}$ (* Theoretical Std. Model $\theta\gamma$=60° *)

$\sigma := \frac{1}{A}$

$\rho := \frac{1}{A}\sqrt{\frac{1}{4}}$

$\eta := \frac{1}{A}\sqrt{\frac{3}{4}}$

$A = \frac{3}{2}$;

$\theta\gamma = 60\,\frac{\pi}{180}$;

$\theta\gamma == \delta == \text{ArcSin}[A\,\eta] == 60\,\frac{\pi}{180}$

True

$\theta\beta = \frac{\pi}{8}$;

$\%\,\frac{180}{\pi}$ // N

22.5

$\theta\alpha = \pi - \theta\beta - \theta\gamma$

$\%\,\frac{180}{\pi}$ // N

$\frac{13\pi}{24}$

97.5

$\theta\beta = \text{ArcSin}[\rho]$;

$\%\,\frac{180}{\pi}$ // N

19.4712

$\theta\alpha = \pi - \theta\beta - \theta\gamma$;

$\%\,\frac{180}{\pi}$ // N

100.529

$\text{Re}\left[V_{\text{CKM}-\lambda A\rho\eta}[[1, 3]]\right] == \text{Re}\left[A\,x_w^3\,(\rho - i\,\eta)\right] == \frac{4\,\pi\,\alpha}{16} == \frac{\pi}{4}\,\alpha$

True

```
V_CKM-Play := {
  {1 - λ^2/2, λ, A λ^3 σ ⅇ^(-ⅈ θγ)},
  {-λ, 1 - λ^2/2, λ^2},
  {A λ^3 (1 - σ ⅇ^(ⅈ θγ)), - λ^2, 1}
 }
V_CKM-Play
```

$$\begin{pmatrix} 0.974581 & 0.225473 & 0.00573133 - 0.00992695\, i \\ -0.225473 & 0.974581 & 0.0508382 \\ 0.0114627 - 0.00992695\, i & -0.0508382 & 1 \end{pmatrix}$$

```
Abs[Re[%] / KMValues];

Abs[1/(1 - %)]
```

$$\begin{pmatrix} 1061.37 & 49.4045 & 22.332 \\ 49.4045 & 5386.35 & 9.50767 \\ 23.7758 & 9.50767 & 832.333 \end{pmatrix}$$

$$V_{\text{CKM}} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} 1 - \frac{\lambda^2}{2} & \lambda & A\, e^{-i\,\theta\gamma}\, \lambda^3\, \sigma \\ -\lambda & 1 - \frac{\lambda^2}{2} & \lambda^2 \\ A\, \lambda^3 \left(1 - e^{i\,\theta\gamma}\, \sigma\right) & -\lambda^2 & 1 \end{pmatrix} = \begin{pmatrix} 0.974581 & 0.225473 & 0.00573133 - 0.00992695\, i \\ -0.225473 & 0.974581 & 0.0508382 \\ 0.0114627 - 0.00992695\, i & -0.0508382 & 1 \end{pmatrix} \tag{28}$$

where it is interesting to note, $| \text{V}_{\text{CKM}}[1, 3] = \alpha\, \pi / 4$ and $| \text{V}_{\text{CKM}}[3, 1] = \alpha\, \pi / 2$. The error for each value (in 1/parts per unit) gives:

$$\begin{pmatrix} 1061.37 & 49.4045 & 22.332 \\ 49.4045 & 5386.35 & 9.50767 \\ 23.7758 & 9.50767 & 832.333 \end{pmatrix} \tag{29}$$

A simpler model which gives the same results, but with a large error in $|V_{td}|$=50% is given where With $\delta = \pi / 3 = 60°$, $\sigma = \frac{1}{A} = 1$, $\rho = \frac{\sigma}{2}$, and η=$\sqrt{3}\, \rho$) gives:gives:

```
A = 1;

V_CKM-Play
```

$$\begin{pmatrix} 0.974581 & 0.225473 & 0.00573133 - 0.00992695\, i \\ -0.225473 & 0.974581 & 0.0508382 \\ 0.00573133 - 0.00992695\, i & -0.0508382 & 1 \end{pmatrix}$$

```
Abs[Re[%] / KMValues];
```

```
Abs[1/(1 - %)]
```

$$\begin{pmatrix} 1061.37 & 49.4045 & 22.332 \\ 49.4045 & 5386.35 & 9.50767 \\ 2.08781 & 9.50767 & 832.333 \end{pmatrix}$$

$$\begin{pmatrix} 0.974581 & 0.225473 & 0.00573133 - 0.00992695\,i \\ -0.225473 & 0.974581 & 0.0508382 \\ 0.00573133 - 0.00992695\,i & -0.0508382 & 1 \end{pmatrix} \quad (30)$$

The error for each value (in 1/parts per unit) gives:

$$\begin{pmatrix} 1061.37 & 49.4045 & 22.332 \\ 49.4045 & 5386.35 & 9.50767 \\ 2.08781 & 9.50767 & 832.333 \end{pmatrix} \quad (31)$$

Axial Vector Coupling (C_{A-V})

It has been found that the Axial-Vector relationship can be defined within experimental error as:

```
Convert[VectorAxialCouplingConstant / MKS`c^2, Mega eVperC2 (Centi Meter)^3]
```

6.19783×10^{-44} Centi^3 eVperC2 Mega Meter^3

```
Convert[LengthUnit^3 MassUnit (TimeUnit H0), Mega eVperC2 (Centi Meter)^3]
```

5.58369×10^{-44} Centi^3 eVperC2 Mega Meter^3

```
Abs[%/%% - 1] / VectorAxialCouplingConstantError
```

0.990881

$$C_{A-V} = l_{\text{unit}}^3 \cdot (H_0\, t_{\text{unit}}) \cdot m_{\text{unit}} = 5.58369\times10^{-44}\ \text{cm}^3\ \text{MeV}/c^2 \quad (32)$$

Fermi Constant (G_F)

To *a posteriori* obtain the weak boson masses and the charged lepton masses requires the theoretical derivation of G_F and $<\phi^0>_0=\text{v}\sqrt{2}$. The definition of m_H in (18) can be used such that:

```
GF := (2 mH)^-2
Convert[GF, 1 / (Giga eVperC2)^2]
```

$$\frac{0.0000114151}{\text{eVperC2}^2\ \text{Giga}^2}$$

```
Convert[1 / (((MKS`c^2 MuonLife)/(MKS`ħ) (MKS`mμ^5)/(3 (4 π)^3))^2)^(1/4), 1 / ((Giga eVperC2)^8)^(1/4)]
```

$$\frac{0.000011638}{\sqrt[4]{\text{eVperC2}^8\ \text{Giga}^8}}$$

```
100 (Convert[MKS`GF, 1/ (Giga eVperC2)^8^(1/4)] /
   Convert[1/ ((MKS`c^2 MuonLife/MKS`ℏ MuonMass^5/(3 (4 π)^3))^2)^(1/4), 1/ (Giga eVperC2)^8^(1/4)] - 1)
```

0.222131

```
100 (Convert[MKS`GF, 1/ (Giga eVperC2)^2] / Convert[G_F, 1/ (Giga eVperC2)^2] - 1)
```

2.1792

$$G_F = \frac{G_F^{'}}{(\hbar\, c)^3} = \left(\frac{m_H}{1+\Delta\mathrm{r}}\right)^{-2} = 1.16638878775\,\mathrm{x}10^{-5}\left(\mathrm{GeV}/c^2\right)^{-2}$$
$$\approx \frac{\alpha^8}{8\, m_{\mathrm{unit}}^2} = 1.14151298702\,\mathrm{x}10^{-5}\left(\mathrm{GeV}/c^2\right)^{-2} \tag{33}$$

```
Abs[Convert[MKS`GF, 1/ (Giga eVperC2)^2] / Convert[G_F, 1/ (Giga eVperC2)^2] - 1] /
 FermiConstantError
```

2533.95

```
Abs[
 Convert[MKS`GF, 1/ (Giga eVperC2)^8^(1/4)] /
   Convert[1/ ((MKS`c^2 MuonLife/MKS`ℏ MuonMass^5/(3 (4 π)^3))^2)^(1/4), 1/ (Giga eVperC2)^8^(1/4)] - 1]
```

0.00222131

```
Abs[
  Convert[G_F, 1/ (Giga eVperC2)^8^(1/4)] /
    Convert[1/ ((MKS`c^2 MuonLife/MKS`ℏ MuonMass^5/(3 (4 π)^3))^2)^(1/4), 1/ (Giga eVperC2)^8^(1/4)] - 1] /
 %
```

8.62251

where Δr=2.1791955% due to radiative corrections in the definition of G_F \footnotetext[8]{As explained in footnote \footnotemark[6] re: Natural UoM, it is less commonly (but more precisely) represented as G_F=$(\hbar c)^3/\mathrm{mass}^2$. This model explicitly defines G_F in terms of m_H^2 only. Depending on usage, the factor of $(\hbar c)^3$ is only needed for proper conversions.}. As in the calculation of particles' anomalous magnetic moments (e.g. a_e), the radiative corrections are precisely calculated by counting self induced perturbations as described in Feynman loop diagrams. Unfortunately, this prescription for Δr is significantly outside the very small experimental and theoretical standard error of 8.6 ppm by a factor of 2500. When comparing the non-perturbative G_F with an error of

2.2 ppk, this error factor is reducted to 9. This error is expected to be rationalized by changes in perturbation theory based on the new model.

The Vacuum Energy (VEV or v, and $<\phi^0>_0$)

The EW Fermi model, m_H, e and G_F gives:

```
v := 1/Sqrt[Sqrt[2] G_F]
Convert[v, Giga eVperC2]
```

248.887 eVperC2 Giga

$$v = \frac{1}{\sqrt{\sqrt{2}\,G_F}} \approx 2^{3/4}\, m_H = 248.887\,\text{GeV}\big/c^2 \tag{34}$$

```
Symbolize["<ϕ⁰>₀"] := v/Sqrt[2]
Convert[Symbolize["<ϕ⁰>₀"], Giga eVperC2]
```

175.99 eVperC2 Giga

$$<\phi^0>_0 = \frac{v}{\sqrt{2}} \approx 2^{1/4}\, m_H = 175.989628624\,\text{GeV}\big/c^2 \tag{35}$$

The Self Dual Standard Model (sdSM)

The dual SM (dSM) [15] is based on the SU(5)→$SU(3)_C\times SU(2)_I\times(U(1))_Y/\mathbb{Z}_6$ group theory. It relates the $SU(2)_I$ representation of left-right (L,R) isospin (I), the $SU(3)_C$ representation of red-green-blue (r,g,b) color (C), and $(U(1))_Y$ representation of Yukawa hypercharge (Y) in SU(5). This is done using a diagonal transformation matrix T=(r,g,b,L,R):

```
(* Self Dual Symmetry SM *)

(* SU(5)→SU(3)_C×SU(2)_I×U(1)_Y/ℤ6 *)

T_C := 3 ( -1/3  -1/3  2/3  0  0 )

T_C
```

(−1 −1 2 0 0)

```
T_I := ( 0  0  0  1  -1 )

T_Y := 2 ( 1  1  1  -3/2  -3/2 )

T_Y
```

(2 2 2 −3 −3)

$$\begin{gathered} T_C = \text{Diag}(-1/3,\ -1/3,\ 2/3,\ 0,\ 0) \\ T_I = \text{Diag}(0, 0, 0, 1, -1) \\ T_Y = \text{Diag}(1,\ 1,\ 1,\ -3/2,\ -3/2) \end{gathered} \tag{36}$$

```
TM := ( T_C  T_I  T_Y )

M[x_, y_, z_] :=
 {( x  y  z ), (( x  y  z ) × TM)⟦1⟧⟦1⟧ + (( x  y  z ) × TM)⟦1⟧⟦2⟧ + (( x  y  z ) × TM)⟦1⟧⟦3⟧}
```

$\bar{\nu}_R := \frac{1}{2}$ M[0, -1, 1] (* $\nu_L := \frac{1}{2}$M[0,1,-1] *)

$\bar{\nu}_R$

$$\begin{pmatrix} \{0, -\frac{1}{2}, \frac{1}{2}\} \\ \{1, 1, 1, -2, -1\} \end{pmatrix}$$

$\bar{\nu}_L := 0\, \bar{\nu}_R$ (* ν_R:=M[0,0,0] *)

These matrices are then used with the standard SU(3) monopole representation of each particle m(C,I,Y) producing the SU(5) group monopoles M(r,g,b,L,R) for that particle. The specific transformation is M(r,g,b,L,R)=$m_C \cdot T_C + m_I \cdot T_I + m_Y \cdot T_Y$. For example, the left and right handed spin electrons $(e_{L,R})$ transform as follows:

$\bar{e}_R := \frac{1}{2}$ M[0, 1, 1] (* $e_L := \frac{1}{2}$M[0,-1,-1] *)

$\bar{e}_R$

$$\begin{pmatrix} \{0, \frac{1}{2}, \frac{1}{2}\} \\ \{1, 1, 1, -1, -2\} \end{pmatrix}$$

$\bar{e}_L := \bar{\nu}_R + \bar{e}_R$ (* M[0,0,1]==T_Y==-e_R *)

$\bar{e}_L$

$$\begin{pmatrix} \{0, 0, 1\} \\ \{2, 2, 2, -3, -3\} \end{pmatrix}$$

$$\begin{gathered} e_L = m(0, -1/2, -1) \to M(-1, -1, -1, 2, 1) \\ e_R = m(0, 0, 2) \to M(-2, -2, -2, 3, 3) \end{gathered} \tag{37}$$

$\bar{\nu}_R + \bar{e}_R == \bar{e}_L + \bar{\nu}_L == \begin{pmatrix} \{0, 0, 1\} \\ \{2, 2, 2, -3, -3\} \end{pmatrix}$

True

$\bar{d}_L := \frac{1}{3}$ M[-1, 0, 1] (* $d_R := \frac{1}{3}$M[1,0,-1] *)

M[1, 0, -1] + M[0, 0, 1]

$$\begin{pmatrix} \{1, 0, 0\} \\ \{-1, -1, 2, 0, 0\} \end{pmatrix}$$

$\frac{1}{3}$ M[1, 0, -1] + 2 (M[0, 0, 1] + $\frac{1}{3}$ M[1, 0, -1])

M[1, 0, -1] + 2 M[0, 0, 1]

M[1, 0, 1]

$$\begin{pmatrix} \{1, 0, 1\} \\ \{1, 1, 4, -3, -3\} \end{pmatrix}$$

$$\begin{pmatrix} \{1, 0, 1\} \\ \{1, 1, 4, -3, -3\} \end{pmatrix}$$

$$\begin{pmatrix} \{1, 0, 1\} \\ \{1, 1, 4, -3, -3\} \end{pmatrix}$$

$\bar{d}_L$

$$\begin{pmatrix} \{-\frac{1}{3}, 0, \frac{1}{3}\} \\ \{1, 1, 0, -1, -1\} \end{pmatrix}$$

$\bar{u}_L := \bar{d}_L - \bar{e}_L$

$\bar{u}_L$

$$\begin{pmatrix} \{-\frac{1}{3}, 0, -\frac{2}{3}\} \\ \{-1, -1, -2, 2, 2\} \end{pmatrix}$$

$\bar{d}_R := \bar{d}_L + \nu_L$

$\bar{d}_R$

$$\begin{pmatrix} \{-\frac{1}{3}, \frac{1}{2}, -\frac{1}{6}\} \\ \{0, 0, -1, 1, 0\} \end{pmatrix}$$

$\bar{d}_R == -\frac{1}{6}$ M[2, -3, 1] == $-(d_R + \bar{\nu}_R)$

True

$\bar{u}_R := \bar{u}_L + \bar{\nu}_R$

$\bar{u}_R$

$$\begin{pmatrix} \{-\frac{1}{3}, -\frac{1}{2}, -\frac{1}{6}\} \\ \{0, 0, -1, 0, 1\} \end{pmatrix}$$

$\bar{u}_R == -\frac{1}{6}$ M[2, 3, 1] == $\bar{u}_L - \nu_L == \bar{d}_L - \bar{e}_R$

True

$\overline{W^-}_R := \bar{d}_R - \bar{u}_R$

$\overline{W^-}_R$

$\begin{pmatrix} \{0, 1, 0\} \\ \{0, 0, 0, 1, -1\} \end{pmatrix}$

$\overline{W^-}_R == M[0, 1, 0] == \bar{d}_R - \bar{u}_R == \bar{d}_R - \bar{d}_L + \bar{e}_R == \bar{e}_R - \bar{\nu}_R == \bar{d}_R + u_L == \bar{d}_L + \nu_L + u_L == -d_L + u_L == \nu_L - e_L == \nu_L + \bar{e}_R == -(\bar{\nu}_R + e_L)$

True

$(W^-)_L$

$\begin{pmatrix} \{0, -1, 0\} \\ \{0, 0, 0, -1, 1\} \end{pmatrix}$

$\overline{W^-}_L := \bar{d}_L - \bar{u}_L$

$\overline{W^-}_L$

$\begin{pmatrix} \{0, 0, 1\} \\ \{2, 2, 2, -3, -3\} \end{pmatrix}$

$\overline{W^-}_L == M[0, 0, 1] == \bar{d}_L - \bar{u}_L == \bar{e}_L == \bar{e}_R + \bar{\nu}_R$

True

$(W^-)_R$

$\begin{pmatrix} \{0, 0, -1\} \\ \{-2, -2, -2, 3, 3\} \end{pmatrix}$

$\overline{W^+}_R := (W^-)_L$

$\overline{W^+}_R$

$\begin{pmatrix} \{0, -1, 0\} \\ \{0, 0, 0, -1, 1\} \end{pmatrix}$

$(W^+)_L$

$\begin{pmatrix} \{0, 1, 0\} \\ \{0, 0, 0, 1, -1\} \end{pmatrix}$

$\overline{W^+}_L := (W^-)_R$

$\overline{W^+}_L$

$\begin{pmatrix} \{0, 0, -1\} \\ \{-2, -2, -2, 3, 3\} \end{pmatrix}$

$(W^+)_R$

$\begin{pmatrix} \{0, 0, 1\} \\ \{2, 2, 2, -3, -3\} \end{pmatrix}$

$\bar{Z}_L := \overline{W^-}_L + \overline{W^+}_L$

$\bar{Z}_L$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

$\bar{Z}_L == -\bar{\nu}_R + \bar{e}_R - \nu_L + e_L == -d_L + u_L - \nu_L + e_L$

True

$Z_R := \bar{\nu}_L + e_L + \nu_L + \bar{e}_L$ (* $-\bar{Z}_L$ *)

$\bar{Z}_R := \overline{W^-}_R + \overline{W^+}_R$

$\bar{Z}_R$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

$\bar{Z}_R == -\bar{\nu}_L + \bar{e}_L - \nu_R + e_R == -d_R + u_R - \nu_R + e_R$

True

$Z_L := \bar{\nu}_R + e_R + \nu_R + \bar{e}_R$ (* $-\bar{Z}_R$ *)

$-\bar{e}_L == -(\bar{e}_L + \bar{\nu}_L) == -(\bar{e}_L + \nu_R) == e_R == e_R + \bar{\nu}_L == e_R + \nu_R$

True

$\bar{Z}_L == -Z_R == -\bar{Z}_R == Z_L == \begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$

True

$(\bar{\nu}_L + \bar{e}_L) == -e_R == -(\nu_L + e_L) == (\bar{\nu}_R + \bar{e}_R) == -(\nu_R + e_R) == \begin{pmatrix} \{0, 0, 1\} \\ \{2, 2, 2, -3, -3\} \end{pmatrix}$

True

$2\, d_L + u_L + (W^+)_L == d_L + 2\, u_L$ (* Beta Decay in Neutron→ Proton *)

True

$d_L + 2\, u_L$

$$\begin{pmatrix} \{1, \frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -1, -2\} \end{pmatrix}$$

$\frac{1}{6}$ (2 M[2, -3, 1] + M[2, 3, 1])

M[2, -1, 1] / 2

$$\begin{pmatrix} \{1, -\frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -2, -1\} \end{pmatrix}$$

$$\begin{pmatrix} \{1, -\frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -2, -1\} \end{pmatrix}$$

$\frac{1}{6}$ (M[2, -3, 1] + 2 M[2, 3, 1])

M[2, 1, 1] / 2

$$\begin{pmatrix} \{1, \frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -1, -2\} \end{pmatrix}$$

$$\begin{pmatrix} \{1, \frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -1, -2\} \end{pmatrix}$$

$2\, d_L + u_L$

$$\begin{pmatrix} \{1, -\frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -2, -1\} \end{pmatrix}$$

$2\, d_L + u_L == d_L + 2\, u_L + (W^-)_L$ (* Beta Decay in Neutron→ Proton *)

True

$(W^-)_L == d_L - u_L$

True

$\bar{\nu}_R + \bar{e}_R$

$$\begin{pmatrix} \{0, 0, 1\} \\ \{2, 2, 2, -3, -3\} \end{pmatrix}$$

$u_L + d_L$

$$\begin{pmatrix} \{\frac{2}{3}, 0, \frac{1}{3}\} \\ \{0, 0, 2, -1, -1\} \end{pmatrix}$$

$T_Y{}^* := 3\, \bar{d}_L$

$T_Y{}^*$

$$\begin{pmatrix} \{-1, 0, 1\} \\ \{3, 3, 0, -3, -3\} \end{pmatrix}$$

The sdSM model is essentially the same with the addition of a factor of 3 and 2 for T_C and T_Y respectively. In order to maintain SU(5) consistency, the typical m_C and m_Y values also change by an inverse factor (respectively). This has the effect of creating all integer matrices for M and T. More importantly, it maintains integer particle representations of m(C,I,Y) by factoring out simple integer fractions of 1/2 and/or 1/3.

It should also be noted that m_I is a left handed representation with L=-R. In the absence of isospin, the particle will be right handed. It is this rotational (I) symmetry that represents the assymetry of time (T) due to a_U Color is slightly complicated with m_C having an even distribution of an arbitrarily chosen (negative) color with a 3-fold degenerate distribution of (r,g, or b) added (or subtracted). It is this translational color symmetry, now labeled as (Clr) in order to avoid confusion upon the introduction of Charge parity (C), that represents the assymetry of sPace parity (P) also due to a_U. It establishes a complex linkage with the real dimensions of space (x,y,z), as well as the imaginary (x',y',z') dimensions related to the discussion of (1). This has direct implications for GR and the formation of the more significant mass of the 3 flavor generations and nucleons. Both m_I and m_C sum to zero within their representations. Hypercharge is more complicated with an even distribution of color (r,g,b) and isospin (L,R) components, which sum to zero across (Clr) and (I). Hypercharge can be said to represent the interchange of color and isospin.

In this model, e_R=-m_Y and represents an arbitrarily chosen (negative) hypercharge. The down quark represents a 1/3 interchange of hypercharge and color d_R=(m_Y-m_C)/3. Of course, the $W^\pm$ represents the interchange of the up and down quarks, but it is interesting to note that they also represent the pure couplings $W_R^\pm$=±m_Y and $W_L^\pm$=±m_I . Looking into composite 3 quark (baryon) particle representations, it is interesting to note that $n_R^0\left(d_R^r,\, d_L^g,\, u_R^b\right) = m_C$, and $\Delta_R^0 = 3\, d_R + (W_R)^+ = 3\, m_C$.

As in SM, strong Yukawa hypercharge (Y) and Isospin (I, $I_{x,y,z}$, I_3) is 0 for generation 2 and 3 particles. Weak Yukawa hypercharge (Y_W) and isoTopic spin (T, $T_{x,y,z}$, T_3) is related to strong hypercharge and Isospin through θ_c and the CKM matrix.

Space parity and angular momentum quantum numbers

In standard representations [16], the principle integer quantum number is n=1 for fundamental SM particles and n≥1 for composite particles. This gives a specific orbital (or azimuthal) angular momentum (L=l-1≤n-1=0). The orbital magnetic quantum number (m, not to be confused with the monopole matrix representation above) is -l≤m≤l. It affects the probability distributions, but not the total momentum of the particles.

Space parity transformation (P) has a translational transformation of $P_{x,y,z}$→-$P_{x,y,z}$ and a quantum rotational transformation P=$(-1)^{L+1}$ (a.k.a. even or odd parity). P=CT violation is shown by a lack of evidence for right handed neutrinos (ν_R).

"Spin" has horizontal and vertical axial components ($s_{y,z}$) and vector components along the direction of momentum (s_x). A generic representation of a spin axis is ($s_{x,y,z}$=s_3). The specific particle angular momentum is (S=±s_3). Total angular momentum (J) is |L-S|≤ J≤ L+S of dimension $\hbar$. For fundamental SM particles where n=l=1, L=0, J=S=s. Single SM particle fermions (leptons and quarks) are J=1/2, while single gauge (and Higgs) boson (force) particles are J=1. Leptons have only J transformations.

The +(-) or up(down) for the axial spins are also labeled as R(L) handed for the chiral polarizations which have spins parallel (anti-parallel) to the direction of momentum (x). These are typically identified through Stern-Gerlach experiments on accelerated particles. For composite particles made up of multiple fundamental fermions, J is half the difference of left and right handed particles or simply J=|$\sharp_L$-$\sharp_R$|/2 \footnotetext[9]{Alternate representations: orbital designations from traditional representation in atomic physics for l=1 to 8 are (S,P,D,F,G,H,I,K) respectively. Other notations have n=s, J=m_l, S=m_s, $s_{y,z}$=$s_{x,y}$, s_x=s_z=s_p, T_Z=I^W.}.

Charge conjugation and time reversal

Total charge in this model is Q=(I+Y)J of dimension $q_{\text{unit}}^2 = e^2$. Charge conjugation is $C = (-1)^{L+S}$. C=PT violation is the basis for the weak interactions.

The multiplicative parity transformation $G = (-1)^{I+C}$ applies only to mesons. The complete charge representation for a particle is often shown as $I^G\left[J^{\text{PC}}\right]$.

As in translational space transformation, time reversal is (T→-T). Anti-particles ($\overline{x}$) are T=CP transformations giving the negative of a particle with opposite handedness. The known violations of CP transformations were originally found in the short and long lifetimes of the neutral kaons (K_S^0, K_L^0) and more recently in B$\overline{B}$ mesons from the BaBar collaboration. The arrow of time is intuitively related to the second law of thermodynamics (entropy). This model relates this to the acceleration of the universe as well. This is the basis for the new model's ability to predict the parameters of all particles. The new model's sdSM charge configurations are shown in Table I.

```
(* Right-handed neutron
 or minus right-handed WeakPlus boson & Delta (-∇⁻)
    or minus right-handed electron & Delta (-∇⁻) *)
```

T_C[[1]] == M[1, 0, 0][[2]][[1]] == (T_Y - T_Y^*[[2]])[[1]] == -$(2\,\bar{d}_L + \bar{u}_L)$[[2]][[1]] == $(\overline{W^-}_L - 3\,\bar{d}_L)$[[2]][[1]] == $(\bar{e}_L - 3\,\bar{d}_L)$[[2]][[1]]

True

```
(* Minus left-handed WeakPlus boson
  or left-handed up minus a down
  or a left-handed neutrino minus an electron *)
```

T_I[[1]] == M[0, 1, 0][[2]][[1]] == $\overline{W^-}_R$[[2]][[1]] == $(\bar{d}_R - \bar{u}_R)$[[2]][[1]] == $(\bar{e}_R - \bar{\nu}_R)$[[2]][[1]]

True

```
(* Minus right-handed WeakPlus boson
  or minus right-handed Electron
  or right-handed up minus a down
  or a left-handed minus neutrino minus an electron *)
```

T_Y[[1]] == M[0, 0, 1][[2]][[1]] == $\overline{W^-}_L$[[2]][[1]] == $\bar{e}_L$[[2]][[1]] == $(\bar{d}_L - \bar{u}_L)$[[2]][[1]] == $(\bar{e}_R + \bar{\nu}_R)$[[2]][[1]]

True

$\overline{\text{Lepton}}_L := \begin{pmatrix} \bar{\nu}_L \\ \bar{e}_L \end{pmatrix}$

$\overline{\text{Lepton}}_R := \begin{pmatrix} \bar{\nu}_R \\ \bar{e}_R \end{pmatrix}$

$\overline{\text{Quark}}_L := \begin{pmatrix} \bar{u}_L \\ \bar{d}_L \end{pmatrix}$

$\overline{\text{Quark}}_R := \begin{pmatrix} \bar{u}_R \\ \bar{d}_R \end{pmatrix}$

$\overline{\text{SM}}_L := \begin{pmatrix} \overline{\text{Lepton}}_L \\ \overline{\text{Quark}}_L \end{pmatrix}$

$\overline{\text{SM}}_R := \begin{pmatrix} \overline{\text{Lepton}}_R \\ \overline{\text{Quark}}_R \end{pmatrix}$

$\text{SM}_L == -\overline{\text{SM}}_R$

True

$\text{SM}_R == -\overline{\text{SM}}_L$

True

SM_L

$$\begin{pmatrix} \begin{pmatrix} \begin{pmatrix} \left\{0, \frac{1}{2}, -\frac{1}{2}\right\} \\ \{-1, -1, -1, 2, 1\} \end{pmatrix} \\ \begin{pmatrix} \left\{0, -\frac{1}{2}, -\frac{1}{2}\right\} \\ \{-1, -1, -1, 1, 2\} \end{pmatrix} \end{pmatrix} \\ \begin{pmatrix} \begin{pmatrix} \left\{\frac{1}{3}, \frac{1}{2}, \frac{1}{6}\right\} \\ \{0, 0, 1, 0, -1\} \end{pmatrix} \\ \begin{pmatrix} \left\{\frac{1}{3}, -\frac{1}{2}, \frac{1}{6}\right\} \\ \{0, 0, 1, -1, 0\} \end{pmatrix} \end{pmatrix} \end{pmatrix}$$

SM_R

$$\begin{pmatrix} \begin{pmatrix} \begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix} \\ \begin{pmatrix} \{0, 0, -1\} \\ \{-2, -2, -2, 3, 3\} \end{pmatrix} \end{pmatrix} \\ \begin{pmatrix} \begin{pmatrix} \left\{\frac{1}{3}, 0, \frac{2}{3}\right\} \\ \{1, 1, 2, -2, -2\} \end{pmatrix} \\ \begin{pmatrix} \left\{\frac{1}{3}, 0, -\frac{1}{3}\right\} \\ \{-1, -1, 0, 1, 1\} \end{pmatrix} \end{pmatrix} \end{pmatrix}$$

```
(* Proton *)
```

$P1_{S1\_,S2\_}$:= $u_{S1} + u_{S2} + d_{S2}$

$P1_{L,R}$

$$\begin{pmatrix} \left\{1, \frac{1}{2}, \frac{1}{2}\right\} \\ \{0, 0, 3, -1, -2\} \end{pmatrix}$$

$P1_{R,L}$

$$\begin{pmatrix} \{1, 0, 1\} \\ \{1, 1, 4, -3, -3\} \end{pmatrix}$$

$P_{S1\_,S2\_}$:= $2\, u_{S1} + d_{S2}$

$P_{L,R}$

$$\begin{pmatrix} \{1, 1, 0\} \\ \{-1, -1, 2, 1, -1\} \end{pmatrix}$$

```
(2 M[2, 3, 1] + M[2, 0, -2]) / 6
```

$$\begin{pmatrix} \{1, 1, 0\} \\ \{-1, -1, 2, 1, -1\} \end{pmatrix}$$

```
M[2, 2, 0] / 2
```

$$\begin{pmatrix} \{1, 1, 0\} \\ \{-1, -1, 2, 1, -1\} \end{pmatrix}$$

$P_{R,L}$

$$\begin{pmatrix} \left\{1, -\frac{1}{2}, \frac{3}{2}\right\} \\ \{2, 2, 5, -5, -4\} \end{pmatrix}$$

```
(2 M[2, 0, 4] + M[2, -3, 1]) / 6
```

$$\begin{pmatrix} \left\{1, -\frac{1}{2}, \frac{3}{2}\right\} \\ \{2, 2, 5, -5, -4\} \end{pmatrix}$$

```
M[2, -1, 3] / 2
```

$$\begin{pmatrix} \left\{1, -\frac{1}{2}, \frac{3}{2}\right\} \\ \{2, 2, 5, -5, -4\} \end{pmatrix}$$

$$\text{SDSMproton} = \frac{P1_{L,R} + P_{L,R} + P1_{R,L} + P_{R,L}}{1}$$

$$\begin{pmatrix} \{4, 1, 3\} \\ \{2, 2, 14, -8, -10\} \end{pmatrix}$$

```
(* Neutron *)
```

$N1_{S1\_,S2\_}$:= $d_{S1} + d_{S2} + u_{S2}$

$N1_{L,R}$

$$\begin{pmatrix} \{1, -\frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -2, -1\} \end{pmatrix}$$

$N1_{R,L}$

$$\begin{pmatrix} \{1, 0, 0\} \\ \{-1, -1, 2, 0, 0\} \end{pmatrix}$$

$N_{S1\_,S2\_}$:= $2\, d_{S1} + u_{S2}$

$N_{L,R}$

$$\begin{pmatrix} \{1, -1, 1\} \\ \{1, 1, 4, -4, -2\} \end{pmatrix}$$

```
(2 M[2, -3, 1] + M[2, 0, 4]) / 6
```

$$\begin{pmatrix} \{1, -1, 1\} \\ \{1, 1, 4, -4, -2\} \end{pmatrix}$$

```
M[1, -1, 1]
```

$$\begin{pmatrix} \{1, -1, 1\} \\ \{1, 1, 4, -4, -2\} \end{pmatrix}$$

$N_{R,L}$

$$\begin{pmatrix} \{1, \frac{1}{2}, -\frac{1}{2}\} \\ \{-2, -2, 1, 2, 1\} \end{pmatrix}$$

```
(2 M[2, 0, -2] + M[2, 3, 1]) / 6
```

$$\begin{pmatrix} \{1, \frac{1}{2}, -\frac{1}{2}\} \\ \{-2, -2, 1, 2, 1\} \end{pmatrix}$$

```
M[2, 1, -1] / 2
```

$$\begin{pmatrix} \{1, \frac{1}{2}, -\frac{1}{2}\} \\ \{-2, -2, 1, 2, 1\} \end{pmatrix}$$

$$\text{SDSMneutron} = \frac{N1_{L,R} + N_{L,R} + N1_{R,L} + N_{R,L}}{1}$$

$$\begin{pmatrix} \{4, -1, 1\} \\ \{-2, -2, 10, -4, -2\} \end{pmatrix}$$

```
(* Pion0 *)
```

$$\text{Pion0}_{S1\_,S2\_} := \frac{(u_{S1} + \bar{u}_{S2}) - (d_{S1} + \bar{d}_{S2})}{\sqrt{2}}$$

$\text{Pion0}_{L,L}$

$$\begin{pmatrix} \left\{0, \frac{1}{\sqrt{2}}, -\frac{1}{\sqrt{2}}\right\} \\ \left\{-\sqrt{2}, -\sqrt{2}, -\sqrt{2}, 2\sqrt{2}, \sqrt{2}\right\} \end{pmatrix}$$

$\text{Pion0}_{L,R}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

$\text{Pion0}_{R,L}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

$\text{Pion0}_{R,R}$

$$\begin{pmatrix} \left\{0, -\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}\right\} \\ \left\{\sqrt{2}, \sqrt{2}, \sqrt{2}, -2\sqrt{2}, -\sqrt{2}\right\} \end{pmatrix}$$

$$\text{SDSMpion0} = \frac{\text{Pion0}_{L,L} + \text{Pion0}_{L,R} + \text{Pion0}_{R,L} + \text{Pion0}_{R,R}}{1}$$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

(* PionP *)

$$(\text{Pion}^+)_{S1\_,S2\_} := u_{S1} + \bar{d}_{S2}$$

$(\text{Pion}^+)_{L,L}$

$$\begin{pmatrix} \left\{0, \frac{1}{2}, \frac{1}{2}\right\} \\ \{1, 1, 1, -1, -2\} \end{pmatrix}$$

$(\text{Pion}^+)_{L,R}$

$$\begin{pmatrix} \{0, 1, 0\} \\ \{0, 0, 0, 1, -1\} \end{pmatrix}$$

$(\text{Pion}^+)_{R,L}$

$$\begin{pmatrix} \{0, 0, 1\} \\ \{2, 2, 2, -3, -3\} \end{pmatrix}$$

$(\text{Pion}^+)_{R,R}$

$\begin{pmatrix} \{0, \frac{1}{2}, \frac{1}{2}\} \\ \{1, 1, 1, -1, -2\} \end{pmatrix}$

$$\text{SDSMpionP} = \frac{(\text{Pion}^{+})_{L,L} + (\text{Pion}^{+})_{L,R} + (\text{Pion}^{+})_{R,L} + (\text{Pion}^{+})_{R,R}}{1}$$

$\begin{pmatrix} \{0, 2, 2\} \\ \{4, 4, 4, -4, -8\} \end{pmatrix}$

(* PionM *)

$(\text{Pion}^{-})_{S1\_,S2\_} := \bar{u}_{S1} + d_{S2}$

$(\text{Pion}^{-})_{L,L}$

$\begin{pmatrix} \{0, -\frac{1}{2}, -\frac{1}{2}\} \\ \{-1, -1, -1, 1, 2\} \end{pmatrix}$

$(\text{Pion}^{-})_{L,R}$

$\begin{pmatrix} \{0, 0, -1\} \\ \{-2, -2, -2, 3, 3\} \end{pmatrix}$

$(\text{Pion}^{-})_{R,L}$

$\begin{pmatrix} \{0, -1, 0\} \\ \{0, 0, 0, -1, 1\} \end{pmatrix}$

$(\text{Pion}^{-})_{R,R}$

$\begin{pmatrix} \{0, -\frac{1}{2}, -\frac{1}{2}\} \\ \{-1, -1, -1, 1, 2\} \end{pmatrix}$

$$\text{SDSMpionM} = \frac{(\text{Pion}^{-})_{L,L} + (\text{Pion}^{-})_{L,R} + (\text{Pion}^{-})_{R,L} + (\text{Pion}^{-})_{R,R}}{1}$$

$\begin{pmatrix} \{0, -2, -2\} \\ \{-4, -4, -4, 4, 8\} \end{pmatrix}$

(* Kaon0 *)

$\text{Kaon0}_{S1\_,S2\_} := d_{S1} + \bar{d}_{S2}$

$\text{Kaon0}_{L,L}$

$\begin{pmatrix} \{0, -\frac{1}{2}, \frac{1}{2}\} \\ \{1, 1, 1, -2, -1\} \end{pmatrix}$

$\text{Kaon0}_{L,R}$

$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$

Kaon0$_{R,L}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

Kaon0$_{R,R}$

$$\begin{pmatrix} \{0, \frac{1}{2}, -\frac{1}{2}\} \\ \{-1, -1, -1, 2, 1\} \end{pmatrix}$$

$$\mathbf{KaonS0}_{s1\_,s2\_} := \frac{\left(d_{s1} + \bar{d}_{s2}\right) - \left(d_{s1} + \bar{d}_{s2}\right)}{\sqrt{2}}$$

KaonS0$_{L,L}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

KaonS0$_{L,R}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

KaonS0$_{R,L}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

KaonS0$_{R,R}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

$$\mathbf{KaonL0}_{s1\_,s2\_} := \frac{\left(d_{s1} + \bar{d}_{s2}\right) - \left(d_{s1} + \bar{d}_{s2}\right)}{\sqrt{2}}$$

KaonL0$_{L,L}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

KaonL0$_{L,R}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

KaonL0$_{R,L}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

KaonL0$_{R,R}$

$$\begin{pmatrix} \{0, 0, 0\} \\ \{0, 0, 0, 0, 0\} \end{pmatrix}$$

```
(* DeltaPP *)
```

DeltaPPL = 3 u_L

$$\begin{pmatrix} \{1, \frac{3}{2}, \frac{1}{2}\} \\ \{0, 0, 3, 0, -3\} \end{pmatrix}$$

DeltaPPR = 3 u_R

$$\begin{pmatrix} \{1, 0, 2\} \\ \{3, 3, 6, -6, -6\} \end{pmatrix}$$

```
% + %%
```

$$\begin{pmatrix} \{2, \frac{3}{2}, \frac{5}{2}\} \\ \{3, 3, 9, -6, -9\} \end{pmatrix}$$

```
(* DeltaP *)
```

DeltaPL = 2 u_L + d_L

$$\begin{pmatrix} \{1, \frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -1, -2\} \end{pmatrix}$$

DeltaPR = 2 u_R + d_R

$$\begin{pmatrix} \{1, 0, 1\} \\ \{1, 1, 4, -3, -3\} \end{pmatrix}$$

```
% + %%
```

$$\begin{pmatrix} \{2, \frac{1}{2}, \frac{3}{2}\} \\ \{1, 1, 7, -4, -5\} \end{pmatrix}$$

```
M[1, 0, 1]
```

$$\begin{pmatrix} \{1, 0, 1\} \\ \{1, 1, 4, -3, -3\} \end{pmatrix}$$

```
(* Delta0 *)
```

Delta0L = 2 d_L + u_L

$$\begin{pmatrix} \{1, -\frac{1}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -2, -1\} \end{pmatrix}$$

Delta0R = 2 d_R + u_R

$$\begin{pmatrix} \{1, 0, 0\} \\ \{-1, -1, 2, 0, 0\} \end{pmatrix}$$

```
% + %%
```

$$\begin{pmatrix} \{2, -\frac{1}{2}, \frac{1}{2}\} \\ \{-1, -1, 5, -2, -1\} \end{pmatrix}$$

```
(* DeltaM *)
```

```
DeltaML = 3 d_L
```

$$\begin{pmatrix} \{1, -\frac{3}{2}, \frac{1}{2}\} \\ \{0, 0, 3, -3, 0\} \end{pmatrix}$$

```
DeltaMR = 3 d_R
```

$$\begin{pmatrix} \{1, 0, -1\} \\ \{-3, -3, 0, 3, 3\} \end{pmatrix}$$

```
% + %%
```

$$\begin{pmatrix} \{2, -\frac{3}{2}, -\frac{1}{2}\} \\ \{-3, -3, 3, 0, 3\} \end{pmatrix}$$

Table 1.

Fermions, Neutrinos, Twistors, and Particle-Wave Duality

The sdSM charge representation reveals a significant pattern related to neutrinos. Specifically, by adding (or subtracting) the left handed neutrino (ν_L) to e & d, it will change the L→R (or R→L) symmetry of any particle. This is reversed for the u & W particles. This idea is supported by a suggestion that the left-handed spin electron neutrino (ν_{Le}) is made up of a spinless compressed volume of space (a.k.a. particle rest mass m_0) oscillating in superposition with γ_L. As in Penrose' twistor theory [17], where points and lines are duals, the particle and wave are duals of each other. The spinless mass energy of the neutrino is of course equal to the γ wave energy by the Compton effect. Twistor theory has a "unassigned" spin 0 particle with homogeneity of -2. The new model suggests this is in fact m_0 referenced above. Twistor theory has ν_{Le} and $\overline{\nu}_{\text{Re}}$ with homogeneity -1 and -3 respectively (a difference of m_0).

Just as a particle-antiparticle fermion pair can be created out of the "vacuum" or with sufficiently energetic photons, the neutrino particle-wave pair can be annihilated by being brought into superposition with its anti-neutrino partner. As in a closed string, "like fermions" cannot be in superposition. This is what differentiates the Bose-Einstein statistics for wave-like bosons from the Fermi-Dirac statistics of the fermions. These fermion masses must be separated at least by the distance of the radius of their wavelength.

CPT, Neutrinos, and Left Handed Universal Acceleration

Studies of CPT invariance suggests a universal preference for ν_L. In this model, the photons maintain the horizontal {left - right}=$s_y = \pm 1/2$ and vertical $\{\text{up} - \text{down}\} = s_z = \pm 1/2$ spin orientations, while the neutrino(s) maintain the helical (or chiral) spin orientation along the axis of momentum $s_x = \pm 1/2$ \footnotemark[9]. If the anti-symmetric superposition of m_0 and left handed photon (γ_L) symmetric boson wave becomes the model for the observed left handed spin 1/2 fermion, the definition of the right handed photon (γ_R) must account for the lack of evidence for ν_{Re}. Using the SU(5) charge configurations and turning again to Penrose' twistor theory, where the homogeneity of γ_L and γ_R are 0 and -4 respectively, it is suggested that the combination emergent from the VEV and time symmetric particle interactions has ν_{Le}+ $\overline{\nu}_{\text{Re}}$=(0,0,0)=$\gamma_R$.

The ν_{Le} is stable which means the particle-wave duality does not simply separate or randomly decay into its parts. **The lack of evidence for ν_{Re} also suggests that the source of stability in ν_{Le} is obtained by the assignment of universal acceleration to γ_L in the particle-wave duality of ν_{Le}.** This stable acceleration may be visualized as the spiral generated from Golden Sections and Fibonacci numbers. The L-R spin exchange may be visualized as the 3D Lorenz Attractor from chaos theory. This model for particle interaction will be shown to support the transformation of space-time required in the much desired explanation for the measured value of "Dark Energy" contained in Λ.

Particle-Wave Duality and Pilot Wave Theory (PWT)

This begins to make clear the paradox of the particle-wave duality. It is consistent with the results of Aspect's experiments on Bell's Inequality and the Einstein-Podolsky-Rosen (EPR) paradox, which reveals that the universe is either deterministically non-local or locally probabilistic with action-at-a-distance [18]. Taking the former view as that of the deBroglie-Bohm and Ghirardi-Rimini-Weber (GRW) PWT [19], this model's description of the neutrino identifies universal acceleration and massless photons as "the guiding waves" and m_0 with "the guided particles". Both are needed in order to remain stable in an accelerating universe.

Continuing the pattern implies that due to a left handed universal acceleration, e_L is a stable superposition of γ_L and m_0 that will be shown to be the inverse of the neutrino mass. The neutrino mass is thus shown to be integrally related to the measured deviations in the value of the Bohr magneton ($\mu_B = \frac{\hbar m_e}{2}$), understood and precisely calculated theoretically as self induced perturbations (using a base of $\alpha/2\pi$), namely the anomalous magnetic moment of the electron
(a_e=0.115965218598 %).

It is suggested that e_R is generated by random superpositions with ν_{Le} ($e_L \rightarrow e_R + \nu_{\text{Le}}$). Generating e_L out of ν_R requires the subtraction of ν_{Le} or the addition of an anti-neutrino ($e_R \rightarrow e_L - \nu_{\text{Le}} = e_L + \overline{\nu}_{\text{Re}}$). Similar to the polarization of photons, this is the source of randomness found in the spin selection of the electron.

Mass Predictions

The particle mass predictions are all based relationships with α. Approximations based on the Dokshitzer-Gribov-Lipatov-Altarelli-Parisi (DGLAP) quark-gluon momentum splitting structure functions (using a base of 2α) is also noted when appropriate.

■

Unit Mass (m_{Unit})

m_{unit} can be defined using the Compton effect:

```
Convert[MassUnit, eVperC2]
```

296.74 eVperC2

$$\text{Convert}\left[\frac{\text{MKS`mel}^2}{\text{MKS`mp}\sqrt{\text{Cos}[\theta_W]}} + \frac{\text{MassUnit}^2}{2\ \text{MKS`mel}}, \text{eVperC2}\right]$$

296.742 eVperC2

$$\text{Abs}\left[\frac{1}{1 - \%/\%\%}\right]$$

158 649.

```
1 / (% ElectronMassError)
```

37.0778

$$\begin{aligned} m_{\text{unit}} &= \frac{\hbar}{l_{\text{unit}}\, c} = \frac{\hbar R_\infty}{\alpha c} = \frac{\alpha m_e}{4\pi} = 296.74\,\text{eV}/c^2 \\ &\approx \frac{m_e^2}{m_p\sqrt{\cos\theta_w}} + \frac{m_{\nu e}}{2} = 296.742\,\text{eV}/c^2 \end{aligned} \tag{38}$$

The addition of $\frac{m_{\nu e}}{2}$ is due to the aforementioned connection with a_e and μ_B.

■

Weak Bosons ($m_{W^\pm,Z^0}$)

By standard definition of the EW model, the weak boson masses:

$$g_w := x_w \sqrt{\sqrt{2}}$$

$$m_w := \sqrt{\left(\frac{g_w}{\sqrt{G_F}}\right)^2}$$

```
Convert[mw, Giga eVperC2]
```

79.3619 eVperC2 Giga

$$m_{W^\pm} = \frac{g_w}{\sqrt{G_F}} = \sqrt{\frac{\sqrt{2}}{G_F}} \approx x_w\, 2\sqrt[4]{2}\; m_H = 79.3619\,\text{GeV}/c^2 \tag{39}$$

$$m_z := \frac{m_w}{\text{Cos}[\theta_W]}$$

```
Convert[mz, Giga eVperC2]
```

90.1766 eVperC2 Giga

$$m_{Z^0} = \frac{m_{W^\pm}}{\text{Cos}\,\theta_w} = \sqrt{\frac{\sqrt{2}}{G_F}}\; 90.1766\,\text{GeV}/c^2 \tag{40}$$

```
Abs[Convert[mw, Giga eVperC2] / Convert[MKS`mw, Giga eVperC2] - 1] /
 WeakBosonMassError
```

4.12981

```
Abs[Convert[mz, Giga eVperC2] / Convert[MKS`mz, Giga eVperC2] - 1] /
 ZBosonMassError
```

3.46372

Driven by the error in Δr in the definition of G_F, the error in this prescription of weak boson masses is outside the experimental standard error of 3.4 ppk by a factor of 4.

The new definition of e (already related to G_F by m_H and a non-unity $\hbar$) has created an opportunity to simplify the EW model. The standard definition above for g_w=$x_w\sqrt{\sqrt{2}}$ =e and its role in (39) is based on Natural UoM. Using the new UoM from (18), (19), (22), and (24), then:

```
gw = el;
```

```
gw = el;
```

$$(gw / CTC)^2 == (el / CTC)^2 == \left(g\sqrt{x_w}\right)^2 == (2\,x_w)^3 \frac{\hbar}{MTC\; LTC^2}$$

True

$$g_w = e = g\sqrt{x_w} = \sqrt{(2\,x_w)^3\,\hbar} \tag{41}$$

and in terms of g:

```
m_w == Sqrt[(g Sqrt[Sqrt[2]] TimeUnit MTC)^2]
```

True

$$m_{W^{\pm}} = \sqrt{\sqrt{2}}\ g\ t_{\text{unit}} \tag{42}$$

```
m_z == Sqrt[(gPrime Sqrt[Sqrt[2]/x_w] TimeUnit MTC)^2]
```

True

$$m_{Z^0} = \sqrt{\frac{\sqrt{2}}{x_w}}\ g'\ t_{\text{unit}} \tag{43}$$

Charged Leptons ($m_{e,\mu,\tau}$)

Decay modes of the first generation of SM particles have not been observed, they are stable.

Stable Electron Mass (m_e)

By definition in this model, from (13), (19), and (38):

```
m_el = (2 h UNITS[MKS`R∞])/(α^2 c) == (Ω_0 el^2 UNITS[MKS`R∞])/(α^3 c) (LTC/CTC)^2 MTC ==
  SetAccuracy[(4 π)/α MassUnit, 10]
```

True

$$m_e = \frac{4\pi\hbar R_\infty}{\alpha^2 c} = \frac{e^2 R_\infty \Omega_0}{\alpha^3 c} = \frac{4\pi}{\alpha} m_{\text{unit}} \tag{44}$$

exactly. Notice the connection to the CKM matrix in that $m_e/m_{\text{unit}}=(2\,x_w)^3=8|V_{\text{CKM}}[3,1]|=8|V_{\text{td}}|=16|V_{\text{CKM}}[1,3]|=16|V_{\text{ub}}|$. Also of potential interest, it is found to be approximated by a relationship with DGLAP exponents:

```
(2 α)^-(4/3)^2 MassUnit
```

1835.07 MassUnit

```
ProtonElectronMassRatio MassUnit
```

1836.15 MassUnit

```
Abs[1/(1 - % / %%)]
```

1695.76

```
1 / (% ElectronMassError)
```

3468.86

$$m_e \approx (2\,\alpha)^{-(4/3)^2}\, m_{\text{unit}} \tag{45}$$

Unfortunately, this interesting prescription is significantly outside the very small experimental standard error of 170 ppb by a factor of 3470.

Muon Mass (m_μ) and Lifetime (τ_μ)

In SM, $m_{\mu,\tau}$ and $\tau_{\mu,\tau}$ are known relative to G_F. Using the Weisskopf-Wigner relation for mass energy, the decay width mass (Γ) is known as well:

$$\sqrt{\left(\frac{\text{MKS`GF}^2\ \text{MKS`m}\mu^5}{3\,(4\,\pi)^3}\right)^2}$$

$5.36446\times10^{-46}\sqrt{\text{Kilogram}^2}$

$$\tau_{\mu 0} = 1 \Big/ \sqrt{\left(\frac{\text{MKS`c}^2}{\text{MKS`}\hbar}\ \%\right)^2}$$

$$\frac{2.1873\times10^{-6}}{\sqrt{\frac{1}{\text{Second}^2}}}$$

$$\Gamma_{\mu 0} = \sqrt{(\text{MKS`c}\ \%)^2}$$

$655.737\sqrt{\text{Meter}^2}$

```
MuonLife
```

2.19703×10^{-6} Second

```
ParticleData["Muon", "Lifetime"]
```

2.19704×10^{-6}

$$\left(\sqrt{(\%\% / \%\%\%\%)^2} - 1\right) 100$$

0.444755

$$\Gamma_\mu = \frac{\hbar}{c^2\,\tau_\mu} \approx \frac{G_F^2\, m_\mu{}^5}{3\,(4\,\pi)^3} \tag{46}$$

In this new model, the stable particle lifetimes increase with $t_U \approx 4\,\pi\,\alpha^{-8}\, t_{\text{unit}}$. This indicates it is reasonable to set τ_e=τ_p=$4\,\pi\,\alpha^{-8}\, t_{\text{unit}}$. A remarkable pattern is developed, such that each generation (n=1,2,3) of charged leptons (e,μ,τ) gives:

$$\text{L[n\_] := TimeUnit MassUnit}^{11-3\,n}\ (2\,\pi)^{20}\ (\pi/2)^{2\,n^2}\ \pi^{-(1+12\,n)}\ 3^{-(1-n)\,(4-n)/2}\ \alpha^{-8\,(3-n)}$$

$$\tau\text{[n\_] := }\frac{\text{L[n]}}{\text{m[n]}^{11-3\,n}}$$

$$\tau[n]_{e,\mu,\tau}\, m[n]_{e,\mu,\tau}^{11-3n} = t_{\text{unit}}\, m_{\text{unit}}^{11-3n}\, (2\pi)^{20} \cdot \left(\frac{\pi}{2}\right)^{2n^2} \pi^{-(1+12n)}\, 3^{-(1-n)(4-n)/2}\, \alpha^{-8(3-n)}$$

This single equation reduces the input parameters of the SM by three, such that only a prescription for the mass (or lifetime) of the leptons is needed. The results for this equation using experimental values for either the mass (or the lifetime) of the charged leptons are within experimental bounds. They are similar in nature to the exponent in the theory of RCC (11-2n_f/3), where n_f is the number of fermions. It indicates a link to an 11D MT. The Mass($\dot{V}$)·Lifetime(τ) tied to the suggested 3 real dimensions of space (P) and the 8 imaginary dimensions of time (T) make up the charge (C) configurations listed in Table I. Since the L-R charge configuration does not affect the mass of the particles and the generational impact on mass is significant, it is suggested that it is the number (n-1) of additional compressed imaginary time dimensions (multiplied by a factor of three, one for each real dimension: x,y,z) which is affecting the particle's mass. This defines the limit on the number of particle generations, since n=4 would require more than 11D. Another interesting result is that with $\tau[0]=t_{\text{unit}}$ them m[0]=142.58291278 MeV/c^2, which is on the order of the pion mass.

```
m[n_] := (4 π / α) MassUnit /; n == 1

m[n_] := (3 / (2 α)) m[n - 1] /; n == 2

m[n_] := (1 / (8 α)) m[n - 1] /; n == 3
```

$$m_\mu \approx \frac{3\, m_e}{2\, a} \tag{48}$$

Tau Mass and Lifetime (m_τ, τ_τ)

Following the pattern for m_μ gives a prescription for the mass of the tau:

$$m_\tau \approx \frac{m_\mu}{8\, a} \tag{49}$$

While the non-perturbative mass and lifetime prescriptions for μ and τ have an error (<2 %) that is significantly outside the experimental standard error, these values are very consistent with measurement after accounting for the radiative corrections introduced in the standard determination of G_F. These charged lepton prescription values are listed in Table II.

```
(L[1] / (τ[1] UNITS[MKS`mel]^8))^(1/8)
```

1.

```
(L[2] / (τ[2] UNITS[MuonMass]^5))^(1/5)
```

0.994127

```
Sqrt[L[3] / (τ[3] UNITS[ParticleData["TauLepton", "Mass"] Mega eVperC2]^2)]
```

1.01253

```
Table[{m[n], τ[n]}, {n, 3}]
```

$$\begin{pmatrix} 1722.05\,\text{MassUnit} & 1.56274\times10^{18}\,\text{TimeUnit} \\ 353\,973.\,\text{MassUnit} & 8.52621\times10^{-6}\,\text{TimeUnit} \\ 6.06339\times10^{6}\,\text{MassUnit} & 1.02542\times10^{-12}\,\text{TimeUnit} \end{pmatrix}$$

```
Table[{Convert[m[n], Mega eVperC2], Convert[τ[n], Micro Second]}, {n, 3}]
```

$$\begin{pmatrix} 0.510999\,\text{eVperC2 Mega} & 4.31077\times10^{23}\,\text{Micro Second} \\ 105.038\,\text{eVperC2 Mega} & 2.35193\,\text{Micro Second} \\ 1799.25\,\text{eVperC2 Mega} & 2.82858\times10^{-7}\,\text{Micro Second} \end{pmatrix}$$

Table 2.

Mass	Lifetime
$m_e = 0.510999441232\,\text{MeV}/c^2$	$\tau_e = 4.31077\times10^{23}$ M
$m_\mu = 105.03797892\,\text{MeV}/c^2$	$\tau_\mu = 2.35193$ Micro S
$m_\tau = 1799.2480561\,\text{MeV}/c^2$	$\tau_\tau = 2.82858\times10^{-7}$ M

```
τ[n_] := 4 π α^-8 TimeUnit /; n == 1

τ[n_] := UNITS[2.19703 Micro Second] /; n == 2

τ[n_] := UNITS[290 Femto Second] /; n == 3

Table[{m[n], τ[n]}, {n, 3}]
```

$$\begin{pmatrix} 1722.05\,\text{MassUnit} & 1.56274\times10^{18}\,\text{TimeUnit} \\ 353\,973.\,\text{MassUnit} & 7.96468\times10^{-6}\,\text{TimeUnit} \\ 6.06339\times10^{6}\,\text{MassUnit} & 1.05131\times10^{-12}\,\text{TimeUnit} \end{pmatrix}$$

```
Table[{Convert[m[n], Mega eVperC2], Convert[τ[n], Micro Second]}, {n, 3}]
```

$$\begin{pmatrix} 0.510999\,\text{eVperC2 Mega} & 4.31077\times10^{23}\,\text{Micro Second} \\ 105.038\,\text{eVperC2 Mega} & 2.19703\,\text{Micro Second} \\ 1799.25\,\text{eVperC2 Mega} & 2.9\times10^{-7}\,\text{Micro Second} \end{pmatrix}$$

■

Uncharged Leptons or Neutrinos ($m_{\nu_{e,\mu,\tau}}$)

Given current experimental constraints that all values of $\nu_{e,\mu,\tau}\approx 0.3$ eV/c^2 with their sum <0.7 eV/c^2 [20], it is suggested that:

```
(*Neutrino Masses ν(el,μ,τ)*)

mνel = MassUnit^2 / UNITS[MKS`mel];
Convert[%, eVperC2]
```

0.172318 eVperC2

```
mνμ = mνel + MassUnit^2 / UNITS[MuonMass];
Convert[%, eVperC2]
```

0.173152 eVperC2

```
m_ντ = m_νμ + MassUnit^2 / UNITS[ParticleData["TauLepton", "Mass"] Mega eVperC2];
Convert[%, eVperC2]
```

0.173201 eVperC2

$$m_{\nu_e} = \frac{m_{\text{unit}}^2}{m_e} = 0.172318\,\text{eV}\big/c^2$$
$$m_{\nu_\mu} = m_{\nu_e} \pm \frac{m_{\text{unit}}^2}{m_\mu} = m_{\nu_e} \pm 8.33389\,\text{x}10^{-4}\,\text{eV}\big/c^2 \quad (50)$$
$$m_{\nu_\tau} = m_{\nu_\mu} \pm \frac{m_{\text{unit}}^2}{m_\tau} = m_{\nu_\mu} \pm 4.95526\,\text{x}10^{-5}\,\text{eV}\big/c^2$$

Quark Fermions ($m_{u,d}$, $m_{c,s}$, $m_{t,b}$)

Given the ratio of masses in (50), it is interesting to note that from (38}) by rough approximation that:

```
(2 α)^(-(4/3)^2^2) MassUnit
```

3.36748×10^6 MassUnit

```
UNITS[Sqrt[(MKS`mp/(CKC^2 HKC))^2]]
```

$3.16194\times 10^6 \sqrt{\text{MassUnit}^2}$

```
Abs[1/(1 - Sqrt[(% / %%)^2])]
```

16.3831

```
1 / (% ProtonMassError)
```

359 050.

$$m_p \approx \frac{{m_e}^2}{m_{\text{unit}}} \quad (51)$$

suggesting that the mass of the first generation of "light quarks" ($m_{u,d}$) is in some way inversely related to the electron neutrino mass. Generalizing this across the three generations of SM, these baryon masses would be inversely related to neutrino masses with m_{unit} and the charged lepton masses as conversion factors. For the precisely measured m_p (using m_e and the electron-proton-mass-ratio with standard error of 460 ppb) (51}) is merely a non-perturbative approximation.

Stable First Generation Quark (Up/Down) Mass ($m_{u,d}$)

Simply setting the mass of the down quark (d) to:

```
Qd[n_] := Qu[n] 2^(3-2 n) (Sqrt[Sqrt[2]]/2 1/4)^((n-(2-n)^2)/2)
```

$$m_d = 2\pi\, m_e = 3.210704\,\text{MeV} \big/ c^2 \tag{52}$$

and the mass of the up quark (u):

```
Qu[n_] := 2 π 2^(2 n-3) (2/Sqrt[Sqrt[2]] 1/(3 π) 1/(4 π α))^((1-n) (2-n)/2)
```

$$m_u = m_d / 2 = 1.605352\,\text{MeV} \big/ c^2 \tag{53}$$

give values very close to current measurements and creates a simple relationship that supports the sdSM model of charge and mass prescriptions.

```
Qu[1] (L[1]/(τ[1] UNITS[ParticleData["UpQuark", "Mass"] Mega eVperC2]^8))^(1/8)
```

0.729705

```
Qu[2] (L[2]/(τ[2] UNITS[ParticleData["CharmQuark", "Mass"] Mega eVperC2]^5))^(1/5)
```

1.07044

```
Qu[3] (L[3]/(τ[3] UNITS[ParticleData["TopQuark", "Mass"] Mega eVperC2]^2))^(1/2)
```

0.997756

```
Qd[1] (L[1]/(τ[1] UNITS[ParticleData["DownQuark", "Mass"] Mega eVperC2]^8))^(1/8)
```

0.642141

```
Qd[2] (L[2]/(τ[2] UNITS[ParticleData["StrangeQuark", "Mass"] Mega eVperC2]^5))^(1/5)
```

1.04686

```
Qd[3] (L[3]/(τ[3] UNITS[ParticleData["BottomQuark", "Mass"] Mega eVperC2]^2))^(1/2)
```

0.768954

```
(* Vus=d/s *)
```

```
Qd[1] (L[1]/τ[1])^(1/8)
```

$10\,819.9\,\sqrt[8]{\text{MassUnit}^8}$

```
Qd[2] (L[2]/τ[2])^(1/5)
```

$335\,147.\,\sqrt[5]{\text{MassUnit}^5}$

```
√(% / %%)
```

$$5.56552\,\sqrt{\frac{\sqrt[5]{\text{MassUnit}^5}}{\sqrt[8]{\text{MassUnit}^8}}}$$

```
1 / %
```

$$\frac{0.179678}{\sqrt{\frac{\sqrt[5]{\text{MassUnit}^5}}{\sqrt[8]{\text{MassUnit}^8}}}}$$

Up Quark Flavor (Up-Charm-Top) Mass ($m_{u,c,t}$) and Lifetime ($\tau_{u,c,t}$)

Following the pattern established in (42), using the lepton masses as a basis for the quark masses and assuming the quark lifetimes are the same as the lepton's, a simple quark mass and lifetime pattern emerges:

$$\tau[n]_{u,c,t}\, m[n]_{u,c,t}^{11-3n} = \tau[n]_{u,c,t}\, m[n]_{u,c,t}^{11-3n} \cdot \frac{2\pi}{2^{3-2n}}\left(\frac{8}{\sqrt{\sqrt{2}}}\ \frac{1}{12\pi}\ \frac{1}{4\pi\alpha}\right)^{(1-n)(2-n)/2} \tag{54}$$

Down Quark Flavor (Down-Strange-Bottom) Mass ($m_{d,s,b}$) and Lifetime ($\tau_{d,s,b}$)

Continuing the pattern for the down series of quarks and using the up flavor series as a basis for the down flavor series:

```
Clear[α]
```

```
τ[1]
```

$$\frac{4\pi\,\text{TimeUnit}}{\alpha^8}$$

```
τ[2]
```

7.96468×10^{-6} TimeUnit

```
τ[3]
```

1.05131×10^{-12} TimeUnit

```
test[n_] := Simplify[{ Qd[n], Qu[n] / Qd[n]} (L[n] / m[n]^(11-3 n))^(1/(11-3 n)) ]
```

```
test[1]
```

$$\left\{2\sqrt[4]{2}\,\pi^{9/8}\sqrt[8]{\frac{\text{TimeUnit}}{\alpha^8}},\ \frac{\sqrt[8]{\pi}\,\sqrt[8]{\frac{\text{TimeUnit}}{\alpha^8}}}{2^{3/4}}\right\}$$

```
test[2]
```

$$\left\{\frac{\pi^{3/5}\sqrt[5]{\text{TimeUnit}\,\alpha^2}}{2^{7/20}\,3^{4/5}},\ \frac{32\,2^{3/20}\sqrt[5]{\text{TimeUnit}\,\alpha^2}}{3^{4/5}\,\pi^{2/5}}\right\}$$

```
test[3]
```

$$\left\{\frac{\sqrt{\text{TimeUnit}\,\alpha^6}}{3\sqrt{3}\,\pi^{3/2}\,\alpha},\ \frac{256\,2^{3/4}\sqrt{\text{TimeUnit}\,\alpha^6}}{\sqrt{3\,\pi}}\right\}$$

```
ttest[n_] := { Qd[n], Qu[n]}
```

```
test[1]
```

$$\left\{2\sqrt[4]{2}\,\pi^{9/8}\sqrt[8]{\frac{\text{TimeUnit}}{\alpha^8}},\ \frac{\sqrt[8]{\pi}\,\sqrt[8]{\frac{\text{TimeUnit}}{\alpha^8}}}{2^{3/4}}\right\}$$

```
test[2]
```

$$\left\{\frac{\pi^{3/5}\sqrt[5]{\text{TimeUnit}\,\alpha^2}}{2^{7/20}\,3^{4/5}},\ \frac{32\,2^{3/20}\sqrt[5]{\text{TimeUnit}\,\alpha^2}}{3^{4/5}\,\pi^{2/5}}\right\}$$

```
test[3]
```

$$\left\{\frac{\sqrt{\text{TimeUnit}\,\alpha^6}}{3\sqrt{3}\,\pi^{3/2}\,\alpha},\ \frac{256\,2^{3/4}\sqrt{\text{TimeUnit}\,\alpha^6}}{\sqrt{3\,\pi}}\right\}$$

```
α = 1 / 137.0359997094;
```

$$x_W = \sqrt[3]{\frac{\pi}{2}\,\alpha}\ ;$$

```
test[n_] := { Qd[n], Qu[n]}
```

```
test[1]
```

$\{2\,\pi,\ \pi\}$

```
test[2]
```

$\left\{\frac{\pi}{2\,2^{3/4}}, 4\pi\right\}$

```
test[3]
```

{1.8175, 97.8129}

It is interesting to note the identification of the EW factor $\sqrt{\sqrt{2}}$ as well as the inverse (or dual) relationships between the up and down series of quarks, as well as between the leptons and the up series. These values were also guided by the assignment of $<\phi^0>_0$ to the mass of the top quark, which nicely closes the sdSM mass progression with its link to m_H. These equations give the results in Table III.

$$\text{test[n\_]} := \left\{\text{Convert}\left[\text{Qd[n]}\sqrt[11-3n]{\frac{\text{L[n]}}{\tau\text{[n]}}}, \text{Mega}\sqrt[11-3n]{\text{eVperC2}^{11-3n}}\right], \text{Convert}\left[\text{Qu[n]}\sqrt[11-3n]{\frac{\text{L[n]}}{\tau\text{[n]}}}, \text{Mega}\sqrt[11-3n]{\text{eVperC2}^{11-3n}}\right]\right\}$$

```
test[1]
```

$\left\{3.2107\sqrt[8]{\text{eVperC2}^8}\ \text{Mega}, 1.60535\sqrt[8]{\text{eVperC2}^8}\ \text{Mega}\right\}$

```
test[2]
```

$\left\{99.4515\sqrt[5]{\text{eVperC2}^5}\ \text{Mega}, 1338.05\sqrt[5]{\text{eVperC2}^5}\ \text{Mega}\right\}$

```
test[3]
```

$\left\{3229.61\sqrt{\text{eVperC2}^2}\ \text{Mega}, 173\,809.\sqrt{\text{eVperC2}^2}\ \text{Mega}\right\}$

$$\tau[n]_{d,s,b}\, m[n]_{d,s,b}^{11-3n} = \tau[n]_{u,c,t}\, m[n]_{u,c,t}^{11-3n} \cdot 2^{3-2n}\left(\frac{\sqrt{\sqrt{2}}}{8}\right)^{\left(n-(2-n)^2\right)/2} \quad (55)$$

Table 3. Quark Masses

$m_d = 3.21070418039\,\text{MeV}/c^2$	$m_u = 1.6053520902$ M
$m_s = 99.4514789205\ \text{MeV}/c^2$	$m_c = 1338.05427385$
$m_b = 3229.60822804\,\text{MeV}/c^2$	$m_t = 173\,809.022825$

■

Composite 2 Quark Hadrons (Mesons)

For this section, several important meson particle parameter predictions (PPPs) are reviewed. The branching ratios (Γ_i/Γ) and resonant cross sections (σ_R) for the many decay modes of composite particles are determined from the specific masses and lifetimes. The complete meson PPPs will be reviewed in Appendix A.

Pion Mass ($\mathfrak{m}_{\pi^{0,\pm}}$) *and Lifetime* ($\tau_{\pi^{0,\pm}}$)

Speculating on the masses of the pions using the mass relationships above and a modified Weinberg relation [21] gives:

```
ℝ = UniversalMassDensityPerExpansion;
```

$m_{\pm Pion} := \alpha^{-8/3}\ \text{MassUnit} \Big/ \sqrt{gc2}$

$m_{\pm Pion}$

468 288. MassUnit

$\text{Convert}[m_{\pm Pion},\ \text{Mega eVperC2}]$

138.96 eVperC2 Mega

$m_{Pion} := m_{\pm Pion} \Big/ \sqrt{\sqrt{gc2}}$

m_{Pion}

453 584. MassUnit

$\text{Convert}[m_{Pion},\ \text{Mega eVperC2}]$

134.596 eVperC2 Mega

$$\sqrt[3]{\sqrt{\left(\mathbb{R}\ \frac{\hbar^2}{c}\right)^2}} == \alpha^{-8/3}\ \sqrt[6]{\text{MassUnit}^6}$$

True

$$m_{\pi^\pm} = \sqrt{\mathbb{R}\ \frac{\hbar^2}{c}} \Big/ g_c = \alpha^{-8/3}\ m_{\text{unit}} / g_c = 138.959\ \text{MeV} \big/ c^2 \tag{56}$$

where:

$$\mathbb{R} = \frac{g_c^2}{G_N}\ 4\,\pi \text{H}_0 = \frac{t_{\text{unit}}}{l_{\text{unit}}{}^3}\ m_{\text{unit}} = 1\ \text{Dimensionless Unit} \tag{57}$$

and:

$$m_{\pi^0} = m_{\pi^\pm} \Big/ \sqrt{g_c} = 134.596\ \text{MeV} \big/ c^2 \tag{58}$$

This intriguing prescription for the mass of the pion is outside the experimental standard error of 5ppm by a factor of 875.

Neutral Kaon Mass ($m_{K^0_{S,L}}$) *and Lifetime* ($\tau_{K^0_{S,L}}$)

In order to understand the detail relating to the CPT symmetry and their violations (e.g. CP↔T), it is critical to understand the mass and (more importantly) the lifetime of ($K^0_S(d\bar{s}\text{-}\bar{d}s)/\sqrt{2}$, $K^0_L{=}(d\bar{s}+\bar{d}s)/\sqrt{2}$).

■

Composite 3 Quark Hadrons (Baryons)

The complete baryon PPPs will be reviewed in Appendix A.

Stable Proton Mass (m_p) *and Radius* (r_p)

The quark composition of the proton has the mass of the up quarks precisely equal to the mass of the down quark. It is this equality that provides for the stability of the proton. Equations (45) and (51) give:

$$(2\,\alpha)^{-(4/3)^{2^2}}\ \mathbf{MassUnit}$$

3.36748×10^{6} MassUnit

$$\mathbf{UNITS}\left[\sqrt{\left(\mathbf{MKS`mp / HKC} \big/ \mathbf{CKC}^2\right)^2}\ \right]$$

$3.16194\times10^{6}\sqrt{\text{MassUnit}^2}$

$$m_p \approx \frac{m_e{}^2}{m_{\text{unit}}} = \left(\frac{4\,\pi}{\alpha}\right)^2 m_{\text{unit}} \approx (2\,\alpha)^{-(4/3)^4}\, m_{\text{unit}} \tag{59}$$

$$\mathbf{Abs}\left[\frac{1}{1-\sqrt{(\%\,/\,\%\%)^2}}\right]$$

16.3831

1 / (% ProtonMassError)

359 050.

$$\rho c := \frac{3}{8\,\pi}\,H_0^2\,\frac{gc2}{G_N}$$

$$R_H := \frac{c}{H_0}$$

Clear[V]

$$V_U := \frac{4\,\pi}{3}\,R_H{}^3$$

$$M_H := \rho c\ V_U$$

$$M_U := \frac{M_H}{4}$$

$$V_P := \frac{4\,\pi}{3}\,l_P{}^3$$

$$\sqrt{(M_U / m_P)^2}$$

1.13554×10^{60}

$$r_p = \sqrt[3]{\mathbf{Convert}\left[\frac{3}{4\,\pi}\,\%\,V_P,\ (\mathbf{Femto\ Meter})^3\right]}\ \Big/\ 2$$

$0.843098\sqrt[3]{\text{Femto}^3\,\text{Meter}^3}$

It is interesting to note that by extending this relationship to the 3 generations of SM, the mass of the 3rd generation particles (p^+, Δ^{++}) approach that of the m_p. This would suggest that the "Cosmic Egg" or "Primordial Atom" responsible for the "Big Bang (BB)" may have been 3rd generation leptons which would immediately disintegrate into the naturally inflationary accelerating universal expansion of protons and electrons that we know today. It can be shown that when forming a black hole from the current estimate for the mass of the universe derived from the matter density (Ω_m) and the Hubble radius (R_H=c/H_0), if compressed into Planck volumes (V_P=4π l_P^3/3) each of mass m_P, it results in a radius precisely 2 times the proton radius (r_p=0.8x10^{-15}m). The proton radius' link to the Planck and matter densities is the first indicator of the duality that resolves the hierarchy problem related to VEV, Higgs, and matter densities.

Cosmological Predictions

This new model is able to give reasonable causes for many cosmological unknowns and their experimentally determined values.

Milne-Dirac, Eddington, and Weinberg Relations

All of these notable physicists attempted to reduce the number of fundamental parameters in physics by creating relationships between them. Some were approximations limited by experimental accuracy. To this end, understanding the intentions as they relate to the new more natural model is interesting. From (14), it is easy to associate this new model to the Milne-Dirac Large Number Hypothesis (LNH) and a time varying G_N [22].

Eddington attempted to quantify the LNH with the number of baryons in the universe using α and binary numerology. Unfortunately, he used an integer value of 1/α=136 (and subsequently 137) giving $N_{\text{Eddington}}$=137x2^{256}. LNH and $N_{\text{Eddington}}$ were modified by Weinberg resulting in the relation:

$$h^2\, H_0 \approx c\, G_N\, m_{\text{nucleon}}^3 \tag{60}$$

while:

```
Convert[ ∛(h²/c H₀/G_N) , Mega ∛(eVperC2³) ]
```

$207.895 \sqrt[3]{\text{eVperC2}^3}$ Mega

$$m_{\text{nucleon}} = \sqrt[3]{\frac{h^2}{c}\,\frac{H_0}{G_N}} = 207.9\,\text{eV}\big/c^2 \tag{61}$$

is referenced as being "on the order of m_π", yet with current measures of H_0 giving $\approx m_\pi$ 3/2, it is not even close to being within current experimental standard error. Following Milne-Dirac, Eddington and Weinberg, the new model offers a better approximation of the pion mass(es) to within 0.4 % using the most accurate current value of α and a binary exponent in MT dimensions, it also gives a very precise value for a large number related to time as:

$$N_{\text{time}} = a^{-8} = 1.24359\,\text{x}10^{17} \tag{62}$$

and similar in form to (60), the new model has more precisely:

```
ℏ 4 π H₀ == G_N/gc2 (MassUnit/LengthUnit)² (c TimeUnit) == MassUnit (LengthUnit/TimeUnit)²
```

$$\frac{1.\,\text{LengthUnit}^2\,\text{MassUnit}}{\text{TimeUnit}^2} = \frac{\text{LengthUnit}^2\,\text{MassUnit}}{\text{TimeUnit}^2}$$

$$\hbar\, 4\, \pi\, H_0 = \frac{G_N}{g_c^2}\left(\frac{m_{\text{unit}}}{t_{\text{unit}}}\right)^2 (c\, t_{\text{unit}}) = \text{UnitEnergy} \tag{63}$$

Using the new model's definition for $m_\pi^\pm$ from (56) gives Weinberg's number (now closely associated with VEV) for the number of nucleons (pions) in the observable universe ($M_U = M_H/4$), where M_H is the mass in the observable volume of the universe ($V_U = 4\,\pi\, R_H^3 \big/ 3$) from Hoyle's Steady State (SS) model and the critical mass energy density of the vacuum

```
√((Convert[ρc, Kilogram/Meter^3] HKC CKC^2/MKS`mp)^2)
```

$6.53729 \sqrt{\frac{1}{\text{Meter}^6}}$

$$\rho_c = \frac{3}{8\pi} H_0^2 \frac{g_c^2}{G_N} \tag{64}$$

Specifically:

```
NWeinberg = MU / m±Pion
```

9.97685×10^{79}

$$N_{\text{Weinberg}} = \frac{M_U}{m_\pi^\pm} = \left(c^3 \big/ 8\, G_N\, H_0\right) g_c\, \alpha^{8/3} \big/ m_{\text{unit}} = g_c\, \alpha^{-112/3}\, \pi / 2 = 9.97684762939 \times 10^{79} \tag{65}$$

The New Physics of Black Hole Singularities

Given the definition of mass (9) and charge (17), it is proposed that the process for increasing the mass density of a volume is limited to the stopping of universal acceleration and expansion in the space which that volume occupies ($Q = \dot{M}/5 = \ddot{V} \big/ 30 = 0$). This would require a compressive force. By SR's link between mass and velocity, if a given mass experiences no compressive force (or change in velocity) relative to free space ($\dot{c}_{\text{space}} = \dot{c}_{\text{mass}}$), it is seen as expanding and accelerating with space. There is no change to its mass density and its charge is 0.

Therefore, without invoking "time reversal (T)" symmetries, the lower limit of compressibility in terms of a change in mass density per unit time is $\dot{c}_{\text{space}} - \dot{c}_{\text{mass}} = 0$. The given mass experiences no change in mass density. This is of course a particle traveling at the speed of light (which is the rate of universal expansion as defined above).

If a given mass experiences maximum compressibility relative to free space, the space it occupies has stopped expanding $\dot{c}_{\text{mass}} = 0$ and its mass density changes at the same rate as the universe expands $\dot{\rho}_{\text{space}} = \dot{c}_{\text{space}}$. The upper limit of compressibility in terms of a change in mass density per unit time is $\dot{c}_{\text{space}} - \dot{c}_{\text{mass}} = \dot{\rho}_{\text{space}} - 0 = 1$. The given mass and charge is seen as a black hole singularity at the limit of GR physics.

This eliminates the need for any "new physics" beyond black hole singularities. It also offers more natural explanations relating to Hawking radiation in the evaporation of black holes, entropy and information loss (or not) in black hole physics.

The Cosmological Constant

In terms of billions of light-years (Gly), the Hubble radius is:

```
Convert[RH, Giga LightYear]
```

13.66 Giga LightYear

$$R_H = \frac{c}{H_0} = 13.66\,\text{Gly} \tag{66}$$

While Λ is properly defined as an energy (or m=E/c^2) per volume (a.k.a. density $\rho_\Lambda = M\,L^{-3}$), its representation varies due to a lack of understanding on its origin. It is sometimes represented in terms of dimension L^{-2} (using R_H^{-2}) or simply as T^{-2} (using H_0^2) , where the value in this new model can be given as:

```
ρΛ := ΩΛ ρc
```

$$\Lambda := \left(8\,\pi\,\frac{G_N}{gc2}\right)\rho\Lambda$$

$$\text{Convert}\left[\Lambda\,,\,1\big/\text{Second}^2\right]$$

$$\frac{1.6144\times 10^{-35}\,\Omega\Lambda}{\text{Second}^2}$$

$$\Omega\Lambda == \frac{\Lambda}{3\,H_0^2} == \frac{\rho\Lambda}{\rho c}$$

$$\Omega\Lambda = 1.\,\Omega\Lambda$$

```
Clear[c]
```

$$c[t\_] := \int_0^t 1\, dt$$

$$\Omega\Lambda_0 = \int_0^1 \sqrt{c[t]}\, dt$$

$$\frac{2}{3}$$

$$H[t\_] := \frac{1}{4\,\pi\, c[t]}$$

$$\Lambda = 1\Big/\int \frac{4\,\pi}{H[t]}\, dt$$

$$\frac{1}{8\,\pi^2\,t^2}$$

$$\Lambda == \Omega\Lambda_0\; 3\; H[t]^2$$

True

$$c := \alpha^{-8}\ \text{LengthUnit} / \text{TimeUnit}$$

$$\Lambda = 8\,\pi\,\frac{G_N}{g_c^2}\,\rho_\Lambda = \text{x}3\text{H}_0^2 \tag{67}$$

where the factor x is introduced such that $\rho_\Lambda = \text{x}\rho_c$. Another, even more common, representation has:

$$\Omega_\Lambda = \frac{\Lambda}{3\,H_0^2} = \frac{\rho_\Lambda}{\rho_c} = x \tag{68}$$

The Lambda Cold Dark Matter (ΛCDM) model of a Friedmann-Lematre-Robertson-Walker (FLRW) metric [22] for a flat accelerating universe has density parameters for energy, matter, and curvature (K):

$$\Omega = \Omega_m + \Omega_\Lambda = 1$$

$$\Omega_m = \Omega_{\text{mDark}} + \Omega_{\text{mVisible}} = \frac{\rho_m}{\rho_c} = \Omega - x = 1 - x$$
$$K = H_0(\Omega - 1) = 0$$

The new model suggests a natural dark energy component originating from universal acceleration that fits very nicely with recent cosmological data [23]:

$$\Omega_{\Lambda_0} = \int_0^1 \sqrt{c}\ \text{dt} = 2/3 \tag{70}$$

It is suggested that without visible (baryonic) matter, the dark universe has $\Omega_{\text{mDark}\,0}$=1-$\Omega_{\Lambda\,0}$=1/3. With the addition of baryons, which given the structure of the new sdSM are constructed by adding 2 parts to the universal acceleration (dark energy), which is now in the form of dark neutrino-bound γ_R while subtracting 1 part m_0 and 2 parts γ_L from the dark matter, which are now visible as baryons. Based on an integer approximation for the measured value of the visible mass in the observable universe:

Ω_{mVisible} = 1 / 24;

Ω_{mDark_0} = 1 - $\Omega\Lambda_0$

$\frac{1}{3}$

Ω_{mDark} = Ω_{mDark_0} - 3 Ω_{mVisible}

$\frac{5}{24}$

Ω_{m} = Ω_{mDark} + Ω_{mVisible}

$\frac{1}{4}$

$\Omega\Lambda$ = $\Omega\Lambda_0$ + 2 Ω_{mVisible}

$\frac{3}{4}$

Ω = Ω_{m} + $\Omega\Lambda$

$\Omega = 1$

$$\begin{aligned} \Omega_{\text{mVisible}} &= 1/24 = 4.166\ldots\% \\ \Omega_\Lambda &= \Omega_{\Lambda_0} + 2\,\Omega_{\text{mVisible}} = 3/4 = 75\,\% \\ \Omega_{\text{mDark}} &= \Omega_{\text{mDark}_0} - 3\,\Omega_{\text{mVisible}} = 5/24 = 20.833\ldots\% \\ \Omega_m &= \Omega_{\text{mDark}} + \Omega_{\text{mVisible}} = 1/4 = 25\,\% \end{aligned} \tag{71}$$

and using an FLRW age factor of:

```
Clear[a]
```

$$\texttt{a[z\_] :=} \int_0^{1/(1+z)} \left(\sqrt{\Omega_m / a + \Omega\Lambda\, a^2}\right)^{-1} da$$

```
a[0] // N
```

1.01379

$$a(z) = \int_0^{1/1+z} \left(\sqrt{\Omega_m / a + \Omega_\Lambda\, a^2}\right)^{-1} \text{da}$$

$$a(0) = \frac{2}{3\sqrt{\Omega_\Lambda}} \ln\left(\frac{1+\sqrt{\Omega_\Lambda}}{\sqrt{\Omega_m}}\right) = 1.01379\,...$$

gives a very precise calculation for the current age of the universe of:

```
a[0] Convert[1 / H0, Giga Year]
```

13.8579 Giga Year

```
8 * InverseFineStructureConstantError % 10^9/Giga
```

77.6044 Year

$$t_U = \frac{a(0)}{H_0} = 13\,857\,928\,235\,(78)\text{ years} \tag{73}$$

Just as M(3D)/M(1D)=Q(2D)=A, there is an equivalence in this model between $\rho_\Lambda\left(\text{ML}^{-3} = T^{-1}\right)$ by a GR conversion, and $\rho_\Lambda\left(M^4 = L^{-4} = \text{cT}^{-4}\right)$ by QM conversions. Getting to the L^{-2} or T^{-2} requires selective L=M conversions by assuming gravitational radii and Planck units. Comparing the critical mass density to that of the expected Higgs field shows that they are related by a factor of:

```
Clear[α]
```

$$\rho_H = \frac{(m_H\, v)^2}{\sqrt{8}}$$

$$\frac{4\,\text{MassUnit}^4}{\alpha^{16}}$$

$$\rho\Lambda = \left(\frac{\hbar}{c}\right)^3 \Omega\Lambda\, \rho c$$

$$\frac{9\,\text{MassUnit}^4\, \alpha^8}{512\,\pi^3}$$

$$\rho\Lambda / \rho_H == \left(\frac{3}{2}\right)^2 (H_0\, \text{TimeUnit} / 2)^3$$

True

```
α = 1 / 137.0359997094;
```

$$\frac{4}{9}\,(H_0\, t_{\text{unit}} / 2)^3 = \frac{4}{9}\left(\frac{a^8}{8\,\pi}\right)^3 \tag{74}$$

since:

$$\rho_H\left(M^4\right) = \frac{(m_H\, v)^2}{\sqrt{8}} = \frac{m_H^2}{4\, G_F} = m_H{}^4 = 4\left(\alpha^{-4}\, m_{\text{unit}}\right)^4 \tag{75}$$

$$\rho_\Lambda(M^4) = \left(\frac{\hbar}{c}\right)^3 \rho_c\, \Omega_\Lambda = \rho_\Lambda(T^{-1}) = (4\,\pi/3)^{-2}\, H_0/2 = 9\,(4\,\pi)^{-3}\,(\alpha^8/8)/t_{\text{unit}} \tag{76}$$

It is shown that instead of a paradoxical disparity in their magnitudes, they are in fact precisely dual.

Gravitational Coupling and String Length

In natural units, g_c and G_N have a direct relationship to the string length (l_{string}) of order l_P. This model has an inverse relationship to time on a universal scale:

```
t_string = α^-8 TimeUnit;
Convert[t_string, Giga Year]
```

1.08777 Giga Year

```
l_string = t_string^2 LTC;
Convert[l_string, Giga LightYear]
```

1.08703 Giga LightYear

$$t_{\text{string}} = 1/(4\,\pi\,H_0) = \alpha^{-8}\,t_{\text{unit}} \approx 10^9\text{ yr} = \sqrt{l_{\text{string}}} = \sqrt{R_H/4\,\pi} \approx \sqrt{10^9\text{ Gly}} \tag{77}$$

This is consistent with recent findings related to the large-scale structure of the universe.

Photon to Baryon Ratio

A photon to baryon ratio of:

```
γPerB_pm = 2 π α^-4
```

2.21574×10^9

$$\gamma/B_{\text{pn}} = 2.215\times 10^9 \tag{78}$$

is within experimental error. This provides for the opportunity to calculate a precise a(z) which includes the radiation component. This is not included here due to the consideration that the radiation component is already part of $\Omega = \Omega_m + \Omega_\Lambda = 1$ defined above. This increases the age calculations for the early universe at high z.

Cosmic Microwave Background Radiation (CMBR)

```
σ_SB = Sqrt[((PolyLog[4, 1] Gamma[4, 1] MKS`kBoltz^4) / (MKS`ħ^3 (2 π MKS`c)^2))^2]
```

$$5.56273\times 10^{-8}\sqrt{\frac{\text{Kilogram}^2}{\text{Kelvin}^8\,\text{Second}^6}}$$

```
σ_SB == SetAccuracy[Sqrt[(StefanConstant (HKC CKC^2)^3)^2], 11]
```

True

$$\text{Convert}\left[\text{MKS`TCMBR}\ \frac{\text{MKS`kBoltz}}{\text{MKS`c}^2},\ \text{Micro eVperC2}\right]$$

234.847 eVperC2 Micro

$$\sqrt[8]{\left(\text{MKS`TCMBR}^4\ \frac{4\,\sigma_{SB}}{\text{MKS`c}}\ \frac{\text{MKS`c}}{\text{MKS`}\hbar}\ (\text{MKS`c})^2\right)^2}\ \frac{\text{Giga}}{10^9}\Big/2$$

$$159.904\ \text{Giga}\ \sqrt[8]{\frac{1}{\text{Second}^8}}$$

$$\frac{\text{MKS`c}}{\%}\ \frac{\text{Giga Milli}}{10^6}$$

$$\frac{1.87483\ \text{Meter Milli}}{\sqrt[8]{\frac{1}{\text{Second}^8}}\ \text{Second}}$$

Recent studies of CMBR by the Wilkinson Microwave Anisotropy Probe (WMAP) have precisely determined its temperature to be 2.72528 K° [8]. By Boltzmann's constant (k_B), CMBR translates to a mass energy value of 234.8469μeV/c^2. This familiar reference to temperature is a conversion from the determination of the Wien point in the measured Maxwell-Boltzmann blackbody spectrum by using Planck radiation law and the Stefan-Boltzmann constant $\sigma_{\text{SB}} = \frac{L\,i_4(1)\,\Gamma(1)\,k_b^4}{\hbar^3\,(2\,\pi c)^2}$ represented here in terms of polylogarithms or deJonquiere's function (which are also related to the Bose-Einstein and Fermi-Dirac statistics mentioned previously). The Wien point was found at wavelength 1.874827 mm (or frequency of 159.9040 GHz).

From WMAP, the CMBR redshift from first light decoupling from the surface of the universe is z=1089(1). The age of the universe at the time of decoupling is then:

$$z = 1089;$$

$$\text{Convert}\left[\frac{\text{a}[z]}{\text{H}_0},\ \text{Kilo Year}\right]$$

506.463 Kilo Year

$$\frac{a(z)}{H_0} = 506.4625\ \text{kYr} \tag{79}$$

$$\text{aPrime}[\text{z\_}] := \int_{1/(1+z)}^{1} \left(\text{a}\sqrt{\Omega_m/\text{a} + \Omega\Lambda\,\text{a}^2}\right)^{-1} d\text{a}$$

$$R_U = \text{Convert}[\text{R}_H\ \text{Re}[\text{aPrime}[z]],\ \text{Giga LightYear}]$$

46.9463 Giga LightYear

$$D_A = \text{Convert}\left[\frac{\text{R}_U}{z+1},\ \text{Mega LightYear}\right]$$

43.07 LightYear Mega

$$D_L = \text{Convert}[\text{R}_U\ (z+1),\ \text{Tera LightYear}]$$

51.1715 LightYear Tera

The comoving radius (R_U), angular size (D_A), and luminosity distance (D_L) of the observable universe are:

$$R_U = R_H\, a'(z) = 14.3938\ \text{Gpc} = 46.9463\,\text{Gly}$$
$$D_A = \frac{R_U}{z+1} = 43.07\,\text{Mly} \tag{80}$$
$$D_L = R_U(z+1) = 51.1715\,\text{Tly}$$

where:

$$a'(z) = \int_{1/1+z}^{1} \left(a\sqrt{\Omega_m / a + \Omega_\Lambda\, a^2}\right)^{-1} d\,a \tag{81}$$

■

Black Hole Evaporation and the Casimir Force

Confirmation of the assignment of universal acceleration to a "Theory of Everything (ToE)", is found in the identification of the Casimir force (in a blackbody of the Minkowski vacuum) with that of the gravitational acceleration at the surface of black holes with a thermalized Hawking radiation (T_H°). This is accomplished by applying the Fulling-Davies-Unruh (FDU) effect [24] to both theories where:

$$\mathbf{a} = \sqrt{\left(2\,\pi\,\text{MKS`kBoltz}\,\frac{\text{MKS`c}}{\text{MKS`}\hbar}\,\text{Kelvin}\right)^2}$$

$$2.46609\times10^{20}\sqrt{\frac{\text{Meter}^2}{\text{Second}^4}}$$

$$T^\circ_{\text{FDU}} = T^\circ_H = \frac{a}{2\,\pi\,k_B}\,\frac{\hbar}{c} \tag{82}$$

This results in a thermal bath of Rindler particles (e.g. ν_{Re} and unstable protons) in accelerated reference frames with acceleration $a / K^\circ = 2.466085\ \text{x}10^{20}\ m \big/ s^2 \big/ K^\circ$. It should be noted that by definition:

$$\mathbf{a_P} = \sqrt{\left(\frac{\text{l}_\text{P}}{\text{t}_\text{P}^2}\,\frac{1}{\text{LTC}}\right)^2}$$

$$6.36295\times10^{59}$$

$$\mathbf{T_P} = \sqrt{\left(\frac{\text{m}_\text{P}\,\text{c}^2}{\text{UNITS[MKS`kBoltz]}}\right)^2}$$

$$4.11437\times10^{25}\sqrt{\text{TempUnit}^2}$$

$$\text{SetAccuracy}\left[\left(\frac{\text{T}_\text{P}}{\text{a}_\text{P}}\,\text{LTC}\right)^2, 77\right] == \text{UNITS}\left[\left(\frac{\text{MKS`}\hbar}{\text{MKS`kBoltz MKS`c}}\right)^2\right]\text{LTC}^2$$

$$\frac{4.1810893\times10^{-69}\,\text{LengthUnit}^2\,\text{TempUnit}^2}{\text{TimeUnit}^4} = 4.18109\times10^{-69}\,\text{TempUnit}^2$$

$$\frac{2\,\pi\,T^\circ_{\text{FDU}}}{a} = \frac{T^\circ_P}{a_P} = \frac{\hbar}{k_B\,c} \tag{83}$$

where Planck unit temperature and acceleration are:

$$T_P^{\circ} = \frac{m_P\, c^2}{k_B} \tag{84}$$

$$a_P = \frac{l_P}{t_P^2} \tag{85}$$

Since a black hole increases its thermal radiation as it gets smaller, T_P° can be characterized as the maximal thermal radiation just before being totally evaporated. Using universal scales in the new model:

$$T_{\text{FDU}}^{\circ} = T_H^{\circ} = T_U^{\circ} \tag{86}$$

resulting from the universal mass now linked to Ω_m with:

```
M_U == Ω_m V_U ρc
```

True

$$M_U = \Omega_m\, V_U\, \rho_c \tag{87}$$

which gives a Casimir blackbody acceleration, or equivalently the acceleration on the surface of a black hole of gravitational radius, which is 1/2 the Schwarzschild radius:

```
G_N M_U / (gc2 c^2) == R_H / 8 == SetAccuracy[π/2 l_string, -24]
```

True

$$R_{\text{BH}} = \frac{R_S}{2} = \frac{G_N\, M_U}{(g_c\, c)^2} = \frac{R_H}{8} = \frac{\pi}{2}\, l_{\text{string}} = 1.70754\, \text{Gly} \tag{88}$$

Using (2) gives an acceleration:

```
c^4/4 gc2/(G_N M_U) == 2 c H_0 == SetAccuracy[UNITS[aU/(2 π)], 4]
```

True

$$\frac{c^4}{4\, G_N\, M_U} = 2\, c\, H_0 = \frac{a_U}{2\,\pi} \tag{89}$$

As done for Planck units, restating this result in terms of the new model gives a surprising result:

```
SetAccuracy[(T_P/a_P LTC)^2, 77] == UNITS[(MKS`ħ/(MKS`kBoltz MKS`c))^2] LTC^2 ==
 SetAccuracy[UNITS[(aU MKS`ħ/(MKS`kBoltz MKS`c))^2], 72]
```

$$\frac{4.1810893\times 10^{-69}\ \text{LengthUnit}^2\ \text{TempUnit}^2}{\text{TimeUnit}^4} = 4.18109\times 10^{-69}\ \text{TempUnit}^2$$

$$\frac{2\,\pi\, T_{\text{FDU}}^{\circ}}{a} = \frac{T_P^{\circ}}{a_P} = \frac{T_U^{\circ}}{a_U} = \frac{\hbar}{k_B\, c} \tag{90}$$

This implies that today the ZPF, VEV, and $\hbar$ represent the minimal change in mass density (charge) from universal acceleration, while black holes represent maximal change in mass density (e.g. where m_P is within l_P) relative to the current rate of acceleration.

These implications will be significant in resolving the debate concerning the origin of inertia, Mach's principle, and an ether related to the ZPF and VEV.

The Observable Universe at $t_U \leq 1 t_{\text{Unit}}$

In terms of the observable universe today, a black hole of mass M_U=1.13554×$10^{60} m_P$, if compressed into as many V_P, results in sphere of radius $2r_p$=1.6 fm. This suggests that a BB matter-antimatter vacuum fluctuation resulted in $\approx 10^{-60}$ 3rd generation primordial atoms of mass m_P within universal radius $2r_p$ immediately decayed within t_{unit}. Over time t_U they inflated to radius R_H with acceleration a_U leaving radiation (such as CMBR), leptons (ν, e) and baryons (p,n of radius r_p).

In order to understand the universe at t_{unit}, it is a simple matter to set α=1. This has $m_P = m_{\text{unit}}$ at l_{unit} and is the point where Planck units become synonymous with the new units of this model and where grand unification is realized as a natural result! The observable universe (to a hypothetical observer) is l_{unit}. This begs the question; at $t_U \leq 1 t_{\text{unit}}$ and $l_U \leq 1 l_{\text{unit}}$, where were today's $\approx 10^{60} m_P$ (then $\approx 10^{60} m_{\text{Unit}}$) which are currently found within R_H? The answer comes from understanding that ρ_c and Ω_m can be assigned to VEV (and m_H) by (32). They are either to be found within $2r_p$ as the BB model might suggest or present throughout space-time as VEV (a function of time) which the SS model might suggest.

Fundamental parameters and objects scale into fractions as $N_{\text{time}} = \alpha^{-8} \leq 1$. This model predicts the behavior observed in today's particle accelerators as well as the scaled interactions of the sdSM at t_{unit}, and before. If the universe is non-locally deterministic (by GRW) and spin synchronized (by Bell and Aspect), it logically implies that a_U and the laws of physics are non-local. This eliminates the constraint that only interactions which are within a common event's light cone can exhibit similar (not necessarily coherent) behavior. With this, it seems that both BB and SS cosmologies could be synonymous!

Loop Quantum Gravity (LQG) and an Accelerating Universe

The accelerating universe provides for the absolute time lacking in GR without significantly altering the basis for GR's success - namely the space-time metric. It also provides the means for QM to be linked to GR through the FDU effect being equated with both Casimir and Hawking radiation. Quantization is naturally provided by atomic scale unit L, T, M, Q dimensions and unit acceleration. The infinite divisibility of space-time in GR is now limited by the background of an acceleration and its finite measure - time (in t_{units}).

Conclusion

To summarize, the new dimensionality relations from (1), (9), and (17):

$$\begin{gathered} L = T^2 \\ M = L^3\, T^{-1} = T^5 \\ Q = \text{ML}^{-1/2} = \text{MT}^{-1} = T^4 \end{gathered} \tag{91}$$

The dimensional relationships relate CPT and MT by:

$$\begin{gathered} \text{MT}(11\,D) = C(4\,D) + P(6\,D) + T(1\,D) \\ C\sqrt{\hbar\left(T^8\right)} + P\left(L^3 = T^6\right) + T^1 \\ \text{Re}[P(3\,D)] + \text{Im}[T(8\,D)] \\ P(\{x,\, y,\, z\}) + i\hbar\,[\{x',\, y',\, z'\},\, C(\text{SU}(5) = (\{r,\, g,\, b\},\, \{L,\, R\})] \end{gathered} \tag{92}$$

To within all most current experimental error:

$$\frac{\hbar}{l_{\text{unit}}\, m_{\text{unit}}} = c = \frac{g_c^2}{G_N} = \frac{1}{4\,\pi\, H_0} = a^{-8}\, t_{\text{unit}} \tag{93}$$

The new units to MKS conversions in Table IV have been generated from (73).

UNIT to MKS UoM Conversion Constants

```
MKS[TimeUnit]
```

0.275847 Second

```
MKS[LengthUnit]
```

6.64984×10^{-10} Meter

```
MKS[MassUnit]
```

5.28986×10^{-34} Kilogram

```
MKS[ChargeUnit]
```

1.50032×10^{-27} Coulomb

```
MKS[TempUnit]
```

3.44352×10^{6} Kelvin

Table 4.

t_{unit}	0.275847 Second
l_{unit}	6.64984×10^{-10} Meter
m_{unit}	5.28986×10^{-34} Kilog
e_{unit}	1.50032×10^{-27} Coulo
T°_{unit}	3.44352×10^{6} Kelvin

A comprehensive sdSM prescription for fundamental particles summarized in Table V.

This model could be described using terms from [5] as a "one (not-so) constant party view". In this model, the fundamental parameters c, $\hbar$ G_N, and H_0 are derived from α. It restores the idea of an absolute reference frame for time which is embedded in the very core of these fundamental parameters of physics, which helps in understanding "the arrow of time", entropy and cosmic inflation. The micro and macro scales of the universe are limited in magnitude by time in such a way that infinity becomes only a mathematical concept not physically realized as the universe unfolds.

The universe itself becomes the clock upon which time can be measured.

```
\begin{table*}
\caption{\label{tab:V}Complete sdSM Prescriptions}
\begin{ruledtabular}
\begin{tabular}{rlcrrrlr}
&[ Mass & Generations & (in $m_{units})\ ]$ & \multicolumn{4}{c}{[$\ \ \ $Charge (in $q^2_{units})\ \ \ \ $Q=(I+Y)J,$\ \ \ J=\left|\#_L-\#_R\right|/2\ \ \ $]}\\


Particle & $1(e)$ & $2(\mu)$ & $3(\tau)$ & $ Q $ & $\Leftarrow m(C,I,Y)\ \ \cdot$ & $J\Rightarrow$ & M(r,g,b,L,R)\\
\hline

$\tau$(in $t_{units}$) & $4\piα^{-8}$ & $2((4/9)α/2\pi)^2$ & $(2α)^6/3\pi$\\
\hline

$\nu_R=\gamma_R+m_0=0$ & & & & & $2(0,\ \ 0,\ \ 0)\ \ \ $ & $0$ & $(0,0,0,0,0)$\\
$\nu_L=\gamma_L+m_0$ & $1/e$ & $1/e\pm 1/\mu$ & $1/\mu\pm 1/\tau$ & $0$ & $(0,\ \ 1,-1)\ \ \ $ & $1/2$ & $(-1,-1,-1,2,1)$\\
$e_R$ & & & & & $-m_Y=2(0,\ \ 0,-1)\ \ \ $ & $1/2$ & $-T_Y=-(2,2,2,-3,-3)$\\
$e_L=e_R-\nu_L$ & $4\pi/α$ & $3e/2α$ & $\mu/8α$ & $-1$ & $(0,-1,-1)\ \ \ $ & $1/2$ & $(-1,-1,-1,1,2)$\\
\hline
```

d_R & & & & & $2(1,\ \ 0,-1)/3$ & $1/2$ & $(-1,-1,0,1,1)$\\
$d_L=d_R-\nu_L$ & $2u_1$ & $u_2/2^{4-1/4}$ & $u_3/2^{6-1/4} $ & $-1/3$ & $(2,-3,\ \ 1)/3$ & $1/2$ & $(0,0,1,-1,0)$\\
$u_R=d_R+W^+_R=d_R-e_R$ & & & & & $2(1,\ \ 0,\ \ 2)/3$ &$1/2$ & $(1,1,2,-2,-2)$\\
$u_L=u_R+\nu_L$ & πe & $4\pi\mu$ & $<\phi^0>_0$ & $+2/3$ & $(2,\ \ 3,\ \ 1)/3$ & $1/2$ & $(0,0,1,0,-1)$\\
\hline

$\gamma_R=\nu_L+\overline{\nu}_R$ & & & & & $2(0,\ \ 0,\ \ 0)\ \ \ $ & 1 & $(0,0,0,0,0)$\\
$\gamma_L=a_U$ & 0 & & & 0 & $(0,\ \ 1,-1)\ \ \ $ & 1 & $(-1,-1,-1,2,1)$\\
$W^\pm_R=\pm u_R\mp d_R=-e_R$ & & & & & $\pm m_Y=(0,\ \ 0,\ \ 1)\ \ \ $ & 1 & $\pm T_Y=\pm(2,2,2,-3,-3)$\\
$W^\pm_L=W^\pm_R\pm 2\nu_L$ & & $2x_w<\phi^0>_0$ & & ± 1 & $\pm m_I=(0,\ \ 1,\ \ 0)\ \ \ $ & 1 & $\pm T_I=\pm(0,0,0,1,-1)$\\
$Z^0=W^\pm+W^\mp$& & $W^\pm/\cos\theta_w$ & & 0 & $(0,\ \ 0,\ \ 0)\ \ \ $ & 1 & $(0,0,0,0,0)$\\
\hline

m_H & & $\sqrt{2}α^{-4}$\\
$<\phi^0>_0$ & & $\sqrt{\sqrt{2}}m_H$\\
$x_w=\sin^2 \theta_w$\\
$=\sin\theta_c$ & & $\sqrt[3]{α\cdot\pi/2}$\\
$α_s$& & $x_w/2$\\
\end{tabular}
\end{ruledtabular}
\end{table*}

Table 5.

Acknowledgements

I would like to thank my family for their love and patience and those in academia who might take the time (and unfortunately risk) to simply help in the review of this work. For without the support of family, the adventure of this journey would be more lonely; without the support of academia, more difficult!

References

[1] A. Riess, A. Filippenko, P. Challis, A. Clocchiattia, A. Diercks, P. Garnavich, R. Gilliland, C. Hogan, S. Jha, R. Kirshner, et al., Arxiv preprint astro-ph/9805201 (1998).

[2] A. Albrecht and J. Magueijo, Physical Review D 59, 43516 (1999).

[3] S. Nesseris and L. Perivolaropoulos, Physical Review D 75, 23517 (2007).

[4] J. Barrow, Journal of Physics: Conference Series 24, 253 (2005).

[5] M. Duff, L. Okun, and G. Veneziano, Journal of High Energy Physics 2002, 19 (2002).

[6] P. Mohr and B. Taylor, Reviews of Modern Physics 77, 1 (2005).

[7] J. Gundlach and S. Merkowitz, Physical Review Letters 85, 2869 (2000).

[8] C. Bennett, M. Halpern, G. Hinshaw, N. Jarosik, A. Kogut, M. Limon, S. Meyer, L. Page, D. Spergel, G. Tucker, et al., Astrophysical Journal, Supplement Series 148, 1 (2003).

[9] J. Sakurai, Advanced Quantum Mechanics (Addison-Wesley Publishing, 1967).

[10] C. Quigg, Gauge Theories of the Strong, Weak, and Electromagnetic Interactions (Westview Press, 1997).

[11] B. Zwiebach, A First Course in String Theory (Cambridge University Press, 2004).

[12] M. Passera, Physical Review D 75, 13002 (2007).

[13] L. Wolfenstein, Physical Review Letters 51, 1945 (1983).

[14] E. Blucher and W. Marciano, V ud, V us, the Cabibbo angle and CKM unitarity (2006).

[15] H. Liu and T. Vachaspati, Physical Review D 56, 1300(1997).

[16] W. Yao, J. Phys. G: Nucl. Part. Phys. 33, 1 (2006).

[17] F. Peat, Superstrings and the Search for the Theory of Everything (Cardinal, 1991).

[18] A. Aspect, Atomic Physics 8 (1983).

[19] G. Ghirardi, A. Rimini, and T. Weber, Physical ReviewD 34, 470 (1986).

[20] A. Smirnov, Arxiv preprint hep-ph/0512303 (2002).

[21] M. Berman and L. Trevisan, Arxiv preprint gr-qc/0112011 (2001).

[22] P. Peebles, Principles of Physical Cosmology (Princeton University Press, 1993).

[23] M. Tegmark, D. Eisenstein, W. Hu, and R. Kron, Arxiv preprint astro-ph/9805117 (1998).

[24] G. Matsas and D. Vanzella, Arxiv preprint gr-qc/0205078 (2002).

Appendix A: Complete PPP

These tables are a work in progress. They are generated from Particle Data Group (PDG) experimental data [16]. Specifically, the upgraded file (http://pdg.lbl.gov/2006/mcdata/mass$_$width$_$2006.csv) for use in Monte Carlo based lattice QCD calculations. An improved version of this file (http://www.TheoryOfEverything.org/TOE/JGM/ToE.xls) is available, which has been created based on this model by generating the data (with few exceptions) from the quark configuration, L and S. Eventually, it will contain all mass, decay width predictions, and error factors. An error factor of ≤1 is within standard experimental error. An error factor of 0 implies it has yet to be predicted.

Setup for PPP Tables

```
PPP[vals_] :=
 Text[
  Grid[Prepend[vals, {"Symbol", "CParity", "Isospin", "Hypercharge",
     "IsospinProjection",
   "GParity", "Parity", "Spin", "Charge", "Mass", "Lifetime", "Width"}],
   Frame -> All,
  Background -> {None, {{{LightBlue, White}}, {1 -> LightYellow}}}]]

LeptonQuark =
  Table[
   {ParticleData[#, "Symbol"], ParticleData[#, "CParity"],
      ParticleData[#, "Isospin"], ParticleData[#, "Hypercharge"],
      ParticleData[#, "IsospinProjection"], ParticleData[#, "GParity"],
      ParticleData[#, "Parity"], ParticleData[#, "Spin"], ParticleData[#, "Charge"],
      ParticleData[#, "Mass"], ParticleData[#, "Lifetime"],
      ParticleData[#, "Width"]} & /@
    Flatten[{ParticleData["Lepton"], ParticleData["Quark"]}]];

GaugeBoson =
  Table[
   {ParticleData[#, "Symbol"], ParticleData[#, "CParity"],
      ParticleData[#, "Isospin"], ParticleData[#, "Hypercharge"],
      ParticleData[#, "IsospinProjection"], ParticleData[#, "GParity"],
      ParticleData[#, "Parity"], ParticleData[#, "Spin"], ParticleData[#, "Charge"],
      ParticleData[#, "Mass"], ParticleData[#, "Lifetime"],
      ParticleData[#, "Width"]} & /@
    {"Gluon", "Photon", {"WBoson", -1}, {"WBoson", 1}, "ZBoson"}];

Meson =
  Table[
   {ParticleData[#, "Symbol"], ParticleData[#, "CParity"],
      ParticleData[#, "Isospin"], ParticleData[#, "Hypercharge"],
      ParticleData[#, "IsospinProjection"], ParticleData[#, "GParity"],
      ParticleData[#, "Parity"], ParticleData[#, "Spin"], ParticleData[#, "Charge"],
      ParticleData[#, "Mass"], ParticleData[#, "Lifetime"],
      ParticleData[#, "Width"]} & /@ {"Meson"}];

Baryon =
  Table[
   {ParticleData[#, "Symbol"], ParticleData[#, "CParity"],
      ParticleData[#, "Isospin"], ParticleData[#, "Hypercharge"],
      ParticleData[#, "IsospinProjection"], ParticleData[#, "GParity"],
      ParticleData[#, "Parity"], ParticleData[#, "Spin"], ParticleData[#, "Charge"],
      ParticleData[#, "Mass"], ParticleData[#, "Lifetime"],
      ParticleData[#, "Width"]} & /@ {"Baryon"}];
```

Lepton & Quark PPP

Table 6.

PPP[LeptonQuark]

Symbol	CParity	Isospin	Hypercharge	IsospinProjection	GParity	Parity	Spin	Charge	Mass	Lifetime	Width
ν_e	—	—	0	—	—	—	$\frac{1}{2}$	0	$0.\times 10^{-6}$	—	—
$\overline{\nu}_e$	—	—	0	—	—	—	$\frac{1}{2}$	0	$0.\times 10^{-6}$	—	—
ν_μ	—	—	0	—	—	—	$\frac{1}{2}$	0	$0.\times 10^{-1}$	—	—
$\overline{\nu}_\mu$	—	—	0	—	—	—	$\frac{1}{2}$	0	$0.\times 10^{-1}$	—	—
ν_τ	—	—	0	—	—	—	$\frac{1}{2}$	0	$0.\times 10^{1}$	—	—
$\overline{\nu}_\tau$	—	—	0	—	—	—	$\frac{1}{2}$	0	$0.\times 10^{1}$	—	—
e	—	—	0	—	—	—	$\frac{1}{2}$	−1	0.51099892	∞	0.
$\overline{e}$	—	—	0	—	—	—	$\frac{1}{2}$	1	0.51099892	∞	0
μ	—	—	0	—	—	—	$\frac{1}{2}$	−1	105.658369	2.19704×10^{-6}	2.99591×10^{-16}
$\overline{\mu}$	—	—	0	—	—	—	$\frac{1}{2}$	1	105.658369	2.19704×10^{-6}	2.99591×10^{-16}
τ	—	—	0	—	—	—	$\frac{1}{2}$	−1	1776.99	2.906×10^{-13}	2.265×10^{-9}
$\overline{\tau}$	—	—	0	—	—	—	$\frac{1}{2}$	1	1776.99	2.906×10^{-13}	2.265×10^{-9}
u	—	$\frac{1}{2}$	$\frac{1}{3}$	$\frac{1}{2}$	—	1	$\frac{1}{2}$	$\frac{2}{3}$	2.2	—	—
$\overline{u}$	—	$\frac{1}{2}$	$-\frac{1}{3}$	$-\frac{1}{2}$	—	1	$\frac{1}{2}$	$-\frac{2}{3}$	2.2	—	—
d	—	$\frac{1}{2}$	$\frac{1}{3}$	$-\frac{1}{2}$	—	1	$\frac{1}{2}$	$-\frac{1}{3}$	5.0	—	—
$\overline{d}$	—	$\frac{1}{2}$	$-\frac{1}{3}$	$\frac{1}{2}$	—	1	$\frac{1}{2}$	$\frac{1}{3}$	5.0	—	—
s	—	0	$-\frac{2}{3}$	0	—	1	$\frac{1}{2}$	$-\frac{1}{3}$	95.	—	—
$\overline{s}$	—	0	$\frac{2}{3}$	0	—	1	$\frac{1}{2}$	$\frac{1}{3}$	95.	—	—
c	—	0	$\frac{4}{3}$	0	—	1	$\frac{1}{2}$	$\frac{2}{3}$	1250.	—	—
$\overline{c}$	—	0	$-\frac{4}{3}$	0	—	1	$\frac{1}{2}$	$-\frac{2}{3}$	1250.	—	—
b	—	0	$\frac{1}{3}$	0	—	1	$\frac{1}{2}$	$-\frac{1}{3}$	4200.	—	—
$\overline{b}$	—	0	$-\frac{1}{3}$	0	—	1	$\frac{1}{2}$	$\frac{1}{3}$	4200.	—	—
t	—	0	$\frac{1}{3}$	0	—	1	$\frac{1}{2}$	$\frac{2}{3}$	174 200.	—	—
$\overline{t}$	—	0	$-\frac{1}{3}$	0	—	1	$\frac{1}{2}$	$-\frac{2}{3}$	174 200.	—	—

Gauge Boson PPP

Table 7.

```
PPP[GaugeBoson]
```

Symbol	CParity	Isospin	Hypercharge	IsospinProjection	GParity	Parity	Spin	Charge	Mass	Lifetime	Width
g	—	—	0	—	—	—	1	0	0.	—	—
γ	−1	Missing[Unknown, {0, 1}]	0	0	—	−1	1	0	$0. \times 10^{-16}$	∞	0.
W^-	—	—	0	—	—	—	1	−1	80 403.	3.076×10^{-25}	2140.
W^+	—	—	0	—	—	—	1	1	80 403.	3.076×10^{-25}	2140.
Z	—	—	0	—	—	—	1	0	91 187.6	2.6379×10^{-25}	2495.2

Meson PPP

Table 8.

PPP[Meson]

Baryon PPP

Table 9.

PPP[Baryon]