Modeling that matches and augments data about physics properties, elementary particles, astrophysics, and cosmology

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Abstract

This essay suggests advances regarding the following challenges. Describe elementary particles that people have yet to find. Describe dark matter. Explain cosmology and astrophysics data that people have yet to explain. Correlate physics properties with each other. Correlate properties of elementary particles with each other. Show united modeling that leads to the advances.

Keywords: Beyond the Standard Model, Dark matter, Galaxy evolution, Rate of expansion of the universe, Inflation, Quantum gravity

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1. Introduction

This essay suggests advances regarding two sets of physics challenges. One set features describing elementary particles that people have yet to find and describing dark matter. One set features explaining cosmology and astrophysics data that people have yet to explain and predicting cosmology and astrophysics data that people have yet to obtain.

We suggest that our explanations regarding cosmology and astrophysics data correlate with the possibility that our descriptions of new particles and dark matter comport with nature.

We blend two sets of work.

We use the two-word term ongoing modeling to describe models developed by people other than us. We divide the models into two categories. We correlate the word core and the word unverified with that division. The word core correlates with people having found that the models comport with nature. The word unverified correlates with other ongoing modeling.

We use the two-word term proposed modeling to describe our work. We divide the models into two categories. We correlate the word core and the word supplementary with that division. Core proposed modeling addresses properties of elementary particles and dark matter. Core proposed modeling also suggests explanations for cosmology and astrophysics data. Supplementary proposed modeling features suggested supplements to core ongoing modeling kinematics models.

This essay unites core ongoing modeling and core proposed modeling. Core ongoing modeling provides models for the motions of and changes to objects. Core proposed modeling suggests and interrelates properties of objects.

2. Methods

This unit addresses the following opportunities. Motivate and develop methods that proposed modeling uses. Use the methods. Develop and show results from using the methods. Discuss the methods and results.

2.1. Objects

2.1.1. Long-range forces

Ongoing modeling models photons via two harmonic oscillators. One chooses two spatial axes. Each axis is perpendicular to the direction in which the photon moves. The two axes are perpendicular to each other. Ongoing modeling might label the two axes with, respectively, the symbols 1 and 2. Each harmonic oscillator models a number of excitations that people correlate with the photon mode that people correlate with the relevant axis. Equations (1), (2), and (3) show a number of excitations and the raising operator and the lowering operator. Equation (4) shows the ongoing modeling range for the integer n.

$$|n> \tag{1}$$

$$a^{+}|n>= (1+n)^{1/2}|n+1> \tag{2}$$

$$a^{-}|n>= n^{1/2}|n-1> \tag{3}$$

$$n \geq 0 \tag{4}$$

Ongoing modeling correlates with three spatial dimensions. Proposed modeling suggests adding, regarding photons, a third harmonic oscillator. The oscillator correlates with the direction of motion. Modeling might label the axis correlating with the direction of motion with the symbol 0. Ongoing modeling states that photons have zero mass. Ongoing modeling states that longitudinal polarization does not pertain for photons. Proposed modeling suggests extending each of equations (1), (2), and (3) to pertain for the domain that equation (5) shows. Regarding oscillator zero, equation (6) shows that this extension is compatible with zero longitudinal polarization. Longitudinal polarization does not excite.

$$n \geq -1 \tag{5}$$

$$a^{+}|-1>= (1+(-1))^{1/2}|0>= 0|0> \tag{6}$$

Proposed modeling uses the construct $@_k$ to denote a value k that does not change. For example, equation (7) pertains.

$$@_0 = 0 \tag{7}$$

Proposed modeling uses equation (8). Here, z denotes a two-letter construct. The choices for the first letter are K, P, G, and U. K correlates with the three-letter construct KMS, with the three-word phrase kinematics modeling space, and with ongoing modeling kinematics models. P correlates with the three-letter construct PFS and with the four-word phrase particle and field space. PFS correlates with proposed modeling. This essay de-emphasizes discussing the extent to which people might consider that - mathematically - a space correlating with PFS correlates with a tangent space to a space correlating with KMS. G correlates with the three-letter construct GCS and with the three-element phrase G-family component space. (This essay uses the notation Φ to correlate with so-called families of elementary particles. This essay uses the notation $\Sigma\Phi$ to name so-called subfamilies of elementary particles. The two-element term G family includes the photon and the would-be graviton. Here, Φ=G. The symbol Σ denotes a non-negative integer that is twice the ongoing modeling notion of the spin S. Here, S correlates with the ongoing modeling notion of $S(S+1)\hbar^2$.) GCS modeling is an aspect of PFS modeling. U correlates with the three-letter construct UMS and with the three-word term united modeling space. The term UMS refers to modeling that embraces aspects that correlate with KMS modeling, PFS modeling, and GCS modeling. (See tables 10 and 11.) The choices for the second letter are S and T. The letter S correlates with the word spatial. This use of the letter S differs from the spin-centric use of the symbol S. The letter T correlates with the word temporal. The word spatial and the word temporal correlate with vocabulary that people use regarding ongoing modeling (and that this essay uses regarding KMS models). This essay uses S and T in contexts of core proposed modeling, but ongoing modeling notions of spatial and temporal do not necessarily directly pertain in those contexts. In equation (8) (and elsewhere in this essay) the symbol $\{\cdots\}$ denotes the four-element phrase the set of $\cdots$.

$$A_{zA} = \sum_{\{zAj\}} (n_{zAj} + (1/2)) \tag{8}$$

Equation (9) pertains regarding our suggested extension - of ongoing modeling for photons - to include three spatial harmonic oscillators. Equation (10) pertains for mode one. Equation (11) pertains for mode two.

$$\{KSAj\} = \{KSA0, KSA1, KSA2\} \tag{9}$$

$$n_{KSA0} = -1,\ n_{KSA1} = n,\ n_{KSA2} = @_0 \tag{10}$$

$$n_{KSA0} = -1,\ n_{KSA1} = @_0,\ n_{KSA2} = n \tag{11}$$

For each of the two modes, equation (12) pertains.

$$A_{KSA} = \sum_{\{KSAj\}} (n_{KSAj} + (1/2)) = n_{KSA0} + n_{KSA1} + n_{KSA2} + (3/2) = n + (1/2) \tag{12}$$

Ongoing modeling correlates with one temporal dimension. Proposed modeling suggests including an oscillator that correlates with the temporal dimension. Proposed modeling suggests that, for each of the two modes, equations (13), (14), and (15) pertain.

$$\{KTAj\} = \{KTA0\} \tag{13}$$

$$n_{KTA0} = n \tag{14}$$

$$A_{KTA} = \sum_{\{KTAj\}} (n_{KTAj} + (1/2)) = n_{KTA0} + (1/2) = n + (1/2) \tag{15}$$

Equation (16) pertains for each photon mode.

$$A_{KTA} - A_{KSA} = 0 \tag{16}$$

We use the two-element term double-entry bookkeeping to describe the equality that equation (17) shows. Here, x can be any one of K, P, G, and U. Adding a unit to one of A_{xTA} and A_{xSA} requires adding a unit to the other quantity.

$$A_{xTA} - A_{xSA} = 0 \tag{17}$$

Ongoing modeling includes two-mode photon models for which one mode correlates with left circular polarization and the other mode correlates with right circular polarization. Compared to linear polarization models, circular polarization models are more invariant with respect to choice of observer. For models correlating with a photon in a vacuum, all observers would agree on the number of excitations for left circular polarization and on the number of excitations for right circular polarization.

Proposed modeling reinterprets work above - regarding photons - based on equations (18), (19), (20), (21), and (22). Here, $PSA1$ correlates with left circular polarization. $PSA2$ correlates with right circular polarization. We correlate the two-word term longitudinal polarization with $PSA0$.

$$\{PTAj\} = \{PTA0\} \tag{18}$$

$$n_{PTA0} = n \tag{19}$$

$$\{PSAj\} = \{PSA0, PSA1, PSA2\} \tag{20}$$

$$n_{PSA0} = -1,\ n_{PSA1} = n,\ n_{PSA2} = @_0 \tag{21}$$

$$n_{PSA0} = -1,\ n_{PSA1} = @_0,\ n_{PSA2} = n \tag{22}$$

Table 1: A PFS representation for photon ground states

PTA 4	PTA 3	PTA 2	PTA 1	PTA 0	PSA 0	PSA 1	PSA 2	PSA 3	PSA 4	$\Sigma\Phi$
				0	-1	0	0			2G

Table 2: A PFS representation for G-family ground states (with LCP denoting left circular polarization; and with RCP denoting right circular polarization)

PTA $\cdots$	PTA 0	PSA 0	PSA 1	PSA 2	PSA 3	PSA 4	PSA $\cdots$
$\cdots$	0	-1	$\Sigma = 2$:LCP	$\Sigma = 2$:RCP	$\Sigma = 4$:LCP	$\Sigma = 4$:RCP	$\cdots$

Proposed modeling PFS modeling embraces double-entry bookkeeping. Equation (23) pertains.

$$A_{PTA} - A_{PSA} = 0 \tag{23}$$

Before discussing PFS modeling for elementary particles that are not photons, we note two aspects of PFS modeling that pertain for more than just photons.

Equation (23) correlates with an invariance with respect to a choice between KMS modeling that is quadratic in energy and KMS modeling that is linear in energy. Regarding a photon, the expression $0 = E^2 - (pc)^2$ is quadratic in energy. Here, E denotes energy, p denotes the magnitude of momentum, and c denotes the speed of light. One can consider that a PFS raising operator correlates with adding one unit of each of the two relevant items - E^2 and $(pc)^2$ - that have the dimensions of the square of energy. For an object with mass m and modeling based on the equation $E^2 = (mc^2)^2 + (pc)^2$ from special relativity, one can consider that a PFS raising operator correlates with adding one unit of each of the three relevant items - E^2, $(mc^2)^2$, and p^2c^2. The Klein-Gordon equation provides an example of KMS modeling - for other than just photons - that can be quadratic in energy. Regarding a photon, the expression $0 = E - pc$ is linear in energy. One can consider that a PFS raising operator correlates with adding one unit of each of the two relevant items - E and pc - that have the dimensions of energy. Each of the Dirac equation and the Schrodinger equation provides an example of KMS modeling - for other than just photons - that is linear in energy.

Either one of A_{PTA} and A_{PSA} would correlate with the ongoing modeling notion of a photon ground state energy that correlates with the expression $0 + (1/2)$ and with the number one-half. (See, for example, equation (15).) People interpret ongoing modeling KMS models as correlating with notions of nonzero quantum energy of the vacuum. Proposed modeling suggests - via equations such as equation (17) - modeling that might obviate needs to consider nonzero quantum energy of the vacuum. Proposed modeling suggests a notion for which this essay uses the two-word term freeable energy. (See, for example, the use in table 10b, of the four-word term freeable passive gravitational energy.) For a proposed modeling model and a choice of object, the ground state of the object models as having zero freeable energy. (The following example features the topic of choice of model. A model for transitions between energy levels in an atom does not necessarily need to consider the rest energies of the relevant electrons and atomic nucleus as correlating with freeable energy. Such a model can feature a ground state that correlates with the ground state of the atom.)

We discuss PFS modeling for elementary particles that are not photons.

Proposed modeling includes PFS models for elementary particles that are not photons. For discussing this aspect of our work, this essay tends to emphasize ground states and de-emphasize excited states. Such work in this essay tends to feature harmonic oscillator states that correlate with the numbers 0 and -1. Such work tends not necessarily to state explicitly distinctions between $@_k$ and k.

Table 1 shows a PFS representation for photon ground states.

We assume that table 2 pertains for G-family ground states.

We explore aspects regarding G-family forces and regarding so-called components of G-family forces.

In ongoing modeling KMS modeling, an excitation of a G-family force carries information through which people infer aspects of an event that includes the excitation. For example, people measure the energy of a photon and might use that information to infer information about an atomic transition that excited the photon.

We explore GCS modeling that encodes, regarding 2G modes, information about excitations of the overall 2G (or, electromagnetic) field. We anticipate that GCS modeling points to encoded information

Table 3: A GCS representation for G-family ground states (with LCP denoting left circular polarization; and with RCP denoting right circular polarization)

GTA	GTA	GSA	GSA	GSA	GSA	GSA	GSA
$\cdots$	0	0	1	2	3	4	$\cdots$
$\cdots$	0	-1	$\lambda = 2$:LCP	$\lambda = 2$:RCP	$\lambda = 4$:LCP	$\lambda = 4$:RCP	$\cdots$

Table 4: G-family solutions that may be relevant and for which $\lambda \leq 8$

Other	GCS monopole	GCS dipole	GCS quadrupole	GCS octupole
0G∅	2G2	ΣG24	ΣG246	ΣG2468
	4G4	ΣG26	ΣG248	
	6G6	ΣG28	ΣG268	
	8G8	ΣG46	ΣG468	
		ΣG48		
		ΣG68		

to which ongoing modeling KMS modeling does not point. The additional encoded information correlates with the isomer or isomers that participated in the creation of the photon. (See table 7 and table 15b.)

We consider the left circular polarization mode of 2G.

We consider an excitation that models conceptually as combining an excitation of the left circular mode of 4G and the right circular mode of 2G. (This essay de-emphasizes the possible relevance of an actual object that combines a graviton and a photon.) The combination yields a left circular polarization spin-1 excitation. The combination correlates with 2G.

Equation (24) provides notation that we use for such combinations. The symbol ΣG denotes a subfamily of the G-family. The symbol Γ denotes a set of even positive integers. We use the symbol λ to denote an element of Γ. Each value of λ correlates with the oscillator pair $GSA(\lambda - 1)$-and-$GSA\lambda$. For the above example of subtracting spin-1 from spin-2, the notation $\Gamma = 24$ pertains and equation (25) pertains.

$$\Sigma \mathrm{G} \Gamma \tag{24}$$

$$\Sigma = |-2+4| = 2 \tag{25}$$

Table 3 echoes table 2. Table 2 pertains for PFS modeling. Table 3 pertains for GCS modeling.

Table 4 points to possibly relevant solutions for which the limit $\lambda \leq 8$ pertains. (The word solution correlates with harmonic oscillator mathematics and double-entry bookkeeping. We anticipate that some solutions have relevance to models regarding G-family physics. We use the word component - as in component of a ΣG field or force - regarding physics applications of solutions that are relevant to G-family physics. We anticipate that some solutions have relevance regarding modeling that correlates with aspects of physics other than G-family aspects.) The labels GCS monopole through GCS octupole correlate with GCS modeling. The label GCS monopole correlates with the existence of one mathematical solution for each item in the column labeled GCS monopole. The label GCS dipole correlates with the existence of two mathematical solutions for each item in the column labeled GCS dipole. For example, for $\Gamma = 24$, each one of the solutions 2G24 and 6G24 pertains. The symbol 6G24 correlates with $\Sigma = |+2+4| = 6$. The label GCS quadrupole correlates with the existence of four mathematical solutions for each item in the column labeled GCS quadrupole. G-family physics does not include phenomena that might correlate with the symbol 0G. For each of two GCS quadrupole items, the one 0GΓ mathematical solution is not relevant to G-family physics. For example, the solution 0G246, which correlates with $|-2-4+6|$, is not relevant to G-family physics. The label GCS octupole correlates with the existence of eight mathematical solutions for the one item in the column labeled GCS octupole. The solution 0G2468 is not relevant to G-family physics. The table notes a conceptually possible 0G∅ solution. The symbol ∅ denotes the empty set.

We use the symbol $\Sigma\gamma$ to refer to the set of G-family solutions ΣGΓ for which Σ appears in the list Γ. (See equation (26).) Here, the notation $\{a|b\}$ correlates with the ten-element phrase the set of all a such that conditions b pertain. The symbol $\in$ correlates with the four-word phrase is a member of (or, the four-word phrase is an element of). We use the symbol $\gamma\lambda$ to refer to the set of G-family solutions ΣGΓ for which λ appears in the list Γ and Σ does not appear in the list Γ. (See equation (27).) The symbol $\notin$ correlates with the five-word phrase is not a member of.

Table 5: $\Sigma\gamma$ solutions for which both $\Sigma \leq 8$ and, for each $\lambda \in \Gamma$, $\lambda \leq 8$

Σ	GCS monopole	GCS dipole	GCS quadrupole	GCS octupole
2	2G2	2G24	2G248	
4	4G4	4G48	4G246	4G2468a, 4G2468b
6	6G6		6G468	
8	8G8			8G2468a, 8G2468b

$$\Sigma\gamma = \{\Sigma G\Gamma | \Sigma \in \Gamma\} \tag{26}$$

$$\gamma\lambda = \{\Sigma G\Gamma | \lambda \in \Gamma, \Sigma \notin \Gamma\} \tag{27}$$

Table 5 lists G-family solutions $\Sigma G\Gamma$ for which both $\Sigma \leq 8$ and, for each $\lambda \in \Gamma$, $\lambda \leq 8$. The expressions $|-2+4-6+8|$ and $|-2-4-6+8|$ show that two solutions comport with the notion of 4G2468. We use the letters a and b to distinguish the two solutions. We use the letter x to refer to either one of the solutions or to both solutions. The expressions $|+2+4-6+8|$ and $|-2-4+6+8|$ show that two solutions comport with the notion of 8G2468.

Work leading to table 4 does not depend on choosing a kinematics model. Examples of kinematics models include Newtonian physics and general relativity.

We posit that the words monopole through octupole correlate, for ongoing modeling KMS Newtonian modeling, with force laws. RSDF abbreviates the five-word term radial spatial dependence of force. The notion of RSDF pertains regarding KMS modeling. (The notion of RSDF does not directly pertain regarding GCS modeling.) Ongoing modeling correlates the word monopole with a potential energy that varies as r^{-1} and with the RSDF of r^{-2}. Here, r denotes an ongoing modeling KMS radial coordinate and the distance from the center of the one relevant object. Here, we de-emphasize angular aspects of forces. A series that starts with monopole continues. For example, ongoing modeling correlates the word dipole with a potential energy that varies as r^{-2} and with the RSDF of r^{-3}. (Perhaps, see table 6.)

Table 6 notes some aspects related to table 5. Elsewhere, we further discuss the adjustments - regarding 4G - to which table 6a alludes. (See table 22.) Regarding non-4G G-family solutions for which $8 \in \Gamma$, $[\![16]\!] \notin \Gamma$, and at least one of two, four, and six is a member of Γ, one can consider that the presence of $\lambda = 8$ correlates with a KMS factor of $(ct)^{-1}$ and not with a KMS factor of r^{-1}. (For $\lambda \geq 10$, this essay uses $[\![\lambda]\!]$ to denote elements of Γ.) Here, t denotes an ongoing modeling KMS temporal coordinate and c denotes the speed of light. (Perhaps, consider the notion that - at least regarding propagation in a vacuum - $r^{-1} = (ct)^{-1}$.) Regarding non-4G G-family solutions for which $8 \in \Gamma$, $[\![16]\!] \notin \Gamma$, and at least one of two, four, and six is a member of Γ, the GCS (or PFS) notion of quadrupole correlates with the KMS notion of $r^{-3}t^{-1}$ and with the KMS notion of spatial dipole. Regarding KMS modeling, 2G248 correlates with an adjustment - that varies with time - to 2G24 and magnetic dipole moment. (See the 2G248 row in table 6a.) Similarly, the GCS notion of $[\![16]\!] \in \Gamma$ might correlate - for non-4G G-family solutions that are relevant to G-family physics - with a KMS factor of $(ct)^{-1}$ and not with a KMS factor of r^{-1}. (Note table 6b.) Such a correlation with a KMS factor of $(ct)^{-1}$ would pertain only to the extent that six is a member of Γ. Discussion related to table 9 suggests that there might not be any G-family physics relevant non-4G G-family solutions for which $[\![16]\!] \in \Gamma$.

Table 7 defines the two-word term simple particles and notes some aspects regarding the proposed modeling notion of isomers of simple particles. This essay generally de-emphasizes possible applications of PR36ISP modeling, except in regard to a discussion of dark energy density. (Regarding dark energy density and PR36ISP, see discussion related to equation (129).)

Table 8 shows GCS representations for the G-family solutions for which - for each $\lambda \in \Gamma$ - $\lambda \leq 8$. The solutions correlate with symmetries pertaining to ground states. In table 8, the rightmost seven columns comport with double-entry bookkeeping. Table 8c discusses the notion of span. Information about GTA symmetries has two roles. One role pertains to the number of relevant isomers. (See tables 7 and 8c.) One role pertains to the extent to which solutions correlate with interactions with individual elementary particles. (See discussion related to equation (37).) Some components can interact with multicomponent objects and not with individual elementary particles.

Table 9 points to some G-family solutions that one might extrapolate from aspects that underlie table 8. Elsewhere, we elaborate regarding some aspects of table 9. The following notions pertain. We correlate the 4G2468$[\![16]\!]$ solution with an attractive component - of 4G - that might dominate early in the evolution of the universe. (See table 22. See discussion related to equation (110).) Paralleling the notion that some

Table 6: KMS-modeling interpretations correlating with $\Sigma\gamma$ force components for which $\Sigma \leq 4$ and, for each $\lambda \in \Gamma$, $\lambda \leq 8$

(a) Interactions

Components	Property of an object (assuming that modeling pertains for zero translational motion)
2G2	Charge.
2G24	Magnetic dipole moment.
2G248	Magnetic dipole moment for which the direction of the axis (correlating with the dipole moment) changes over time. (Adjustment regarding 2G24. KMS spatial dipole. KMS RSDF r^{-3}.)
4G4	Mass.
4G48	Adjustment regarding 4G, to the extent that the object rotates. KMS spatial dipole. KMS RSDF r^{-3}.
4G246	Adjustment regarding 4G, to the extent that the object has a quadrupole moment of mass. KMS spatial quadruple. KMS RSDF r^{-4}.
4G2468a, 4G2468b	Adjustments regarding 4G, to the extents that quadrupole moments of mass rotate. KMS spatial octupole. KMS RSDF r^{-5}.

(b) An interpretation of $8\in\Gamma$ and a preview of an interpretation of $[\![16]\!] \in \Gamma$ (with the notion that, for $\lambda \geq 10$, this essay uses $[\![\lambda]\!]$ to denote elements of Γ)

Aspect	Interpretation
$8\in\Gamma$	Rotation
$[\![16]\!] \in \Gamma$	Ringing (or, pulsation)

Table 7: PRι_IISP modeling and isomers of simple particles

Note
• The two-word phrase simple particles denotes all elementary particles except G-family elementary particles. • Proposed modeling includes so-called PRι_IISP modeling, with ι_I being one of the integers one, six, and 36. The models address aspects of astrophysics and aspects of cosmology. The two letters PR denote the term physics-relevant. The three letters ISP denote the four-word term isomers of simple particles (or, the five-word term isomers of simple elementary particles). The integer ι_I denotes a number of so-called isomers of the set of all simple particles. • In this respect, PR1ISP modeling correlates with ongoing modeling. • Proposed modeling suggests that PR6ISP models explain more astrophysics data and more cosmology data than do PR1ISP models. For example, PR6ISP modeling explains some observed ratios of dark matter to ordinary matter. • PR36ISP models might explain more data than do PR6ISP models.

Table 8: GCS information regarding G-family solutions for which, for each $\lambda \in \Gamma$, $\lambda \leq 8$

(a) ΣΦΓ, GTA symmetries, and other aspects

ΣΦΓ	Span (for $\iota_I > 1$)	GTA $SU(\_)$ symmetry	GTA 0	GSA 0	GSA 1 and 2	GSA 3 and 4	GSA 5 and 6	GSA 7 and 8
0G∅	1	None	−1	−1				
2G2	1	None	0	−1	$\pi_{0,@_0}$			
4G4	6	$SU(3)$	0	−1	A0+	$\pi_{0,@_0}$		
ΣG24	1	None	0	−2	$\pi_{0,@_0}$	$\pi_{0,@_0}$		
6G6	2	$SU(5)$	0	−1	A0+	A0+	$\pi_{0,@_0}$	
ΣG26	6	$SU(3)$	0	−2	$\pi_{0,@_0}$	A0+	$\pi_{0,@_0}$	
ΣG46	6	$SU(3)$	0	−2	A0+	$\pi_{0,@_0}$	$\pi_{0,@_0}$	
ΣG246	1	None	0	−3	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$	
8G8	1	$SU(7)$	0	−1	A0+	A0+	A0+	$\pi_{0,@_0}$
ΣG28	2	$SU(5)$	0	−2	$\pi_{0,@_0}$	A0+	A0+	$\pi_{0,@_0}$
ΣG48	2	$SU(5)$	0	−2	A0+	$\pi_{0,@_0}$	A0+	$\pi_{0,@_0}$
ΣG68	2	$SU(5)$	0	−2	A0+	A0+	$\pi_{0,@_0}$	$\pi_{0,@_0}$
ΣG248	6	$SU(3)$	0	−3	$\pi_{0,@_0}$	$\pi_{0,@_0}$	A0+	$\pi_{0,@_0}$
ΣG268	6	$SU(3)$	0	−3	$\pi_{0,@_0}$	A0+	$\pi_{0,@_0}$	$\pi_{0,@_0}$
ΣG468	6	$SU(3)$	0	−3	A0+	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$
ΣG2468	1	None	0	−4	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$

(b) Notes regarding notation that table 8a uses and regarding GTA symmetries

Note
• The symbol A0+ correlates with an oscillator pair for which, for each of the two oscillators, the symbol $@_0$ pertains.
• The symbol $\pi_{0,@_0}$ correlates with the notion that either $n_{GSA(odd)} = 0$ and $n_{GSA(even)} = @_0$ pertains or $n_{GSA(odd)} = @_0$ and $n_{GSA(even)} = 0$ pertains. For example, equation (25) and 2G24 correlate with $n_{GSA1} = @_0$ and $n_{GSA2} = 0$ and $n_{GSA3} = 0$ and $n_{GSA4} = @_0$. Here, the two values of zero anti-align with respect to odd and even. In contrast, 6G24 correlates with $n_{GSA1} = 0$ and $n_{GSA2} = @_0$ and $n_{GSA3} = 0$ and $n_{GSA4} = @_0$. Here, the two values of zero align with respect to odd and even.
• For each row for which table 8a shows a GTA symmetry of none, oscillator $GTA0$ suffices regarding double-entry bookkeeping.
• For each row for which table 8a shows a GTA symmetry of $SU(j)$, one adds $j-1$ GTA oscillators. For each added $GTAk$ oscillator, the value of n_{GTAk} is zero. The result satisfies double-entry bookkeeping. The $SU(j)$ symmetry correlates with mathematics for an isotropic harmonic oscillator that features j component harmonic oscillators. Here, the set of component oscillators includes $GTA0$.

(c) Notes regarding G-family excitations, regarding information that correlates with specific ΣGΓ, and regarding the notion of span

Note
• An excitation of a ΣG field does not (directly) encode information about a relevant ΣGΓ.
• For PRι_IISP modeling for which $\iota_I > 1$, the word span denotes the isomers among which a specific instance of a specific ΣGΓ intermediates interactions.
• For PRι_IISP modeling for which $\iota_I > 1$, this essay tends (when not discussing specific isomers of simple particles) to use the word span to denote the number of isomers among which a specific instance of a specific ΣGΓ intermediates interactions. (See, for example, table 8a.)
• For PRι_IISP modeling for which $\iota_I > 1$, an excitation of a ΣG field encodes information that specifies relevant isomers of particles. The number of relevant isomers correlates with the Γ of the relevant ΣGΓ. The word span denotes that number of relevant isomers.
• For PRι_IISP modeling for which $\iota_I > 1$, a de-excitation of a ΣG field must correlate with an isomer in the list of isomers that correlates with the relevant excitation.
• For PR1ISP modeling, there is one isomer of simple particles and the span is always one.

Table 9: Some G-family solutions that one might extrapolate from aspects that underlie table 8

Solutions that correlate with table 8 and with the limits $\Gamma \neq \emptyset$ and $\lambda \leq 8$	Other solution, assuming the limits $\Gamma \neq \emptyset$ and $\lambda \leq 16$	Possibilities, regarding the other solution
4G4, 4G48, 4G246, 4G2468x	4G2468⟦16⟧	Might correlate with the dominant force component for an era two eras before inflation.
4G4, 4G246	4G246⟦16⟧	Might correlate with a significant force component around the time of inflation.
2G2, 4G4, 6G6, 8G8	10G⟦10⟧	Seemingly not relevant. The strength of 10G⟦10⟧ would be zero.
0G246, 0G2468	0G2468⟦16⟧	Might correlate with the 0I elementary boson.
0G268	0G268⟦16⟧	Might correlate with the 2U elementary bosons.
2G2, 2G24, 2G248	2G248⟦16⟧	Seemingly not relevant. $6 \notin \Gamma$.
4G4, 4G48	4G48⟦16⟧	Seemingly not relevant. $6 \notin \Gamma$.
8G8	8G8⟦16⟧	Seemingly not relevant. $6 \notin \Gamma$.

instances of $\lambda = 8$ correlate with rotation, some instances of $\lambda = 16$ might correlate with pulsation (or, with temporal oscillation or ringing). (See table 6b.) The 4G246⟦16⟧ solution might correlate with an attractive KMS octupole component of 4G. The corresponding force might participate regarding ending the inflationary epoch. (See discussion related to equation (114).) This essay de-emphasizes the possible physics relevance of some possible extrapolations. Solution 10G⟦10⟧ provides an example. Per equation (95), a strength factor of four pertains regarding 2G2 and a strength factor of three pertains regarding 4G4. We assume that a strength factor of two pertains regarding 6G6, a strength factor of one pertains regarding 8G8, and a strength factor of zero pertains regarding 10G⟦10⟧. We correlate some 0GΓ solutions with some elementary bosons. (See table 19.) The following notions provide an example - that is not specific to elementary particles - regarding the 2G248⟦16⟧ row in table 9. For the earth, 2G24 correlates with nominal magnetic dipole moment. 2G248 correlates with non-alignment of the axis of planetary spin and the axis correlating with the nominal magnetic dipole moment. Speculatively, 2G248⟦16⟧ might correlate with periodic reversal of the nominal magnetic dipole moment. However, proposed modeling suggests that pulsation (or, ringing) might correlate with freeable energy and a need to have $6 \in \Gamma$.

Elsewhere, this essay discusses the notion that the notions of six isomers and PR6ISP modeling explains the observed ratio - of five-plus to one - of dark matter density of the universe to ordinary matter density of the universe. (See discussion related to table 25.) Here, we show some aspects of group theory and of harmonic oscillator mathematics. Then, we apply some of the aspects to develop the second column - Span (for $\iota_I > 1$) - in table 8a.

We note a relationship between $SU(j)$ groups and the group $U(1)$.

Equation (28) echoes mathematics and some ongoing modeling. Here, each of the positive integers j_1 and j_2 is at least two. The symbol $\supset$ correlates with the notion that each group to the right of the symbol is a subgroup of the group to the left of the symbol.

$$SU(j_1 + j_2) \supset SU(j_1) \times SU(j_2) \times U(1) \tag{28}$$

We use a symbol of the form g_{group} to denote the number of generators for a group. Equation (29) pertains.

$$g_{SU(j)} = j^2 - 1 \tag{29}$$

For $U(1)$, $g_{U(1)} = 2$. One of the two generators of the group $U(1)$ correlates with the raising operator that equation (2) shows. The other of the two generators of the group $U(1)$ correlates with the lowering operator that equation (3) shows.

We posit that equations (30) and (31) have relevance for the domain $-1 \leq n \leq 0$. We use the symbol $U(1)_b$ to denote a construct that correlates with this pair of one raising operator and one lowering operator. We posit that applications of equation (28) pertain for which one replaces the $U(1)$ (in equation (28)) with $U(1)_b$.

$$b^{+}|n>=n^{1/2}|n+1> \tag{30}$$

$$b^{-}|n>=(1+n)^{1/2}|n-1> \tag{31}$$

Ongoing modeling includes the notion of the Poincare group. Equation (32) pertains. The construct for which this essay uses the symbol $S1g$ correlates with conservation of energy and with a group with one generator. Respective instances of $SU(2)$ correlate with conservation of angular momentum, conservation of momentum, and boost symmetry. We posit that applications of equation (28) pertain for which one envisions, for one of $k=1$ and $k=2$, that j_k equals one and that one replaces the would-be $SU(1)$ with $S1g$.

$$S1g \times SU(2) \times SU(2) \times SU(2) \tag{32}$$

We posit that - for GTA aspects of GCS modeling - the substitutions (in either of the two directions) that equation (33) suggests can be appropriate when $S1g$ correlates with the $GTA0$ oscillator.

$$SU(j) \ \leftrightarrow \ SU(j-1) \times S1g \tag{33}$$

We discuss relationships between the numbers of generators for some $SU(j)$ groups.

In equation (34), g_j denotes the number of generators of the group $SU(j)$, the symbol $|$ denotes the word divides (or, the two-word phrase divides evenly), and the symbol $\nmid$ denotes the four-word phrase does not divide evenly. For some aspects of proposed modeling, equation (34) correlates with ending the series $SU(3)$, $SU(5)$, $\cdots$ at the item $SU(7)$. (See discussion related to equation (37).) For some aspects of proposed modeling, the series $SU(3)$, $SU(5)$, $SU(7)$, and $SU(17)$ might pertain.

$$g_3|g_5,\ g_3|g_7,\ g_5|g_7 \quad g_5\nmid g_9,\ g_7\nmid g_9,\ g_7\nmid g_{11} \quad g_3|g_{17},\ g_5|g_{17},\ g_7|g_{17} \tag{34}$$

We discuss spans for components of G-family forces.

For any one value of ι_I (as in PRι_IISP), equation (35) pertains for each simple particle, for each component of G-family force, and for each hadron-like particle. For example, for PR6ISP modeling, for the electron, the number of isomers is six and the span of each isomer is one. (The electron does not correlate directly with a GCS solution.) For PR6ISP modeling, for the 4G4 component of 4G, the number of isomers is one and the span of each isomer is six. (Gravity intermediates interactions between the six isomers of simple particles.)

$$\text{(number of isomers)} \times \text{(span of one isomer)} = \iota_I \tag{35}$$

We start from the span of six that we posit for 4G4. We consider GTA symmetries for G-family solutions. (See table 8a.) We aim to develop numbers that belong in the table 8a column that has the label span (for $\iota_I \geq 6$). The number of generators of each of $SU(3)$, $SU(5)$, and $SU(7)$ divides evenly the integer 48, which is the number of generators of $SU(7)$. Regarding 4G4, we posit that the expression $6 = g_{SU(7)}/g_{SU(3)}$ correlates with the span. We generalize. We assert that, for each G-family solution for which a GTA symmetry of $SU(j)$ pertains, equation (36) provides the span. We assume that we can generalize from the assumption that the span of 2G2 is one. (Ordinary matter photons do not interact - or, at least, do not interact much - with dark matter.) For each G-family solution with no GTA symmetry, the span is one. We anticipate that some G-family solutions - for which some λ exceed eight - have relevance and that equation (36) does not pertain. (See discussion related to equation (109).)

$$g_{SU(7)}/g_{SU(j)} \tag{36}$$

We explore the extents to which components of G-family forces interact with simple particles.

Elsewhere, we correlate an $SU(4)$ symmetry with the notion of additivity - across objects - of energy that modeling correlates with translational motion of the objects. (See the row - in table 11 - that discusses ground state total energy.) We deploy equation (33). Here, we assume that an $SU(5)$ symmetry pertains. The $SU(5)$ symmetry correlates with UTA UMS modeling and with PTA PFS modeling. The symmetry pertains - in PFS modeling - for each G-family force ΣG.

We posit that aspects of the translational motion $SU(5)$ symmetry and the GTA $SU(\_)$ symmetry column in table 8 combine. For example, for 8G8, a GTA $SU(11)$ symmetry would pertain. (In table 8, seven GTA oscillators pertain. For the symmetry correlating with translational motion, five GTA oscillators pertain. The two aspects that combine share their respective $n_{xTA0} = 0$ values. Seven plus five minus one is 11.) For such work, equation (37) pertains. For example, for 4G4, a GTA $SU(7)$ symmetry would pertain. For example, for 2G2 or 2G24, a GTA $SU(5)$ symmetry would pertain. We posit a limit that correlates with aspects of equation (34). We posit that each component that appears in table 8 and has a GTA symmetry of None or $SU(3)$ can interact with simple particles. (Here, combining the GTA symmetry that table 8 shows with the additivity - across objects - of energy symmetry produces, respectively, $SU(5)$ or $SU(7)$.) We posit that components that appear in table 8 and have a GTA symmetry of None or $SU(3)$ can interact with multicomponent objects. We posit that each component that appears in table 8 and has a GTA symmetry of $SU(5)$ or $SU(7)$ does not interact with simple particles. (Here, combining the GTA symmetry that table 8 shows with the additivity of energy symmetry produces, respectively, $SU(9)$ or $SU(11)$.) We posit that a combined symmetry of either $SU(9)$ or $SU(11)$ correlates with possible interactions with multicomponent objects.

$$SU(j_1) \text{ combines with } SU(j_2) \text{ to correlate with } SU(j_1 + j_2 - 1) \quad (37)$$

For example, 2G68 can interact with an atom but not with an isolated electron. (Table 8 shows, regarding 2G68, a GTA $SU(5)$ symmetry.) We correlate 2G68 with at least the 21-centimeter hyperfine interaction with hydrogen atoms. (See discussion related to equation (128).) Generally, $6 \in \lambda$ can correlate with interactions regarding freeable energies of objects. (See table 10b and table 16.) Generally, $8 \in \lambda$ can correlate with interactions regarding rotations of objects or spins of objects. (See table 6b and table 16.)

2.1.2. Objects and their properties

We consider the possibility that table 6 points toward useful new modeling regarding objects and properties of objects. Table 6 links aspects of GCS modeling (and, hence, aspects of proposed modeling PFS modeling) with properties that correlate with ongoing modeling KMS models.

We define aspects of UMS modeling.

Table 10 shows USA aspects of UMS modeling. Table 10a shows modeling regarding a system that includes at least one object. The modeling correlates with ongoing modeling classical physics. The word additivity refers to the notion that modeling correlates with an ability to add, across more than one system, the respective system property. The column with the label USA defines a correlation with oscillators that underlie the modeling. (UMS modeling does not necessarily directly reflect mathematics correlating with excitations of harmonic oscillators.) The assignments comport with aspects of table 5, table 6a, table 7, and table 8. Each instance of $U(1)$ correlates with additivity. (Additivity does not necessarily pertain regarding $U(1)_b$.) The column labeled symmetry is compatible with applying - starting with $SU(17)$ - equation (28) four times. (Here, we assume that equation (28) pertains once with $j_1 = 1$.) Table 10b pertains to an object that is part of the system. The column labeled with the two-word phrase object property differentiates cases. For example, the $USA0$ row differentiates between elementary fermions and other objects, including elementary bosons. Relative to table 10a, table 10b has bases in four applications of equation (28). For each application, $j_1 = j_2 = 2$. Regarding table 10b, for an object, the passive gravitational energy equals the sum of the ground state passive gravitational energy (which - for that object - does not change) and the freeable passive gravitational energy. For this essay, the three-word term passive gravitational energy is synonymous with the four-word term passive gravitational rest energy. The three-word term passive gravitational mass denotes the mass that modeling attributes to the object when modeling the gravitational field that the object - in effect - produces. The passive gravitational mass equals c^{-2} times the passive gravitational energy. In this context, each of the three-word term active gravitational mass and the two-word term inertial mass contrasts with passive gravitational mass. Active gravitational mass correlates with the notion of interaction between an object and the gravitational field that other objects - in effect - produce. Inertial mass correlates notions of accelerations and forces (in general). Inertial mass can refer to a ratio of the force (which does not necessarily correlate with gravity) that acts on the object to the acceleration that the object exhibits (because of the force). This essay comports with the notion that people might have yet to identify any quantified differences between passive gravitational mass, active gravitational mass, and inertial mass. We use the four-word phrase not necessarily gravitational mass to denote notions of mass that do not necessarily correlate with passive gravitational mass or with active gravitational mass. Inertial mass provides an example of not necessarily gravitational mass. Equation (107) might correlate with an example of not necessarily gravitational mass that differs from both passive gravitational mass and active gravitational mass.

Table 11 shows UTA aspects of UMS modeling. Table 11 is a UTA analog to the USA centric table 10. For table 11, the column labeled symmetry is compatible with applying - starting with $SU(7)$ -

Table 10: USA symmetries

(a) Some system properties that correlate with classical physics

System property	Trio	USA	Note	Symmetry
-	-	0	Not applicable	$U(1)_b \times S1g$
Charge	3 signs	1-2, 15-16	Additivity pertains for each sign	$U(1) \times SU(4)$
Ground state passive gravitational energy	-	3-6	Scalar quantity	$SU(4)$
Ground state angular momentum	3 axes	7-10	Additivity pertains for each axis	$U(1) \times SU(4)$
Momentum	3 axes	11-14	Additivity pertains for each axis	$U(1) \times SU(4)$

(b) Some object properties that correlate with proposed modeling

Object property	Trio	USA	Note	Symmetry
Nonzero / zero property choice (charge for elementary fermions, mass otherwise)	-	0	Correlates with a binary choice	$U(1)_b$
Charge	3 signs	1-2	Additivity pertains for each sign	$U(1) \times SU(2)$
Passive gravitational energy	-	3-4	Correlates with a scalar quantity and with six isomers of PR1ISP (and with PR6ISP models)	$U(1) \times SU(2)$
Freeable passive gravitational energy (any object)	-	5-6	Correlates with a scalar quantity (The symmetry might not be relevant.)	$SU(2)$
Generation (for elementary fermions)	one, two, three	5-6	Three values of freeable energy	$SU(2)$
Angular momentum (classical physics)	3 axes	7-8	Additivity pertains for each axis	$U(1) \times SU(2)$
Freeable angular momentum (classical physics)	3 axes	9-10	Three axes of freeable angular momentum	$SU(2)$
Translational momentum	3 axes	11-12	Additivity pertains for each axis	$U(1) \times SU(2)$
Boost symmetry (special relativity)	3 axes	13-14	Specific to special relativity	$SU(2)$
Non-quantized charge (some models)	-	15-16	Correlates with a scalar quantity (The symmetry might not be relevant.)	$SU(2)$
Pulsation (or, ringing) energy (some models)	-	15-16	Correlates with a scalar quantity (The symmetry might not be relevant.)	$SU(2)$
Magnitude of one-zero unit of nonzero charge divided by the magnitude of the charge of an electron	1, 2/3, 1/3	15-16	Allows for quarks	$SU(2)$

Table 11: UTA symmetries

(a) Some system properties that correlate with classical physics

System property	Trio	UTA	Note	Symmetry
-	-	0	Not applicable	$U(1)_b \times S1g$
-	-	1-2	Not applicable	$SU(2)$
Ground state total energy	-	3-6	Additivity pertains regarding the scalar quantity	$U(1) \times SU(4)$

(b) Some object properties that correlate with proposed modeling

Object property	Trio	UTA	Note	Symmetry
Property choice (whether an elementary boson or other object models as entangled)	-	0	Correlates with a binary choice	$U(1)_b$
Color charge	red, blue, green	1-2	Correlates with a three-fold choice	$SU(2)$
Total energy (any object)	-	3-4	Correlates with a scalar quantity and with six isomers of PR6ISP (and with PR36ISP models)	$U(1) \times SU(2)$
Freeable total energy (any object)	-	5-6	Correlates with a scalar quantity (The symmetry might not be relevant.)	$SU(2)$

Table 12: Aspects correlating with oscillators $zTA0$ and $zSA0$, for PFS modeling and for UMS modeling

Object	Parameters ($z = P$ or U)	Note
Any	$n_{zTA0} = 0$	The model correlates with some notions of no entanglement.
Any	$n_{zTA0} = -1$	The model correlates with entanglement.
Elementary particle	$n_{zTA0} = 0$, $n_{zSA0} = -1$	In a vacuum, the object travels at the speed of light. (The ground state passive gravitational energy equals zero.)
Elementary fermion	$n_{zSA0} = -1$	The object has zero charge.
Elementary boson	$n_{zSA0} = -1$	The object has zero mass.

equation (28) twice.

We discuss notions correlating with table 10 and with table 11.

The USA object property of passive gravitational energy correlates with the USA object property of freeable passive gravitational energy. The USA object property of angular momentum correlates with the USA object property of freeable angular momentum. The USA object property of pulsation energy correlates with the UTA object property of freeable total energy.

Table 12 brings together aspects correlating with oscillators $zTA0$ and $zSA0$, for PFS modeling and for UMS modeling.

Modeling for an object can consider a ground state and excited states. For any state, the passive gravitational energy minus the freeable passive gravitational energy equals the passive gravitational energy for the ground state. For any state, the angular momentum minus the freeable angular momentum equals the angular momentum for the ground state.

For each of table 10 and table 11, the appearances (in a row) of the word additivity and of the symmetry $U(1)$ correlate with a conservation law. Conservation of energy is an example of such a conservation law.

Modeling - for an object - that correlates with a change in ground state energy correlates with a change of object.

2.2. Elementary particles and dark matter

Table 13 previews elementary particles that proposed modeling suggests. Table 13 alludes to all known elementary particles and to elementary particles that proposed modeling suggests. Elsewhere, we depict some aspects regarding elementary particles. (See figure 1.)

Table 13: Known and proposed elementary particles (with SM correlating with known; with PM denoting proposed; with (Di) denoting the seven-word phrase if the particles model as Dirac fermions; with (Ma) denoting the seven-word phrase if the particles model as Majorana fermions; and with TBD denoting to be determined)

Description	Sub-family	Spin	Models as free or entangled	Mass	Number of zero-charge particles (includes anti-particles)	Number of charged particles (includes anti-particles)	Number of modes	Status: Standard Model or (if not SM) proposed modeling
Higgs boson	0H	0	Free	>0	1	0	-	SM
Aye	0I	0	Entangled	0	1	0	-	PM
Charged leptons	1C	1/2	Free	>0	0	6	-	SM
Neutrinos	1N	1/2	Free	>0	6(Di) or 3(Ma)	0	-	SM
Quarks	1Q	1/2	Entangled	>0	0	12	-	SM
Arcs	1R	1/2	Entangled	>0	6(Di) or 3(Ma)	0	-	PM
Weak interaction bosons	2W	1	Free	>0	1	2	-	SM
Jays	2J	1	Entangled	0	3	0	-	PM
Gluons	2U	1	Entangled	0	8	0	-	SM
Photon	2G	1	Free	0	-	-	2	SM
Graviton	4G	2	Free	0	-	-	2	PM
TBD	6G	3	Free	0	-	-	2	PM
TBD	8G	4	Free	0	-	-	2	PM

Discussion related to table 25 provides details about proposed modeling regarding dark matter. Table 26 alludes to data - related to dark matter - that proposed modeling seems to explain. (For more details, see table 33.) Elsewhere, we depict some aspects regarding dark matter and ordinary matter. (See figure 2.)

2.2.1. Elementary particles

Table 14 and table 15 preview, list, and discuss elementary particles to which proposed modeling points. (Perhaps, compare with table 13.)

Table 14 alludes to all known elementary particles and to elementary particles that our work suggests. (Table 15b shows names - widely used for known particles and suggested for suggested particles - that correlate with the symbol Φ in the table 14a column labeled $\Sigma\Phi$.) Each known elementary particle correlates with the elementary particle Standard Model. Each other (or, suggested) elementary particle does not correlate with the Standard Model. Table 14a comports with double-entry bookkeeping. Placement of some information in table 14a does not correlate with the placement of similar information in the UMS table 10b and the UMS table 11b. For example, table 14a splits - between DT aspects and DS aspects - information correlating with conservation of fermion generation. (The letter D denotes the word display.) Table 14b discusses some aspects of table 14a. Table 14c defines symbols for some possibilities regarding conservation of some properties of an elementary fermion, from before to after an interaction with an elementary boson. This essay uses the symbols to describe aspects that correlate with elementary bosons.

Table 15 provides details regarding table 14.

For each item in table 14a for which there is at least one j for which $n_{DSAj} = 0$, equation (38) pertains.

$$2S = \max(j | n_{DSAj} = 0) \tag{38}$$

We now develop table 14 by extending work regarding photons and G-family solutions. (See, for example, table 1.)

We discuss proposed modeling PFS models for the weak interaction bosons.

Each of the Z and W bosons has nonzero mass. Three spin states can pertain. Regarding KMS modeling, equations (39) and (40) pertain. The PFS equation (41) pertains.

Table 14: Subfamilies of elementary particles

(a) Representations (with DT denoting DTA; and with DS denoting DSA)

DT 4	DT 3	DT 2	DT 1	DT 0	DS 0	DS 1	DS 2	DS 3	DS 4	$\Sigma\Phi$	Numb-P/M	Notes
		0	0	0	0	0	0			2W	3-P	SCEFG
		−1	0	0	0	0	−1			1C	6-P	3 gen
	−1	−1	0	0	0	0	−1	−1		$1Q^{\pm 2/3}$	6-P	3 gen, 3 col ch
	−1	−1	0	0	0	0	−1	−1		$1Q^{\pm 1/3}$	6-P	3 gen, 3 col ch
		−1	−1	0	0	−1	−1			0H	1-P	CEFG, CEFCC
		0	0	−1	−1	0	0			2J	3-P	SCEFG
		−1	−1	0	−1	0	−1			1N	6-P(Di) or 3-P(Ma)	3 gen
	0	−1	−1	−1	−1	0	−1	−1		1R	6-P(Di) or 3-P(Ma)	3 gen, 3 col ch
		−1	−1	−1	−1	−1	−1			0I	1-P	CEFG, CEFCC
		−1	−1	−1	−1	−1	−1			2U	8-P	CEFG
		−1	−1	0	−1	0	0	−1	−1	2G	2-M	CEFG, CEFCC
		−1	−1	0	−1	−1	−1	0	0	4G	2-M	CEFM, CEFCC
−1	−1	−1	−1	0	−1	…	…	…	…	6G	2-M	CEFM, CEFCC
…	…	…	…	0	−1	…	…	…	…	8G	2-M	CEFM, CEFCC

(b) Notes

Aspect	Note
Numb-P/M	The column labeled Numb-P/N shows a number (#-P) of particles (including antiparticles) or a number (#-M) of modes.
6-P(Di) or 3-P(Ma)	Six pertains to the extent that the particles model as Dirac fermions. Three pertains to the extent that the particles model as Majorana fermions.
3 gen	The two-element item 3 gen denotes three generations.
3 col ch	The three-element item 3 col ch denotes three color charges.
6G	The value −1 pertains for each of $DSA1$, $DSA2$, $DSA3$, and $DSA4$. The value 0 pertains for each of $DSA5$ and $DSA6$.
8G	The value −1 pertains for each of $DTA6$ through $DTA1$ and for each of $DSA1$ through $DSA6$. The value 0 pertains for each of $DSA7$ and $DSA8$.

(c) Possibilities regarding conservation of some properties of an elementary fermion, from before to after an interaction with an elementary boson

Symbol	Note
CEFG	The symbol denotes conservation of elementary fermion generation. CEFG pertains (at least) regarding isolated interactions between weak interaction bosons and elementary fermions. For example, for an incoming electron (which is a generation one charged lepton) and an incoming W^+ boson, the outgoing neutrino correlates with the same generation - one - as does the incoming charged lepton.
SCEFG	The symbol denotes somewhat conservation of elementary fermion generation, which pertains regarding (at least) interactions (in hadrons) between W bosons and quarks.
CEFM	The symbol denotes conservation of elementary fermion (rest) mass. This notion is similar to conservation of elementary fermion generation, but with an exception if the after-interaction fermion has the same mass as has the before-interaction fermion. (Compare with CEFG and with SCEFG.)
CEFCC	The symbol denotes conservation of elementary fermion color charge. Interactions between gluons and quarks do not necessarily exhibit CEFCC.

Table 15: Details regarding a table alluding to known and suggested elementary particles

(a) Definitions and explanations

Aspect (↓). Family (→).	H	I	C	Q	N	R	W	J	U	G
Number of subfamilies	1	1	1	1	1	1	1	1	1	4
Subfamily	0H	0I	1C	1Q	1N	1R	2W	2J	2U	ΣG
Σ (=2S, S=spin/$\hbar$)	0	0	1	1	1	1	2	2	2	Σ
Genera per subfamily	1	1	3	6	3	3	1	1	1	1
Particles per genus (if Dirac ↔ N and R)	1	1	2	2	2	2	3	3	8	-
Particles per genus (if Majorana ↔ N and R)	1	1	2	2	1	1	3	3	8	-
Modes per genus	-	-	-	-	-	-	-	-	-	2
Mass (bosons) : 0	>	=	-	-	-	-	>	=	=	=
Charge (fermions) : 0	-	-	>	>	=	=	-	-	-	-
Nonzero charge (N - none, S - some, A - all)	N	N	A	A	N	N	S	N	N	N
Always models as entangled (Y - yes, N - no)	N	Y	N	Y	N	Y	N	Y	Y	N
Span	1	1	1	1	1	1	1	1	1	(6)

(b) Notes

Item	Note
H	Higgs boson
I	Aye (or, inflaton) - zero-mass analog to the Higgs boson; might have a role during the inflationary epoch
C	Charged leptons
Q	Quarks
N	Neutrinos
R	Arcs - zero-charge analogs to quarks; might be components of (dark matter) hadron-like particles
W	Weak-interaction bosons (Z and W)
J	Jays - zero-mass spin-one bosons; might have a role before inflation; might correlate with the Pauli exclusion force
U	Gluons
G	Photon, graviton, ... - long-range forces
ΣG	Σ=2 (photon), Σ = 4 (graviton), Σ = 6, Σ = 8
Genera for C	Three equals one (magnitude of charge) times three (generations)
Genera for Q	Six equals two (magnitudes of charge) times three (generations)
Genera for N	Three equals one (magnitude of charge) times three (generations)
Genera for R	Three equals one (magnitude of charge) times three (generations)
Particles	Number (for other than U and G) includes antiparticles
Dirac ↔ N and R	Denotes that N and R particles model as Dirac fermions
Majorana ↔ N and R	Denotes that N and R particles model as Majorana fermions
-	Denotes not relevant
Charges re W	The W boson has nonzero charge; the Z boson has zero charge
Entangled	Models as part of a multicomponent system that entangles its component particles
Span	Refers to facilitating interactions between isomers
Isomer	An isomer contains a near-copy of the set of all non-G-family elementary particles
Span	Six pertains - regarding some models for dark matter - for (some ΣGΓ - that comport with the notion of Σγ - correlating with) 2G, 4G, and 6G

$$n_{KSA0} = 0 \tag{39}$$

$$n_{KSA1} = 0,\ n_{KSA2} = 0 \tag{40}$$

$$n_{PSA0} = 0,\ n_{PSA1} = 0,\ n_{PSA2} = 0 \tag{41}$$

Double-entry bookkeeping suggests that equation (42) pertains. Here, n_{PTA2} can correlate with the W$^+$ boson and with positive charge. Here, n_{PTA1} can correlate with the W$^-$ boson and with negative charge. (Alternatively, one might reverse the roles of $PTA2$ and $PTA1$.) Here, n_{PTA0} correlates with the Z boson and with zero charge.

$$\{PTAj\} = \{PTA2, PTA1, PTA0\} \tag{42}$$

We extend, from work regarding 2G, the use of $PSA1$ and $PSA2$. We correlate $PSA1$ with left circular polarization. We correlate $PSA2$ with right circular polarization. Also, $PSA0$ correlates with longitudinal polarization. Equation (43) pertains for ground states.

$$n_{PTA0} = 0,\ n_{PTA1} = 0,\ n_{PTA2} = 0 \tag{43}$$

We discuss a thought experiment that correlates with the ongoing modeling notion of an excitation of one W$^-$ boson during an interaction that converts an electron into a neutrino. Proposed modeling suggests modeling in which - for the W boson - the $PTA1$ oscillator excites by one unit and one of the three $PSAj$ oscillators excites by one unit. The four other oscillators do not excite. One pair from those four oscillators correlates with an $SU(2)$ symmetry that correlates with CEFG (or, conservation of elementary fermion generation). The other pair from those four oscillators correlates with an $SU(2)$ symmetry that would, for interactions involving quarks, correlate with CEFCC (or, conservation of elementary fermion color charge).

We discuss a thought experiment that correlates with ongoing modeling notions of CP violation within a hadron. Ongoing modeling considers the production of two virtual W bosons. Exciting once each of a W$^+$ and a W$^-$ correlates - regarding proposed modeling PFS models - with a PTA factor of one (or, $(1+0)^{1/2} \cdot (1+0)^{1/2}$). (See equation (2).) Raising one $PSAj$ by two units would produce a factor of $2^{1/2}$ (or $(1+0)^{1/2} \cdot (1+1)^{1/2}$). The mismatch between one and $2^{1/2}$ violates double-entry bookkeeping. Double-entry bookkeeping suggests that the PSA result should feature - for some $j \neq k$ - $n_{PSAj} = 1$ and $n_{PSAk} = 1$. We let l denote the one integer that satisfies $0 \leq l \leq 2$, $l \neq j$, and $l \neq k$. Only $PTA0$ and $PSAl$ remain relevant regarding relevant symmetries. Proposed modeling correlates $PTA0$ and $PSAl$ with an $SU(2)$ symmetry and with CEFCC. Here, CEFG does not pertain.

Overall, for interactions involving W bosons, SCEFG pertains.

Regarding table 14 and the above discussion regarding the 2W subfamily, the substitutions - for $0 \leq j \leq 2$ - that equation (44) shows pertain. (Here, the notation $a \leftarrow b$ denotes the nine-element phrase a before the substitution becomes b after the substitution.)

$$PTAj \leftarrow DTAj \text{ and } PSAj \leftarrow DSAj \tag{44}$$

We discuss proposed modeling PFS models for charged leptons.

PFS models for charged leptons reflect PFS models for weak interaction bosons. An electron has negative charge. Modeling uses $n_{PTA2} = -1$ and $n_{PTA1} = 0$. Regarding one of the two possible spin states, $n_{PSA1} = 0$, and $n_{PSA2} = -1$. The $PTA2$-and-$PSA2$ oscillator pair correlates with an $SU(2)$ symmetry. The three generators of $SU(2)$ correlate with three generations. Regarding the other one of the two possible spin states, $n_{PSA1} = -1$, and $n_{PSA2} = 0$. The $PTA2$-and-$PSA1$ oscillator pair correlates with an $SU(2)$ symmetry. The three generators of $SU(2)$ correlate with three generations. This modeling correlates with the electron, muon, and tauon. A swap featuring $n_{PTA2} \leftrightarrow n_{PTA1}$ leads to a representation for the three respective antiparticles.

With respect to equation (44), table 14 directly depicts the case for which $n_{PTA1} = 0$ (or, the charged leptons have negative charges) and $n_{PSA1} = 0$.

We discuss proposed modeling PFS models for quarks.

Compared to modeling for charged leptons, modeling for quarks adds $PTA3$-and-$PSA3$ information correlating with the $DTA3$-and-$DSA3$ oscillator pair in table 14a. This pair correlates with an $SU(2)$ symmetry and three generators. The three generators correlate with three color charges. These notions

Table 16: Some correlations between G-family elementary particles and some properties of objects

ΣG	Property of the object
2G	Charge
4G	Passive gravitational energy (or, equivalently, passive gravitational mass)
6G	Freeable passive gravitational energy
8G	Spin (or, S - as in $S(S+1)\hbar^2$)

correlate with quarks for which the magnitude of charge is two-thirds of the charge of a positron. The same notions correlate with quarks for which the magnitude of charge is one-third of the charge of a positron. For each magnitude of charge, swapping n_{PTA1} and n_{PTA2} correlates with changing the sign of charge.

We discuss proposed modeling PFS models for the Higgs boson.

Ongoing modeling for the Higgs boson correlates with the set $\{KSAj\}$ having one member - $KSA0$. Longitudinal polarization and nonzero mass pertain. Circular polarization does not pertain.

Proposed modeling PFS models start from just the oscillator pair $PTA0$-and-$PSA0$. One can add two PTA oscillators and two PSA oscillators and set each of the corresponding four $n_{P\_A\_}$ to minus one, thereby, expressing a notion of CEFG (or, conservation of elementary fermion generation) and a notion of CEFCC (or, conservation of elementary fermion color charge). Here, CEFG contrasts with SCEFG for W bosons. For W bosons, the word somewhat (in SCEFG) pertains regarding entangled excitations that feature two different particles - the W^- and the W^+. (See discussion related to equation (43).) For Higgs bosons, there is only one relevant particle and only one relevant polarization. CEFG pertains.

Regarding table 14a, equation (44) pertains.

We discuss proposed modeling PFS models for $n_{DSA0} = -1$ analogs to the $n_{DSA0} = 0$ elementary particles to which table 14a alludes.

For this discussion, use of concepts regarding $DTAj$ and $DSAj$ suffices. We note, for example, that $n_{PTA0} = n_{DTA0}$.

The three 2J (or, jay) particles are spin-one zero-mass analogs to the one Z and two W bosons. SCEFG pertains.

The 1N (or, neutrino) particles are spin-one-half zero-charge somewhat analogs to the six charged leptons. Here, $n_{DTA2} = n_{DTA1} = -1$ correlates with zero-charge. This essay does not recommend extents to which neutrinos model as Dirac fermions and as Majorana fermions. The case of Dirac fermions correlates with six neutrinos. The case of Majorana correlates with three neutrinos, with each neutrino being its own antiparticle.

The 1R (or, arc) particles are spin-one-half zero-charge somewhat analogs to quarks. This essay does not recommend extents to which arcs model as Dirac fermions and as Majorana fermions. The case of Dirac fermions correlates with six arcs. The case of Majorana correlates with three arcs, with each arc being its own antiparticle.

The one 0I (or, aye) particle is a spin-zero zero-mass zero-charge analog to the Higgs boson.

The eight 2U (or, gluon) particles have spin one, zero mass, and no charge. Here, three DTA oscillators correlate with three color charges.

For each of 2J, 0I, and 2U, a KMS notion that correlates with equation (45) pertains. Individual bosons would not excite in the absence of entanglement with other aspects of nature.

$$n_{DTA0} = -1 \tag{45}$$

We discuss proposed modeling PFS models for G-family elementary particles.

Table 16 correlates G-family elementary particles with some properties of objects. An interaction between a G-family elementary particle and an object might - in effect - measure the property of the object. For an interaction that does not change the object, the interaction does not change the property. (Regarding an interaction that ionizes an atom, modeling generally correlates with not leaving the atom intact.) Table 16 correlates with and extends aspects of table 10. (Some previous aspects of this essay correlate $USA\_$ aspects with specific elements λ of lists Γ and not necessarily with specific ΣG. Perhaps, see table 10.)

For the two 2G modes, table 14a adds - compared to table 1 - two DT oscillators and two DS oscillators. We are not aware of any evidence that photons correlate with other than CEFG and CEFCC. Proposed modeling correlates the four added oscillators with CEFG and CEFCC.

Proposed modeling suggests that 4G correlates with ongoing modeling classical physics notions of gravity. Proposed modeling suggests that 4G correlates with ongoing modeling quantum physics notions of a would-be graviton. (Note equation (38).) Oscillator $PSA3$ correlates with left circular polarization and spin two. (See table 14a.) Oscillator $PSA4$ correlates with right circular polarization and spin two. Oscillators $PSA1$ and $PSA2$ do not participate. The DS representation that table 14a shows for 4G suggests that CEFM and CEFCC pertain.

Proposed modeling suggests that 6G correlates with CEFM. (See discussion related to table 16.) One might also consider the notion that, in effect, 6G inherits CEFM from 4G. Compared to information - in table 14a - regarding 4G, additional instances of $n\_{A}\_$ pertain for 6G. For 6G, $n_{DSA3} = n_{DSA4} = -1$. The corresponding $SU(2)$ symmetry correlates with three generators. The three generators correlate with three generations of elementary fermions. Strengths of interactions correlating with 6G468 can vary based on elementary fermion generation. The representation that table 14a shows for 6G suggests that CEFM and CEFCC pertain.

Proposed modeling suggests that 8G correlates with CEFM. (See discussion related to table 16.) Compared to information - in table 14a - regarding 6G, additional instances of $n\_{A}\_$ pertain for 8G. For 8G, $n_{DSA5} = n_{DSA6} = -1$. The corresponding $SU(2)$ symmetry correlates with three spatial axes. Strengths of interactions correlating with 8G2468a or with 8G2468b can vary based on elementary fermion generation and based on spatial orientation of elementary fermion spin. The representation that table 14a shows for 8G suggests that CEFM and CEFCC pertain.

Ongoing modeling interprets data as suggesting that at least one difference exists among the three neutrino masses. Proposed modeling suggests that the three neutrino masses are equal to each other. (See table 21.) Proposed modeling suggests that (perhaps virtual) interactions mediated by one or more of 6G468, 8G2468a, and 8G2468b lead to effects that ongoing modeling interprets as implying a lack of equality among the three neutrino masses. (See discussion related to equation (79).)

Table 17 summarizes information regarding spans for simple particles, for hadron-like particles, and for some components of long-range forces. The table summarizes information regarding types of objects with which boson simple particles and some long-range force components interact. The table separates, based on a proposed modeling view, elementary particle Standard Model aspects from aspects that the elementary particle Standard Model does not embrace. The symbol 1Q⊗2U correlates with known and possible hadrons. (See discussion regarding equation (103).) The symbol 1R⊗2U correlates with possible hadron-like particles. (See discussion regarding equation (104).) Regarding the PR6ISP case, the pairings of isomers that isomers of 4G48 span might not equal the pairings of isomers that isomers of 2G68 span. The symbols :4G and :2G correlate with this possible mismatch regarding pairings. Table 17 shows the extent to which each of the simple bosons and some of the long-range force components interacts directly with each of at least some simple fermions and with each of at least some multicomponent objects. The word yes denotes that interactions occur. The word no denotes that interactions do not occur. Proposed modeling suggests the possibility that neither the 0H boson nor the 0I boson interacts directly with multicomponent objects. Proposed modeling suggests that G-family solutions for which the GTA symmetry is $SU(5)$ or $SU(7)$ do not correlate with direct interactions with simple fermions. (See discussion related to table 8.) Table 17d summarizes some concepts relevant to tables 17a and 17c.

Equation (46) shows notation for denoting the span, s, for an elementary particle or for a component of a long-range force.

$$\Sigma(\mathrm{s})\Phi \quad \text{or} \quad \Sigma(\mathrm{s})\Phi\Gamma \tag{46}$$

Table 18 shows the span for each component of G-family forces for which λ does not exceed eight and Σ does not exceed eight. (This essay de-emphasizes discussing the possible relevance - to G-family physics - of ΣG for which $\Sigma \geq 10$.) The table pertains for PR6ISP modeling. Rows in table 18a list $\Sigma\gamma$ components. Table 18a lists 2(6)G248 and does not list 2(1)G248. Rows in table 18b list G-family force components that do not correlate with $\Sigma\gamma$.

We discuss concepts regarding the 2(2)G68 solution and regarding interactions between dark matter and ordinary matter. Here, we assume that PR6ISP modeling comports with nature.

Elsewhere, we posit that 2(2)G68 correlates with some electromagnetic (or, $\Sigma = 2$) interactions with atoms and other objects. (See discussion regarding table 8.) We posit that those interactions include so-called hyperfine interactions.

Each of 2(1)G2 and 2(1)G24 correlates with some electromagnetic (or, $\Sigma = 2$) interactions with atoms and other objects that include both baryons and leptons.

Unlike for the cases of electromagnetic interactions that correlate with 2(1)G2 and 2(1)G24, 2G produced by ordinary matter objects interacts with non-ordinary-matter dark matter objects (for the case in which PR6ISP pertains to nature) via 2(2)G68. Unlike for the cases of electromagnetic interactions

Table 17: Particles and solutions that correlate with one isomer and particles and solutions that might correlate with more than one isomer; plus, the extent to which simple bosons and some long-range force components interact with simple fermions and with multicomponent objects (with the symbol 1f+1b→1f+1b denoting interactions for which one elementary fermion and one elementary boson enter and for which one elementary fermion and one elementary boson exit; and with the symbol MCO denoting multicomponent objects)

(a) Particles and solutions, other than G-family components that are not $\Sigma\gamma$ components (with symbols of the form (†_) denoting possible choices that table 17b discusses)

Standard Model entities	Possible entities	PR1ISP span	PR6ISP span	1b interactions: 1f+1b→1f+1b	1b interactions with MCO
0H	0I	1	1	Yes - CEFG	No
1C	-	1	1	-	-
1N	-	1	1	-	-
1Q	1R	1	1	-	-
2U	-	1	1	Yes - CEFG	No
2W	-	1	1	Yes - SCEFG	No
-	2J	1	1	Yes - SCEFG	Yes
1Q⊗2U	1R⊗2U	1	1	-	-
2G2	-	1	1	Yes - CEFG	Yes
2G24	-	1	1	Yes - CEFG	Yes
2G248	-	1	6	Yes - CEFG	Yes
-	4G4	1	6	Yes - CEFM	Yes
-	4G48	1	2(:4G)	Yes - CEFM	Yes
-	4G246	1	1	Yes - CEFM	Yes
-	4G246⟦16⟧	1	(†1)	Yes - CEFM	Yes
-	4G2468a	1	1	Yes - CEFM	Yes
-	4G2468b	1	1	Yes - CEFM	Yes
-	4G2468⟦16⟧	1	(†2)	Yes - CEFM	Yes
-	6G6	1	1	No	Yes
-	6G468	1	1	Yes - CEFM	Yes
-	8G8	1	1	No	Yes
-	8G2468a	1	1	Yes - CEFM	Yes
-	8G2468b	1	1	Yes - CEFM	Yes

(b) Notes regarding some unresolved choices regarding two spans

Note
• Six equals 288/48, which equals $g_{SU(17)}/g_{(SU(7)}$.
• (†1): One or six. For PR36ISP modeling, might be one, might be six, or might be 36.
• (†2): Six. (See discussion related to equation (110).) For PR36ISP modeling, might be six or might be 36. (Discussion related to equation (110) suggests that 36 pertains.)
• For PR36ISP modeling, 4G246⟦16⟧ and 4G2468⟦16⟧ are the only $\Sigma\gamma$ solutions that might intermediate direct interactions between all 36 isomers.

(c) Selected G-family component that is not a $\Sigma\gamma$ component

Standard Model entities	Possible entities	PR1ISP span	PR6ISP span	1b interactions: 1f+1b→1f+1b	1b interactions with MCO
-	2G68	1	2(:2G)	No	Yes

(d) Notes regarding the case PR6ISP

Note
• For one of $4G\Gamma_4$ with a span of two and $2G\Gamma_2$ with a span of two (and for a numbering system that numbers isomers using the integers zero through five), the pairings 0-and-3, 1-and-4, and 2-and-5 might pertain. For the other one of the two ($4G\Gamma_4$ and $2G\Gamma_2$), different pairings might pertain. (Note the notation :4G and the notation :2G.)

Table 18: A catalog of components of G-family forces for which $\Sigma \leq 8$ and λ does not exceed eight

(a) G-family force components for which $\Sigma \in \Gamma$, $\Sigma \leq 8$, and λ does not exceed eight (with r^{-k} correlating with KMS modeling RSDF)

$\Sigma \in \Gamma$	S	GCS monopole	GCS dipole	GCS quadrupole	GCS octupole
Yes	1	2(1)G2 (r^{-2})	2(1)G24 (r^{-3})	2(6)G248 (r^{-3})	
Yes	2	4(6)G4 (r^{-2})	4(2)G48 (r^{-3})	4(1)G246 (r^{-4})	4(1)G2468a (r^{-5})
Yes	2				4(1)G2468b (r^{-5})
Yes	3	6(2)G6 (r^{-2})		6(6)G468 (r^{-3})	
Yes	4	8(1)G8 (r^{-2})			8(1)G2468a (r^{-4})
Yes	4				8(1)G2468b (r^{-4})

(b) G-family force components for which $\Sigma \notin \Gamma$, $\Sigma \leq 8$, and λ does not exceed eight

$\Sigma \in \Gamma$	S	GCS monopole	GCS dipole	GCS quadrupole	GCS octupole
No	1		2(6)G46	2(6)G468	
No	1		2(2)G68		
No	2		4(6)G26	4(6)G268	
No	3		6(1)G24	6(6)G248	
No	3		6(2)G28		
No	4		8(6)G26	8(1)G246	

that correlate with 2(1)G2 and 2(1)G24, 2G produced by some dark matter objects (for the case in which PR6ISP pertains to nature) interacts with ordinary matter via 2(2)G68.

We discuss other aspects that correlate with table 6a and table 8.

Table 8 does not point to a G-family solution that would correlate with an interaction with nonzero magnetic monopole moment. To the extent that proposed modeling adequately comports with nature, nature does not exhibit magnetic monopole elementary particles.

Table 8 does not point to a G-family solution that would correlate with a nonzero electric dipole moment for an object that does not feature - within the object - non-uniformity of charge. To the extent that an elementary particle models - with respect to KMS modeling - as having zero size, proposed modeling PFS modeling seems to suggest that the particle has zero electric dipole moment.

2.2.2. Properties of elementary bosons

We discuss the masses of elementary bosons.

We suggest that equation (47) comports with current data. (For data, see reference [1].) The most accurately known of the masses is the mass of the Z boson. We use the nominal mass of the Z boson as a base for calculations. Regarding the Higgs and W bosons, the larger deviation from equation (47) correlates with the 9 : 7 ratio. Equation (47) suggests a W boson mass that is about 3.4 standard deviations high with respect to the measured mass of the W boson.

$$(m_{\text{Higgs boson}})^2 : (m_Z)^2 : (m_W)^2 \;::\; 17 : 9 : 7 \quad (47)$$

Discussion regarding table 4 alludes to 0GΓ solutions. Within the constraints of $\Gamma \neq \emptyset$ and $\lambda \leq 8$, there are three 0GΓ solutions - 0G2468, 0G246, and 0G268. Removing the constraint of $\Gamma \neq \emptyset$ admits the 0G∅ solution. For each of the four solutions, we define j_λ to be the number of λ elements in Γ.

For the weak-interaction bosons, people determine the three properties mass, spin, and charge.

Regarding table 10b, we posit that the number $(j_\lambda)^2 + 1$ correlates with a so-called $USA0$ aspect. (This essay does not explore the extent to which the $USA0$ aspect correlates with oscillator $USA0$.) Passive gravitational energy correlates with a $USA4$ aspect. The freeable energy zero correlates with a $USA6$ aspect. We posit that the $USA6$ aspect is zero. The spin correlates with a $USA8$ aspect. We posit that the $USA8$ aspect is zero for spin zero and one for spin one. Charge correlates with a $USA16$ aspect. We posit that the $USA16$ aspect is zero for no charge and two for a magnitude of charge that equals the charge of the electron. (See table 10. Charge also correlates with a $USA2$ aspect. For purposes of discussion, this essay considers here that the two-word term $USA16$ aspect includes the $USA2$ aspect.) We posit that aspects correlating with $USA6$, $USA10$, $USA12$, and $USA14$ do not have relevance regarding the masses of elementary bosons.

Equation (48) pertains for the 0H, 2W, and 2J bosons. Equation (49) follows from equation (48).

Table 19: Some relationships among all elementary bosons to which table 17a alludes

(a) Relationships between non-G-family elementary bosons and GCS items for which $\Sigma = 0$

0GΓ	j_λ (for $[\![16]\!] \notin \Gamma$)	j_λ (for $[\![16]\!] \in \Gamma$)	$USA4$ aspect	$USA0$ aspect	$USA8$ aspect	$USA16$ aspect	Bosons	n_{xTA0}
0G2468	4	-	17	17	0	0	0H (or, Higgs)	+1
0G246 or 0G268	3	-	9	10	1	0	2W: Z	+1
0G268 or 0G246	3	-	7	10	1	2	2W: W	+1
0G∅	0	-	0	1	1	0	2J	−1
0G2468$[\![16]\!]$	-	i	0	0	0	0	0I	−1
0G268$[\![16]\!]$	-	0	0	1	1	0	2U	−1

(b) Notes regarding table 19a

Note
• In table 19a, i denotes a square root of minus one.
• For $[\![16]\!] \notin \Gamma$, the integer j_λ denotes the number of integers λ that appear in the Γ that correlates with 0GΓ.
• Except regarding the column with the two-element label $USA4$ aspect, each integer in the columns labeled with the expression of the form $USA\Sigma$ aspect satisfies - for some k in the set $\{i$, 0, 1, 2, 3, or $4\}$ - the expression $k^2 + 1$.
• This essay does not fully address the topic of which of 0G246 and 0G268 correlates with the Z boson. (The other of 0G246 and 0G268 correlates with the W boson.)
• Regarding table 19a and table 10, the following sentences pertain. The notion of $USA4$ aspect correlates with passive gravitational energy. The notion of $USA6$ aspect correlates with freeable energy and, nominally, for each row in the table the value of zero pertains. The notion of $USA8$ aspect correlates with angular momentum. An aspect correlating with momentum is not appropriate for the purposes of table 19a. The notion of $USA16$ aspect correlates with charge. Table 10 contains no other items that correlate with $SU(4)$ symmetry.

$$(USA0 \text{ aspect}) \approx (USA4 \text{ aspect}) - (USA8 \text{ aspect}) - (USA16 \text{ aspect}) \tag{48}$$

$$m^2 \propto (USA4 \text{ aspect}) = (USA0 \text{ aspect}) - (USA8 \text{ aspect}) - (USA16 \text{ aspect}) \tag{49}$$

Table 19 shows modeling that interrelates all elementary bosons to which table 17a alludes. The first three rows of table 19a correlate with equation (47) and equation (49). The first four rows of table 19a use equation (49). Each G-family boson has representation in (table 19a) via a corresponding $USA\Sigma$ aspect. (See table 16 and note that this essay considers here that the two-word term $USA16$ aspect includes the $USA2$ aspect. Regarding the $USA6$ aspect, see table 19b.) The ordering of the columns (in table 19a) correlating with $USA\Sigma$ aspects correlates with the ordering of terms in equation (49). The one 0I boson represents a zero-mass correlation to the one 0H boson. (Compare with table 9.) The eight 2U bosons represent zero-mass correlations to the two weak interaction bosons.

Table 19 correlates with a notion that G-family solutions might point to all elementary bosons and, thus perhaps, to the notion that table 14a points to all elementary particles.

Elsewhere, we speculate regarding a possible correlation between the $USA16$ aspect and magnetic moment. (See discussion related to equation (130).)

2.2.3. *Properties of elementary fermions*

We discuss formulas that - based on the accuracy of measured quantities - predict a tauon mass that is consistent with and would be more accurate than the measured tauon mass.

Equation (50) shows an experimental result for the tauon mass, m_τ. (See reference [1].)

$$m_{\tau,\text{ experimental}} \approx 1776.86 \pm 0.12 \text{ MeV}/c^2 \tag{50}$$

Table 20: Approximate rest energies (in MeV) for quarks and charged leptons

		M'	3	2	1
		Charge	$-1 \cdot \lvert q_e \rvert$	$+(2/3) \cdot \lvert q_e \rvert$	$-(1/3) \cdot \lvert q_e \rvert$
M''	Legend				
0	name		electron	up	down
0	data		$(0.511 \text{ to } 0.511)\times 10^0$	$(1.8 \text{ to } 2.7)\times 10^0$	$(4.4 \text{ to } 5.2)\times 10^0$
0	calculation		$m_e c^2 \approx 0.511\times 10^0$	$m_u c^2 \approx 2.2\times 10^0$	$m_d c^2 \approx 4.8\times 10^0$
1	name			charm	strange
1	data			$(1.24 \text{ to } 1.30)\times 10^3$	$(0.92 \text{ to } 1.04)\times 10^2$
1	calculation			$m_c c^2 \approx 1.263\times 10^3$	$m_s c^2 \approx 0.938\times 10^2$
2	name		muon	top	bottom
2	data		$(1.06 \text{ to } 1.06)\times 10^2$	$(1.56 \text{ to } 1.74)\times 10^5$	$(4.15 \text{ to } 4.22)\times 10^3$
2	calculation		$m_\mu c^2 \approx 1.06\times 10^2$	$m_t c^2 \approx 1.72\times 10^5$	$m_b c^2 \approx 4.18\times 10^3$
3	name		tauon		
3	data		$(1.777 \text{ to } 1.777)\times 10^3$		
3	calculation		$m_\tau c^2 \approx 1.777\times 10^3$		

Equation (51) defines the symbol β'. Equation (52) defines β. Here, m denotes mass, e denotes electron, q denotes charge, ε_0 denotes the vacuum permittivity, and G_N denotes the gravitational constant. Equation (53) possibly pertains. Equation (53) predicts a tauon mass, which equation (54) shows. (For relevant data, see reference [1].) Eight standard deviations fit within one experimental standard deviation of the nominal experimental result. Equation (55) shows an approximate value of β that we calculate, using data that reference [1] shows, via equation (52).

$$\beta' = m_\tau / m_e \tag{51}$$

$$(4/3) \times \beta^{12} = ((q_e)^2/(4\pi\varepsilon_0))/(G_N (m_e)^2) \tag{52}$$

$$\beta' = \beta \tag{53}$$

$$m_{\tau,\text{ calculated}} \approx 1776.8400 \pm 0.0115 \text{ MeV}/c^2 \tag{54}$$

$$\beta \approx 3477.1891 \pm 0.0226 \tag{55}$$

We discuss formulas that - based on the accuracy of measured quantities - fit the masses of the six quarks and three charged leptons.

Table 20 shows, regarding the rest energies of quarks and charged leptons, data that people report and numbers that we calculate via equation (58). Below, we discuss the table and the data before we discuss the equation and the calculations. Equation (58) results from fitting data. This essay does not show modeling that would generate equation (58).

The data in table 20 reflect information from reference [1]. For each particle other than the top quark, reference [1] provides one estimate. For the top quark, reference [1] provides estimates correlating with each of three bases. For each quark, table 20 shows a data range that runs from one standard deviation below the minimum nominal value that reference [1] shows to one standard deviation above the maximum nominal value that reference [1] shows. Each standard deviation correlates with the reported standard deviation that correlates with the nominal value. For charged leptons (that is, for $M' = 3$), the table does not completely specify accuracy regarding ranges.

The following concepts pertain regarding developing equation (58). Use of modular arithmetic in equation (60) anticipates uses of equation (58) that pertain to neutrino masses and that pertain regarding inferences about dark matter. The notion of $M'' = 3/2$ correlates with modeling. (No elementary particle correlates with $M'' = 3/2$.) Regarding equations (62) and (63), uses of $M' = 0$ anticipate uses of equation (58) that pertain to arc masses. Equation (56) produces a meaningful value for $m(3,1)$. (No elementary particle correlates with $M'' = 3$ and $M' = 1$.) For each $0 \leq M'' \leq 3$, equation (57) produces a meaningful value of $m(M'', 3/2)$. (No elementary particle correlates with $M' = 3/2$. The notion of $M' = 3/2$ correlates with the average of $M' = 2$ and $M' = 1$ and correlates with equation (57). Aspects of equations (58), (62), and (63) correlate with the concept that $m(M'', 3/2)$ values have meaning. The concepts of $M' = 3/2$ and $m(M'', 3/2)$ are useful mathematically, though not necessarily directly relevant to physics.) Within each cluster of rows - in table 20 - for which $M'' \neq 3$, the fine-structure constant plays a role regarding linking the masses that pertain for that cluster of rows. (Aspects of equation (58) comport with this role.) Regarding equations (64), (65), and (66), we choose values that fit data. Regarding each charged lepton, our calculations fit data to more significant figures than the numbers in table 20 show.

$$m(3,1)m(3,2) = m(3,0)m(3,3) \tag{56}$$

$$(m(M'', 3/2))^2 = m(M'', 2)m(M'', 1) \tag{57}$$

The following concepts pertain regarding developing and using equation (58). We use equation (52) to calculate β. Equation (58) calculates the same value of m_τ that equation (54) calculates.

Equation (58) shows a formula that approximately fits the masses of the six quarks and three charged leptons. The formula includes two integer variables and seven parameters. One integer variable, M'', correlates somewhat with generation. For the electron and each of the six quarks, the generation equals $M'' + 1$. For each of the muon and the tauon, the generation equals M''. The other integer variable, M', correlates with magnitude of charge. The seven parameters can be m_e, m_μ (or, the mass of a muon), β, α, $d'(0)$, $d'(1)$, and $d'(2)$. The symbol α denotes the fine-structure constant. (See equation (59).) Here, $d'(k)$ pertains regarding generation-$(k+1)$ quarks. For each generation, the number $d'(k)$ correlates with the extent to which the two relevant quark masses do not equal the geometric mean of the two quark masses. (See equation (57).) Regarding charged leptons, $M' = 3$, the term $g(M')$ is zero, and the factor - in equation (58) - that includes the fine-structure constant is one. (See equation (62).)

$$m(M'', M') = m_e \times (\beta^{1/3})^{M'' + (j^{''}_{M''}) d''} \times (\alpha^{-1/4})^{g(M') \cdot (1+M'') + j^{'}_{M'} d'(M'')} \tag{58}$$

$$\alpha = ((q_e)^2/(4\pi\varepsilon_0))/(\hbar c) \tag{59}$$

$$j^{''}_{M''} = 0, +1, 0, -1 \text{ for, respectively, } M'' \bmod 3 = 0, 1, 3/2, 2 \tag{60}$$

$$d'' = (2 - (\log(m_\mu/m_e)/\log(\beta^{1/3}))) \approx 3.840679 \times 10^{-2} \tag{61}$$

$$g(M') = 0, 3/2, 3/2, 3/2, 3/2, \text{ for, respectively, } M' = 3, 2, 3/2, 1, 0 \tag{62}$$

$$j^{'}_{M'} = 0, -1, 0, +1, +3 \text{ for, respectively, } M' = 3, 2, 3/2, 1, 0 \tag{63}$$

$$d'(0) \sim 0.318 \tag{64}$$

$$d'(1) \sim -1.057 \tag{65}$$

$$d'(2) \sim -1.5091 \tag{66}$$

$$m(1,3) \approx 8.59341 \text{MeV}/c^2 \tag{67}$$

We explore possibly useful variations and extensions regarding uses of equation (58).

Equations (68), (69), and (70) characterize a possible approach to re-estimating rest energies for the six quarks.

$$d'(0) \approx 0.264835 \tag{68}$$

$$d'(1) = -1 \tag{69}$$

$$d'(2) = -3/2 \tag{70}$$

The calculations yield new calculated rest energies for the six quarks. (See table 21.) Of the six quarks, the rest energies that one calculates via equation (58) differ from measured values (that reference [1] provides) by more than 1.2 units of estimated error for, at most, $m(1,2)$ or the charm quark and $m(2,2)$ or the top quark. (Our calculations use the estimated errors - regarding experimental data - that reference [1] provides.) For the charm quark, the calculated number differs from the experimental number by about 4.6 units of estimated error. For the top quark, the largest (of the three differences correlating with the three experimental interpretations) difference would be about 4.0 units of estimated error and one other difference would be about 0.6 units of estimated error.

To the extent that table 21 comports with nature, various straightforward equations interrelate the masses of elementary fermions. Equation (71) provides an example.

$$(m_s)^2 m_\mu = m_e m_\tau m_c \tag{71}$$

Equation (72) points to possibilities for estimating rest energies for arcs and neutrinos. Equations (73) and (74) would pertain.

$$m(M'',0) = m(M'',1) \cdot (m(M'',1)/m(M'',2)) \tag{72}$$

$$m(0,0) \approx m(1,0) = m(1,3) \tag{73}$$

$$m(2,0) = m(2,3) \tag{74}$$

To the extent that $m(0,0)$, $m(1,0)$, and $m(2,0)$ correlate with masses of arc particles, approximate rest energies (in MeV/c^2) for arcs are 8.593 for generation one, 8.593 for generation two, and 105.66 for generation three.

We consider the possible extension that has bases in equations (75) and (76).

$$m(-1,3) = (\beta')^{-1} m(2,3) \tag{75}$$

$$d'(-1) = 0 \tag{76}$$

Equation (77) pertains.

$$m(-1,M')c^2 \approx 3.0386 \times 10^{-2} \text{ MeV, for } M' = 3, 2, 3/2, 1, \text{ and } 0 \tag{77}$$

We discuss possible rest energies for neutrinos.

Equation (78) provides ongoing modeling limits for the sum, across three generations, of neutrino masses. (The limits have bases in interpretations of astrophysics data. See reference [1].) The integer j correlates with generation.

$$0.06\text{eV}/c^2 \lesssim \sum_{j=1}^{3} m_j \lesssim 0.12\text{eV}/c^2 \tag{78}$$

Extending work that produces equation (77) produces equation (79). Here, $m(-4,3) = (\beta')^{-1} m(-1,3)$ pertains. (Compare with equation (75).) Equation (76) extends to the notion that $d'(-4) = 0$ pertains. For any one neutrino and regarding all three neutrinos, this rest energy is not incompatible with equation (79).

$$m(-4,0)c^2 = m(-4,3/2)c^2 \approx 3.4475 \times 10^{-2} \text{ eV}/c^2 \tag{79}$$

Ongoing modeling interpretations of data suggest that the squares of masses of neutrinos might differ from each other. (See, for example, reference [1].) Proposed modeling suggests that such inferred differences regarding squares of masses might correlate with neutrino interactions with at least one of 6G468, 8G2468a, and 8G2468b. (See discussion related to table 16 and see table 17.)

Proposed modeling suggests that equation (79) shows the rest energy for each of the three neutrinos. Based on the rest energies being equal, CEFM symmetry pertains regarding 4G interactions with neutrinos. (See table 14c.) Gravity catalyzes neutrino oscillations. At least one of 6G and 8G also catalyzes neutrino oscillations. For example, the following notions pertain regarding 6G468. Neutrinos

Table 21: Suggested rest energies for some elementary fermions

Particles	Approximate rest energy	Notes
Tauon	1776.8400 ± 0.0115 MeV/c^2	The error reflects the measured error re G_N
Up quark	2.335 MeV/c^2	
Down quark	4.479 MeV/c^2	
Charm quark	1.178×10^3 MeV/c^2	
Strange quark	1.006×10^2 MeV/c^2	
Top quark	1.695×10^5 MeV/c^2	
Bottom quark	4.232×10^3 MeV/c^2	
Arcs - generation one	8.593 MeV/c^2	
Arcs - generation two	8.593 MeV/c^2	
Arcs - generation three	1.0566×10^2 MeV/c^2	Equals muon rest energy
Neutrinos	3.4475×10^{-2} eV/c^2	

have nonzero mass and - regarding 6G468 - $4 \in \Gamma$. Neutrinos correlate with generations and - regarding 6G468 - $6 \in \Gamma$. Neutrinos have nonzero spin and - regarding 6G468 - $8 \in \Gamma$. The notion that $\Sigma = 6$ correlates with the notion that the strength of 6G468 varies by fermion generation.

Table 21 lists approximate rest energies that ongoing modeling suggests for some elementary fermions. (Some results regarding quarks differ from those that table 20 shows. Equations (68), (69), and (70) lead to results that table 21 shows for quarks.)

We discuss the notion of an analog - for elementary fermions - to equation (49), which pertains for elementary bosons. Compared to for elementary bosons, an analog for elementary fermions would add aspects correlating with $USA6$ and generation and would add aspects correlating with $USA16$ and lepton number and baryon number. Compared to for elementary bosons, an analog for elementary fermions might or might not contain an aspect correlating with $USA8$ and spin. All elementary fermions have the same spin, $S = 1/2$. Also, quantities would combine via addition and subtraction of logarithms of amounts, not (as for elementary bosons) squares of amounts. And, quantities (that correlate with various $USA\lambda$ aspects) pertaining to elementary fermions might not necessarily correlate with the corresponding quantities that pertain regarding elementary bosons. Something like equation (80) might pertain. Here, one needs to select an m_{ref}, but m_{ref}, does not necessarily need to equal the mass of any elementary fermion. For solutions for a specific $M'' \leq -1$, the charge can model as zero and, also, the mass can model as being independent of M'.

$$\log(m/m_{ref}) \propto (USA4 \text{ aspect}) = \sum_{j=1}^{k} \log(f_j(\{USAl \text{ aspects} | l \in \{0, 2, 6, 8, 16\}\})) \quad (80)$$

This essay does not show an implementation of something like equation (80). We note that $m(M'' = -1/2, M' = 3/2)$ might provide a useful m_{ref}.

We discuss the possibility that proposed modeling can produce useful results regarding the topic of anomalous magnetic dipole moments for charged leptons. (This essay de-emphasizes discussing the extent to which the 2G248 solution might correlate with anomalous magnetic dipole moments for elementary particles. Perhaps, note table 6a.)

Equations (81), (82), and (83) show ongoing modeling KMS interpretations of results of experiments regarding anomalous magnetic dipole moments. (See reference [1].) The subscripts e, μ, and τ denote, respectively, electron, muon, and tauon. The symbol a correlates with anomalous magnetic dipole moment.)

$$a_e \approx 0.00115965218091 \quad (81)$$

$$a_\mu \approx 0.0011659209 \quad (82)$$

$$-0.052 < a_\tau < +0.013 \quad (83)$$

Ongoing modeling provides means, correlating with Feynman diagrams, to calculate an anomalous magnetic dipole moment for each of, at least, the electron and the muon. The ongoing modeling Standard Model suggests computations whereby the anomalous magnetic dipole moment for a charged lepton is a sum of terms. The first term is $\alpha/(2\pi)$. The second term is proportional to α^2. The third term is proportional to α^3. The exponent associated with α correlates with a number of virtual photons.

Regarding the tauon, equation (84) shows a result correlating with a first-order Standard Model (or, ongoing modeling) calculation. (See reference [2].)

$$a_{\tau,\mathrm{SM}} \approx +1.177 \times 10^{-3} \tag{84}$$

Proposed modeling suggests that notions of anomalous electromagnetic moments correlate with $\gamma 2$ solutions. Electromagnetic dipole solutions correlate with $\gamma 2$ solutions for which RSDF is r^{-3}. The following remarks pertain for other than the 2G24 solution, which correlates with the ongoing modeling nominal magnetic moment result of $g \approx 2$. (2G24 correlates with 2γ and not with $\gamma 2$.) Relevant G-family solutions (for which $\lambda \leq 8$) might be 4G26, 6G24, 6G28, 8G26, and (if we allow $\Sigma \geq 10$) 10G28. However, 6G28 and 10G28 do not interact with individual simple fermions. (Each of 6G28 and 10G28 correlates with a *GTA* $SU(5)$ symmetry. See table 8a. Perhaps, note table 17.) Solutions 6G28 and 10G28 might correlate with, for example, the Lamb shift. Regarding anomalous electromagnetic dipole moments, we assume that 4G26, 6G24, and 8G26 pertain.

For each of solutions 4G26 and 8G26, $4 \notin \Gamma$. Solutions 4G26 and 8G26 might correlate with results that do not vary with charged lepton rest mass. For solution 6G24, $4 \in \Gamma$. Solution 6G24 might correlate with a result that varies with charged lepton rest mass.

We explore modeling for which equation (85) pertains. Here, the subscript cl can be any one of e, μ, and τ. The symbol $a_{6\mathrm{G}24^*}$ correlates with the notion of adding together effects of 4G26 and 8G26. We explore the notions that t_{cl} might be one of $(\log(m_{\mathrm{cl}}/m_e))^2$, $(M'')^2$, and $(\mathrm{generation})^2$. For each of the three possibilities regarding t_{cl}, $(a_\tau - a_{\tau,\mathrm{SM}})/a_{\tau,\mathrm{SM}}$ is more than -0.003 and less than -0.0006.

$$a_{\mathrm{cl}} \approx a_{4\mathrm{G}26^*} + a_{6\mathrm{G}24} t_{\mathrm{cl}} \tag{85}$$

Ongoing modeling might provide modeling relevant to anomalous magnetic dipole moments for charged leptons.

2.2.4. Strengths of long-range forces

We explore concepts that might correlate with the ongoing modeling notion that the strength of gravity is much less than the strength of electromagnetism.

We explore modeling for interactions that involve a charged simple fermion, such as an electron, that models as not entangled.

We assume that we can work within aspects of proposed modeling that de-emphasize translational motion and multicomponent objects. We assume that conservation of angular momentum pertains.

We correlate the symbol 1F with that fermion. We explore interactions that model as if the number of incoming elementary bosons equals the number of outgoing elementary bosons. Equation (86) shows an interaction in which the fermion absorbs a photon. The spin of the fermion flips. Conservation of angular momentum pertains. Trying to replace, in equation (86), 2G with 4G does not work. The angular momentum associated with the fermion can change by no more than one unit. The interaction would not conserve angular momentum. Equation (87) can pertain. (Equation (87) does not portray an interaction - mediated by a 2J boson - between two fermions. One can consider that the 2J particle in equation (87) is a $2\mathrm{J}_{\pm}$. See table 23. One might want to consider the notion that equation (87) pertains regarding modeling and - in the current state of the universe - does not necessarily pertain regarding easily directly observable physics. Such modeling might involve the notion of virtual particles.)

$$1\mathrm{F} + 2\mathrm{G} \rightarrow 1\mathrm{F} + 0\mathrm{I} \tag{86}$$

$$1\mathrm{F} + 4\mathrm{G} \rightarrow 1\mathrm{F} + 2\mathrm{J} \tag{87}$$

The notion that $1\mathrm{F} + 4\mathrm{G} \rightarrow 1\mathrm{F} + 0\mathrm{I}$ does not pertain might correlate with ongoing modeling notions that the strength of gravity is much less than the strength of electromagnetism.

We explore the strengths - for the monopole components of interactions between pairs of charged leptons - of electromagnetism and gravity. We use KMS Newtonian modeling.

For each of the three charged leptons, equation (88) characterizes the strength of the 2G2 component of electromagnetism. Here, r denotes the distance between the two particles. Here, F denotes the strength of the force. The equation correlates with a magnitude of the force. The interaction is repulsive. Equation (89) shows notation regarding the masses of charged leptons. (See discussion related to table 20.) Here,

e, μ, and τ denote respectively the electron, the muon, and the tauon. Here, the three in $m(M'', 3)$ correlates with charged leptons. (Compare with equation (58), which pertains to the masses of quarks and charged leptons.) Equation (90) repeats equation (51). Equation (91) shows results that reflect data. (We used data that reference [1] shows.) Equation (92) provides a 4G4 analog to the 2G2 equation (88). The symbol G_N denotes the gravitational constant. The equation correlates with a magnitude of the force. Here, the interaction is attractive.

$$r^2 F = (q_e)^2/(4\pi\varepsilon_0) \tag{88}$$

$$m(M'', 3) = m_x, \text{ for the pairs } M'' = 0, x = e;\ M'' = 2, x = \mu;\text{ and } M'' = 3, x = \tau \tag{89}$$

$$\beta' = m_\tau/m_e \tag{90}$$

$$m(M'', 3) = y_{M''}(\beta')^{M''/3} m_e, \text{with } y_0 = y_3 = 1 \text{ and } y_2 \approx 0.9009 \tag{91}$$

$$r^2 F = G_N(m(M'', 3))^2 \tag{92}$$

We pursue the concept that a value of M'' can point to a relationship between the strength of electromagnetism and the strength of gravity. Based on the definitions just above, equation (93) pertains within experimental errors regarding relevant data. (Reference [1] provides the data.) Here, in essence, the equation $y_{18} = y_0 = 1$ pertains. Equation (93) echoes equation (52).

$$((q_e)^2/(4\pi\varepsilon_0))/4 = (G_N(m(18, 3))^2)/3, \text{ with } m(18, 3) = (\beta')^6 m_e \tag{93}$$

The following notes pertain. Equation (93) links the ratio of the masses of two simple particles to a ratio of the strengths of two G-family force components. Equation (93) links the strength of 2G2 interactions to the strength of 4G4 interactions. Equation (94) correlates the fine-structure constant, α, with a function of the tauon mass and the electron mass. (Regarding the fine-structure constant, see equation (59).) Equation (95) recasts equation (52) to feature, in effect, the magnitudes of three interactions, with each one of the interactions involving two similar particles. (For example, $G_N(m_\tau)^2$ correlates with a gravitational interaction between two tauons.) Equation (96) shows a ratio that pertains for interactions between two electrons.

$$\alpha = ((q_e)^2/(4\pi\varepsilon_0\hbar c)) = (4/3) \times (m_\tau/m_e)^{12} G_N(m_e)^2/(\hbar c) \tag{94}$$

$$(4/3)((G_N(m_\tau)^2)/(G_N(m_e)^2))^6 = ((q_e)^2/(4\pi\varepsilon_0))/(G_N(m_e)^2) \tag{95}$$

$$(((q_e)^2/(4\pi\varepsilon_0))/4) \,/\, ((G_N(m_e)^2)/3) \approx 3.124 \times 10^{42} \tag{96}$$

We explore a possible relationship between the strength of electromagnetism correlating with G-family monopole interactions with charge and the strength of electromagnetism correlating with G-family dipole interactions with nominal magnetic dipole moment.

Equation (97) provides one definition of the fine-structure constant. (Compare with equation (59), which provides a more common definition.) In equation (97), $(q_e)^2/(4\pi\varepsilon_0 c)$ correlates with the strength of 2G2.

$$\alpha = ((q_e/\hbar)^2/(4\pi\varepsilon_0 c)) \cdot \hbar \tag{97}$$

Equation (97) provides a link between the strength of 2G2 and the strength of 2G24. The equation includes the term $(q_e/\hbar)^2$. The Josephson constant K_J equals $2q_e/h$ (or, $q_e/(2\pi\hbar)$). Ongoing modeling considers that magnetic flux is always an integer multiple of $h/(2q_e)$. (We note the existence of an analog - to equation (97) - for which $\alpha = (\cdots) \cdot K_\mathrm{J}$. Elsewhere, this essay links spin to aspects pertaining to the squares of masses of elementary bosons. See, for example, discussion related to equation (47). Elsewhere, this essay mentions the notion that aspects pertaining to squares of masses of elementary bosons might link with nominal magnetic dipole moment. See discussion related to equation (47). Possibly, the $\alpha = (\cdots) \cdot K_\mathrm{J}$ analog to equation (97) has relevance to aspects pertaining to squares of masses of elementary bosons. This essay does not further discuss possible relevance of the $\alpha = (\cdots) \cdot K_\mathrm{J}$ analog to equation (97).)

We explore a concept regarding ongoing modeling notions that correlate with relationships between the strengths of the electromagnetic, weak, and strong interactions.

We use the symbol ΣB to denote an elementary boson having a spin of $\Sigma/2$. The expression 1F+2B→1F+0B can pertain for each of the following cases - 2B correlates with 2G, 2B correlates with 2W, and 2B correlates with 2U. This notion might correlate with ongoing modeling notions that correlate with relationships between the strengths of the electromagnetic, weak, and strong interactions.

We explore the relative strengths of interactions regarding G-family bosons with spins of at least two.

Equations (98) and (99) parallel equation (87). Compared to equation (87), equation (98) requires dissipation (from the incoming G-family boson) of one more unit (of magnitude $\hbar$) of spin. Compared to equation (98), equation (99) requires dissipation (from the incoming G-family boson) of one more unit (of magnitude $\hbar$) of spin.

$$1\text{F} + 6\text{G} + 0\text{I} \rightarrow 1\text{F} + 2\text{J} + 2\text{J} \tag{98}$$

$$1\text{F} + 8\text{G} + 0\text{I} + 0\text{I} \rightarrow 1\text{F} + 2\text{J} + 2\text{J} + 2\text{J} \tag{99}$$

Each of 4G4, 6G6, and 8G8 interacts with a different property of objects. In effect, 4G4 interacts with (at least some) elementary fermions, while neither one of 6G6 and 8G8 interacts with elementary fermions. (See table 17a.)

We explore the notion that a strength scaling relationship might pertain regarding G-family components ΣGΓ that share a value of Γ. For two such ΣGΓ, Σ_1GΓ and Σ_2GΓ, equation (100) pertains.

$$|\Sigma_2 - \Sigma_1|/4 \text{ is an integer} \tag{100}$$

We interpret equation (97) as suggesting that a factor of α might pertain regarding modeling the absorbing of a unit of spin. For a step from equation (87) to equation (99), two factors of α would pertain.

We discuss the adjustments - to the strength of 4G4 - to which table 6a alludes.

Table 22 discusses some aspects regarding the strength of gravitation and some components of 4γ.

2.2.5. Interactions involving jay bosons

We note one observational result that might correlate with effects correlating with jay bosons.

Reference [3] reports a discrepancy between the observed energy correlating with one type of fine-structure transition in positronium and a prediction based on core ongoing modeling. (Perhaps, see also reference [4].) Equation (101) states a transition frequency. The observed value of transition frequency correlates with the energy that correlates with the transition. Equation (102) correlates with ongoing modeling. The observed energy exceeds the predicted energy. Reference [3] characterizes the transition via the expression $2^3S_1 \rightarrow 2^3P_0$.

$$18501.02 \pm 0.61 \text{ MHz} \tag{101}$$

$$18498.25 \pm 0.08 \text{ MHz} \tag{102}$$

We explore the topic of interactions and effects correlating with jay bosons.

Table 23 discusses aspects regarding physics, interactions, and modeling involving jay (or, 2J) bosons. Here, B denotes the ongoing physics notion of baryon number and L denotes the ongoing physics notion of lepton number.

Table 24 shows some possible reactions involving pairs of jay bosons. The leftmost column describes the pair of incoming jay bosons. We discuss, as an example, the case of incoming $2\text{J}_{\pm}$+$2\text{J}_{\mp}$. The incoming particles correlate with units of spin that have opposite circular polarizations. In effect, the circular polarizations sum to zero circular polarization. The outgoing pair 0I+0I is possible. The outgoing pair 2G+0I is not possible. The outgoing circular polarizations would sum to plus one or minus one.

2.2.6. Dark matter particles

We discuss one type of dark matter.

We introduce the symbols that equations (103) and (104) show. The symbol 1Q⊗2U denotes a particle that includes just quarks and gluons. The word hadron pertains for the particle. The one-element term hadron-like pertains for the particle. Examples of 1Q⊗2U particles include protons, neutrons, and pions.

Table 22: Aspects regarding the strength of gravitation and some components of 4γ

Components and aspect
• 4G4: We consider a thought experiment in which a first object has a spherically symmetric distribution of matter and has no charge. A second object has a spherically symmetric distribution of the same matter and has some net charge. The second object uses - more than does the first object - more freeable energy to maintain its net charge. (Without use of that energy, the charge would repel itself and the object would bulge outward.) A lesser amount of freeable energy correlates with a lesser amount of passive gravitational energy. (Perhaps, note a parallel to equation (49).) Net charge correlates with a repulsive component that detracts from attraction that correlates with 4G.
• 4G48: We consider a thought experiment in which a first object has a spherically symmetric distribution of matter and has no spin. A second object has a spherically symmetric distribution of the same matter and has some spin. The second object uses - more than does the first object - more freeable energy to maintain its shape. (Without use of that energy, the second object would bulge near its equator and flatten near its poles.) A lesser amount of freeable energy correlates with a lesser amount of passive gravitational energy. (See discussion regarding table 10b. Also, perhaps, note a parallel to equation (49).) 4G48 does not interact with the first object. 4G48 interacts with the second object. 4G48 correlates with a repulsive component that detracts from attraction that correlates with 4G.
• 4G246: We consider a thought experiment in which a first object has a spherically symmetric distribution of matter and has no spin. A second object has a non-spherically symmetric distribution of the same matter and has no spin. The second object has - more than does the first object - more freeable energy. (The second object would - during a transition to having the shape of the first object - lose freeable energy. A greater amount of freeable energy correlates with a greater amount of passive gravitational energy. See discussion regarding table 10b.) 4G246 does not interact with the first object. 4G246 interacts with the second object. 4G246 correlates with an attractive component that augments attraction that correlates with 4G.
• 4G246⟦16⟧: We consider a thought experiment in which a first object has a distribution of matter and does not exhibit ringing (or, pulsations). A second object has the same distribution of the same matter and exhibits ringing. The second object has - compared to the first object - more freeable energy. (The second object would - during a transition to having the characteristics of the first object - lose freeable energy. A greater amount of freeable energy correlates with a greater amount of passive gravitational energy. See discussion regarding table 10b.) 4G246⟦16⟧ does not interact with the first object. 4G2468⟦16⟧ interacts with the second object. 4G246⟦16⟧ correlates with an attractive component that augments attraction that correlates with 4G.
• 4G2468a and 4G2468b: We consider a thought experiment in which a first object has a non-spherically symmetric distribution of matter and has no spin. A second object has the same non-spherically symmetric distribution of the same matter and has some spin. The second object uses - more than does the first object - more freeable energy to maintain its shape. A lesser amount of freeable energy correlates with a lesser amount of passive gravitational energy. (See discussion regarding table 10b.) 4G2468a and 4G2468b correlate with repulsive components that detract from attraction that correlates with 4G.
• 4G2468⟦16⟧: We consider a thought experiment in which a first object has a distribution of matter, perhaps has some spin, and does not exhibit ringing. A second object has the same distribution of the same matter, has the same spin, and exhibits ringing. The second object has - compared to the first object - more freeable energy. (The second object would - during a transition to having the characteristics of the first object - lose freeable energy. A greater amount of freeable energy correlates with a greater amount of passive gravitational energy. See discussion regarding table 10b.) 4G2468⟦16⟧ does not interact with the first object. 4G2468⟦16⟧ interacts with the second object. 4G2468⟦16⟧ correlates with an attractive component that augments attraction that correlates with 4G.

Table 23: Aspects regarding 2J bosons

(a) Aspects - correlating with observations and modeling - that might correlate with 2J bosons

Aspect
• Interactions - between identical fermions - that correlate with ongoing modeling notions of a Pauli exclusion force. (A pair of such identical fermions can be, for example, two hadrons in an atomic nucleus or two elementary particles. In ongoing modeling, the notion of identical can involve rest energy, charge, generation, and - for example, in an atom - spin orientation and orbital state. Aspects such as spin orientation and orbital state correlate with ongoing modeling KMS aspects. Proposed modeling might include - in the notion of identical - $B-L$. This inclusion would not necessarily add to the list that correlates with ongoing modeling. Proposed modeling would suggest - regarding the notion of identical - including a number that correlates with isomer. This inclusion would add to the list that correlates with ongoing modeling.)
• Forces correlating with some energy levels of positronium atoms. (See discussion related to equation (101).)
• Some interaction vertices that involve an incoming spin-one-half elementary fermion, an incoming or outgoing ΣG for which $\Sigma \geq 4$, and an outgoing spin-one-half elementary fermion. (See discussion related to equation (87). For this example, a 2J boson absorbs, in effect, one unit of spin that correlates originally with an incoming fermion. The unit correlates with $\hbar$.)
• Some interaction vertices that involve no fermions. (See discussion related to equation (112). For this example, two 2J bosons might correlate with, in effect, two units of spin that correlate with an outgoing component of a graviton. Each unit of spin correlates with $\hbar$.)

(b) Suggested aspects regarding 2J bosons

Aspect
• For each of the three 2J bosons, the following sentences pertain. The equation $n_{PSA0} = -1$ pertains. In modeling for an entangled environment, $n_{PSA0} = (-1)^+$ pertains and the longitudinal polarization state can excite. (In modeling regarding a free environment, the longitudinal polarization state would not excite. The notion of $n_{PSA0} = (-1)^+$ correlates with aspects of proposed modeling supplementary modeling regarding some KMS models. Proposed modeling supplementary modeling suggests that $n_{PSA0} = (-1)^+$ can correlate - for photons - with an index of refraction that exceeds one. Modeling would have bases in non-isotropic harmonic oscillators. This essay de-emphasizes further discussion regarding the notion of $n_{PSA0} = (-1)^+$.)
• We use the following notation and posit the following notions regarding the three 2J bosons. $2\mathrm{J}_0$ can exhibit left circular polarization and right circular polarization. $2\mathrm{J}_-$ can exhibit (say) left circular polarization and cannot exhibit right circular polarization. $2\mathrm{J}_+$ can exhibit right circular polarization and cannot exhibit left circular polarization.
• The Pauli exclusion force (in ongoing modeling) correlates with (in proposed modeling) a repulsive force based on the $2\mathrm{J}_\pm$ bosons. The force, in effect, tries to flip the spin of a fermion. In so doing, the $2\mathrm{J}_\pm$ boson would transit from circular polarization to longitudinal polarization.
• The positronium energy shift involves the notion that the two fermions - an electron and a positron - have identical properties (including spin orientation), except - essentially - for $B-L$. (The difference in $B-L$ correlates with a difference in charge.) We posit that an energy level shift (regarding at least one of the two positronium states) correlates with, in effect, aspects of $2\mathrm{J}_\pm$ bosons. Presumably, the effect correlates with the notion of 2J boson transitions from longitudinal polarization to circular polarization or from circular polarization to longitudinal polarization. Here, at least with respect to ongoing modeling based on the Dirac equation, a notion of charge (or $B-L$) exchange (between the electron and the positron) might be appropriate.
• We posit that $2\mathrm{J}_\pm$ bosons correlate with some interaction vertices that involve an incoming spin-one fermion, an incoming or outgoing ΣG for which $\Sigma \geq 4$, and an outgoing spin-one fermion. (See, for example, equation (87).)
• We posit that 2J bosons can correlate with some interaction vertices that involve no fermions. (See, for example, discussion related to equation (112).)

Table 24: Some possible reactions involving pairs of jay bosons

Incoming particles	Allowed outgoing particles	Precluded outgoing particles
$2J_{\pm}+2J_{\pm}$	4G+0I	2G+0I
$2J_{\pm}+2J_{\mp}$	0I+0I	2G+0I
$2J_0+2J_0$	8G+0I or 0I+0I	2G+0I

The symbol 1R⊗2U denotes a particle that includes just arcs and gluons. The one-element term hadron-like pertains for the particle. The particle does not include quarks.

$$1Q \otimes 2U \tag{103}$$

$$1R \otimes 2U \tag{104}$$

A 1R⊗2U hadron-like particle contains no charged simple particles. The 1R⊗2U hadron-like particles do not interact with 2γ. The 1R⊗2U hadron-like particles measure as being dark matter.

If we correlate notions above with PR1ISP modeling, the existence of 1R⊗2U hadron-like particles seems insufficient to explain observed ratios of dark matter effects to ordinary matter effects (for example) of five-plus to one for densities of the universe.

We explore the notion that some five-plus to one ratios reflect something fundamental in nature. We correlate some results from this exploration with PR6ISP modeling. (See table 8c.)

The notion of isomer correlates with a $U(1) \times SU(2)$ symmetry . (See table 10b.)

This proposed modeling notion of isomers does not necessarily correlate with ongoing modeling notions of isomers. This proposed modeling notion of isomers does not necessarily parallel the nuclear physics notion - same numbers of protons and neutrons, but different energy states - of isomer. This proposed modeling notion of isomers does not necessarily correlate with the chemistry notion - same numbers of various atoms, but different spatial arrangements - of molecular isomers.

GCS modeling correlates interactions with charge with the 2G2 component of the 2G force. We posit that nature includes six isomers of charge. GCS modeling correlates interactions with nominal magnetic dipole moment with the 2G24 component of the 2G force. We posit that each isomer of charge correlates with one isomer of nominal magnetic dipole moment. We posit that each of six pairings of one isomer of charge and one isomer of nominal magnetic moment correlates with its own isomer of all simple particles. One isomer of charge, nominal magnetic dipole moment, and related simple particles measures mostly as ordinary matter. (The previous sentence also pertains regarding PR1ISP modeling. Regarding PR6ISP modeling, the one isomer of charge, nominal magnetic dipole moment, and simple particles correlates with 1R ⊗ 2U hadron-like particles that measure as dark matter. Hence, we used the word mostly.) We label that isomer as isomer zero. We posit that each of the other five isomers of charge, nominal magnetic dipole moment, and related simple particles measures as dark matter. (PR1ISP modeling does not include these five isomers.) We label those isomers as isomer one, isomer two, . . ., and isomer five. Each of the six isomers correlates with its own 2U particles (or, gluons). We posit that one isomer of 4G4 interacts with each one of the one (mostly) ordinary matter isomer and five dark matter isomers.

We posit that the next two sentences pertain. The six-isomer notion explains the five that pertains regarding five-plus to one ratios of amounts of dark matter to ordinary matter. The existence of isomer zero 1R⊗2U hadron-like particles explains the plus that pertains regarding five-plus to one ratios of amounts of dark matter to ordinary matter. Such five-plus to one ratios pertain regarding densities of the universe and regarding the compositions of some (perhaps, most) galaxy clusters.

Table 25 provides perspective regarding PR6ISP modeling.

Regarding each one of the six PR6ISP isomers, we suggest that each combination - that table 20 shows - of magnitude of charge and magnitude of mass pertains to a simple fermion that correlates with the isomer. For example, each isomer includes a charged lepton for which the magnitude of charge equals the magnitude of the charge of the ordinary matter electron and for which the rest energy equals the rest energy of the electron. However, regarding charged leptons, the combination of mass and generation number does not necessarily match across isomers. (See table 29.) For example, for isomer one, the generation three charged lepton may have the same mass as the ordinary matter electron. (See table 20.) The ordinary matter electron has a generation number of one.

Table 25: Perspective regarding PR6ISP modeling

PR6ISP modeling ...
• Explains observed dark matter to ordinary matter ratios of five-plus to one, four to one, one to one, zero-plus to one, and one to zero-plus.
• Correlates with a $U(1) \times SU(2)$ symmetry to which table 10b alludes.
• Echoes the notion that PFS modeling intertwines 2G-related aspects and 4G-related aspects in ways that ongoing modeling does not. (See, for example, equation (58).)
• Echoes the exponent of six that equation (93) discusses.
• Echoes the six ranges that equation (105) and table 29 feature.

Table 26: Cumulative features of various types of modeling (with NR denoting not relevant)

Modeling	ι_I	New descriptions and new explanations	New subtleties
Ongoing modeling	NR	• (Baseline)	-
PR1ISP	1	• New simple particles and long-range forces • Some dark matter	• Eras regarding the rate of expansion of the universe
PR6ISP	6	• More dark matter • Ratios of dark matter effects to ordinary matter effects • Objects, smaller than galaxies, that feature dark matter	• Spans • Eras regarding the rate of expansion of the universe

Table 8c discusses the symbol ι_I. Discussion just above pertains regarding PRι_IISP, with ι_I being one or six.

We preview features of each of PR1ISP and PR6ISP modeling.

Table 26 discusses cumulative features of various types of modeling. Generally, each row augments the rows above that row. Regarding ongoing modeling, the symbol NR denotes the concept that the notion of isomers is not relevant. We think that PR6ISP provides useful insight about nature.

Table 27 shows relationships regarding PR1ISP, PR6ISP, and G-family forces.

2.2.7. Isomers of quarks and charged leptons

We consider PR6ISP modeling.

Table 28 lists aspects that seem to correlate with each other regarding the one isomer that correlates with ordinary matter (and some dark matter) and the five isomers that correlate with (most) dark matter.

We explore modeling that correlates each of the six relevant isomers with a range of M''. (Regarding M'', perhaps see discussion related to equation (58).) In equation (105), the integer n numbers the isomers. The ordinary matter isomer correlates with $n = 0$.

$$\text{isomer } n \;\leftrightarrow\; 3n \leq M'' \leq 3n + 3, \text{ for } 0 \leq n \leq 5 \tag{105}$$

Table 27: Relationships regarding PR1ISP, PR6ISP, and G-family forces

Aspects
• Absent the notion that some components of G-family forces have spans of more than one, PR6ISP would correlate with six non-interacting sub-universes.
• In PR6ISP models, each sub-universe consists of an isomer of PR1ISP. The six isomers of PR1ISP might exhibit differing matches between generation of charged lepton and mass of charged lepton. (See discussion related to table 29.)
• In PR6ISP models, the main interactions between PR1ISP-like isomers correlate - except before the era of inflation - with the monopole component (or, 4G4) of gravity (or, 4G). Some other interactions between PR1ISP-like isomers correlate with a KMS dipole (or, 4G48) component of gravity (or, 4G). Some other interactions between PR1ISP-like isomers correlate with a KMS dipole component (or, 2G248 - which correlates with the notion of GCS quadrupole) of electromagnetism (or, 2G).

Table 28: Aspects that seem to correlate with each other regarding the one isomer that correlates with ordinary matter (and some dark matter) and the five isomers that correlate with (most) dark matter

Aspect
• The exponent of six in equation (93) correlates with the notion of six isomers, one of which correlates with ordinary matter and five of which correlate with (most) dark matter.
• The number, six, of isomers correlates with the number, six, of generators of a $U(1) \times SU(2)$ symmetry. (See table 10b.)
• The $U(1) \times SU(2)$ symmetry breaks - across the six isomers - based on aspects that correlate with relationships between - for charged leptons - gravitational mass and generation.

Table 29: Relationships between quark generation and charged lepton aspects

M''	n	Quark n	Quark generation	Lepton n (for n even)	Lepton aspect (for even n)	Lepton n (for n odd)	Lepton aspect (for odd n)
0	0	0	1	0	1	-	-
1	0	0	2	-	-	-	-
2	0	0	3	0	2	-	-
3	0 or 1	1	1	0	3	1	3
4	1	1	2	-	-	-	-
5	1	1	3	-	-	1	1
6	1 or 2	2	1	2	2	1	2
7	2	2	2	-	-	-	-
8	2	2	3	2	3	-	-
9	2 or 3	3	1	2	1	3	1
10	3	3	2	-	-	-	-
11	3	3	3	-	-	3	2
12	3 or 4	4	1	4	3	3	3
13	4	4	2	-	-	-	-
14	4	4	3	4	1	-	-
15	4 or 5	5	1	4	2	5	2
16	5	5	2	-	-	-	-
17	5	5	3	-	-	5	3
18	5	-	-	-	-	5	1

Table 29 shows, for each value of n, relationships between quark generation and charged lepton aspects. For each n, the order for quarks is generation one, generation two, and then generation three. We de-emphasize the following notions. Dark matter lepton passive gravitational masses might correlate with $m(M'', 3)$ and $M'' > 3$. Results that correlate with $M'' < 0$ might be useful for estimating magnitudes of ordinary matter 2G interactions with dark matter analogs to ordinary matter charged leptons.

Table 29 has roots in models that correlate with the relative strengths of 2G2 and 4G4. We posit that, for each item (in table 29) that correlates with a particle, equation (106) provides the (passive and active) gravitational mass. Here, the notions of $n = 0$ and $m_{grav}(M'', M')$ correlate with work that correlates with isomer zero and equation (58). For example, for the dark matter lepton for which $n = 1$ and M''=3, the generation is three and the gravitational mass equals the gravitational mass of the ordinary matter electron.

$$m_{grav}(M'' + 3n, M') = m_{grav}(M'', M'), \text{ for } 0 \leq n \leq 5 \tag{106}$$

We speculate regarding the extent to which aspects of table 29 correlate with origins for baryon asymmetry.

Aspects of ongoing modeling consider that early in the universe baryon symmetry likely pertained. Unverified ongoing modeling posits mechanisms that might have led to asymmetry. Some conjectured mechanisms would suggest asymmetries between matter simple fermions and antimatter simple fermions. One set of such simple fermions might feature the neutrinos. (See reference [5].)

Observed baryon asymmetry correlates with isomer zero (or, ordinary matter).

We think that some aspects of proposed modeling might shed light on baryon asymmetry. For example, a modeling centric notion of baryon symmetry might pertain regarding the combination of isomer zero and isomer three.

We consider a thought experiment. We consider that modeling for isomer three quarks parallels modeling for isomer zero quarks. Per table 29, modeling for isomer three leptons can differ from modeling for isomer zero leptons. One difference might correlate with handedness, for example regarding (let us use the word interactive) neutrinos. Such differences might correlate with the two-fold symmetry that correlates with the $U(1)$ component of the $U(1) \times SU(2)$ symmetry that table 10b shows regarding the oscillator pair $USA1$-and-$USA2$.

2.2.8. Right-handed W bosons and neutrinos

Reference [6] notes that the (ongoing modeling) Standard Model predicts that the fraction f_+ of W bosons - produced by decays of top quarks - that are right-handed is $f_+ = 3.6 \times 10^{-4}$. Reference [1] suggests that, with a confidence level of 90 percent, the rest energy of a W_R (or, right-handed W) would exceed 715 GeV. (Perhaps, note also, reference [7].)

Proposed modeling suggests that each of isomers one through five includes its own isomer of W bosons. The suggested passive gravitational mass for dark matter W bosons is the same as the passive gravitational mass for the ordinary matter W boson.

We suggest that leptons correlating with isomers zero, two, and four correlate with left-handedness and that leptons correlating with isomers one, three, and five correlate with right-handedness. (Note the pattern that table 29 exhibits regarding leptons.) We suggest that W bosons correlating with isomers zero, two, and four correlate with left-handedness and that W bosons correlating with isomers one, three, and five correlate with right-handedness. Table 28 and equation (93) suggest that equation (107) pertains regarding measurements that feature aspects centric to ordinary matter and interactions intermediated by span-six aspects of 2G. (Note, for example, 2(6)G248 in table 18a.) We know of no measurements that correlate with interactions intermediated by 4G. To the extent that equation (107) has relevance to nature, one might use the four-word phrase not necessarily gravitational mass to describe $m_{W_R(\text{isomer one}),\text{ inferred not via 4G}}$.

$$m_{W_R(\text{isomer one}),\text{ inferred not via 4G}}c^2 = \beta m_W c^2 \approx 2.8 \times 10^5 \text{ GeV} \tag{107}$$

We consider a thought experiment. We consider a possibly relevant notion that would have bases in statistics related to inferable not necessarily gravitational masses. Perhaps equation (108) approximates fractions of non-longitudinal polarization W bosons observed via ordinary matter non-4G interactions. (For isomers not numbered as zero or one, the $m_{W_R(\text{isomer \_}),\text{ inferred ...}}c^2$ would be larger than $m_{W_R(\text{isomer one}),\text{ inferred ...}}c^2$. Effects based on the existence of isomer three W bosons and isomer five W bosons would be small compared to effects correlating with each of isomer zero W bosons and isomer one W bosons.)

$$f_+/f_- \sim e^{(\beta^{-1})} \approx \beta^{-1} \approx 2.9 \times 10^{-4} \tag{108}$$

Equation (108) is not necessarily incompatible with the estimate - $f_+ = 3.6 \times 10^{-4}$ - based on the Standard Model.

Regarding neutrinos, similar notions might pertain. Proposed modeling suggests that neutrinos do not interact with 2G. Direct inferences of the presence of right-handed neutrinos might correlate with isomer one neutrinos and with interactions - mediated by 4G - with isomer zero. This essay de-emphasizes discussing the question of when people might have observations that would point to right-handed neutrinos.

2.3. Cosmology

Table 30 lists opportunities for advances regarding cosmology. Proposed modeling suggests advances regarding each opportunity.

2.3.1. An earlier of two eras that might occur before inflation

We discuss possibilities regarding times before the inflationary epoch.

We explore possibilities pertaining to an era before a later pre-inflation era that proposed modeling associates with prominence for the jay boson and the 4G2468x components of 4γ. (Regarding the later of the two eras before inflation, see discussion related to equation (112). Regarding the symbol 4G2468x, see discussion related to table 5.)

We assume that modeling correlating with G-family solutions for which the RSDF is r^{-6} pertains. No solutions of the form ΣG2468⟦10⟧ comport with $\Sigma = 4$. One solution of the form ΣG2468⟦16⟧ comports with $\Sigma = 4$. (Here, $|-2-4-6-8+16|$ equals four. Perhaps, see table 9.) Regarding KMS Newtonian

Table 30: Opportunities for advances regarding cosmology

Opportunity
• Describe aspects of the universe that occurred before inflation.
• Identify - within a context that is broader than inflation - the inflaton elementary particle that ongoing modeling hypothesizes.
• Describe mechanisms underlying three eras in the rate of expansion of the universe.
• Explain the magnitude of current increase in the rate of expansion of the universe.
• Describe bases leading to the ratio of dark matter density of the universe to ordinary matter density of the universe.

modeling, the RSDF (or, radial spatial dependence of force) would be r^{-6}. Table 22 notes that attraction (not repulsion) pertains. (Perhaps, also note that extrapolation based on aspects of table 32 might point to attraction.)

We consider interactions between two similar, neighboring, non-overlapping objects (or clumps of energy). Equation (109) suggests scaling for a 4G2468⟦16⟧ component of G-family force. Here, υ is a non-dimensional scaling factor that correlates with linear size (or, a length) pertaining to each object and that correlates with the distance between the centers of the objects, ρ is the relevant object property for the case for which $\upsilon = 1$, and r is the distance (for the case of $\upsilon = 1$) between the centers of the objects. The factor υ^3 provides for scaling for an object that has three spatial dimensions. The force would be independent of υ. That independence might suggest, from a standpoint of physics, that a 4G2468⟦16⟧ component of 4G would correlate with concentrating matter or energy before the suggested era in which much of the matter in the universe consists of jay bosons.

$$(\upsilon^3\rho)^2/(\upsilon r)^6 \tag{109}$$

The method that we use to calculate spans for other components of G-family forces would not pertain for 4G2468⟦16⟧. (See discussion regarding equation (36).) We assume that the span ι_I - as in PRι_IISP - pertains for 4G2468⟦16⟧. The notation that equation (110) shows pertains.

$$4(\iota_I)\mathrm{G}2468\,[\![16]\!] \tag{110}$$

We assume that 4G provides the dominant phenomena that pertain early in this era. (For later eras, we identify a combination of stuff - or non-G-family phenomena - and dominant components of G-family forces.)

We assume that interactions of the form that equation (111) shows pertain. Here, we assume that the net circular polarization for before the interaction is zero.

$$4(\iota_I)\mathrm{G}2468[\![16]\!]+4(\iota_I)\mathrm{G}2468[\![16]\!] \rightarrow 2(1)\mathrm{J}_-+2(1)\mathrm{J}_+ \tag{111}$$

We assume that interactions that equation (111) shows populate - roughly equally - the relevant ι_I isomers. (The span of 2(1)J is one.)

4G4 has a span of six. To the extent that ι_I exceeds one, isomers interact with each other during and after this period.

2.3.2. The later of two eras that might occur before inflation

We explore the notion that, just before the inflationary epoch, the main component of the universe might have consisted of jay bosons.

Ongoing modeling seems to suggest that nature creates photons (or, 2G) primarily after the inflationary epoch. Regarding times just before inflation, we assume that the allowed reactions that table 24 shows pertain.

We assume that the particle density is sufficiently large that modeling can correlate the production of 4G with the 4G2468x components of 4G.

Equation (112) describes a possible interaction. The span for each of $2\mathrm{J}_-$, 4G2468x and 0I is one. For PRι_IISP models for which ι_I exceeds one, modeling suggests roughly equal creation of ι_I isomers for each of $2\mathrm{J}_-$, 4G2468x, and 0I.

$$2(1)\mathrm{J}_- + 2(1)\mathrm{J}_- \rightarrow 4(1)\mathrm{G}2468\mathrm{x} + 0(1)\mathrm{I} \tag{112}$$

Table 24 suggests that interactions between pairs of jay bosons do not create photons. A lack of photons is compatible with ongoing modeling that suggests that significant presence of photons starts after inflation.

2.3.3. Inflation

We discuss possibilities regarding the inflationary epoch.

Ongoing modeling suggests that an inflationary epoch might have occurred. Ongoing modeling suggests that the epoch started around 10^{-36} seconds after the Big Bang. Ongoing modeling suggests that the epoch ended around 10^{-33} seconds to 10^{-32} seconds after the Big Bang. We are not certain as to the extent to which data confirms the occurrence of an inflationary epoch.

Ongoing modeling includes models that people claim would support notions of inflation. The models point to states of the universe, at and somewhat after the inflationary epoch, that would provide bases for evolution that would be consistent with observations about later phenomena and would be consistent with aspects of ongoing modeling. (Reference [8] summarizes aspects related to inflation, points to references regarding ongoing modeling, and discusses some ongoing modeling work.)

Reference [9] suggests the possibility that a repulsive aspect of gravity drove phenomena correlating with the inflationary epoch. The reference suggests that the composition of the universe was nearly uniform spatially. The reference suggests the importance of a so-called inflaton field.

Proposed modeling suggests the possibility that, during the inflationary epoch, aye particles (or, 0I particles) provided a major non-long-range-force component of the universe. The aye particle matches ongoing modeling notions of a boson with zero spin. (See reference [8].) Ongoing modeling uses the word inflaton to name that boson. Proposed modeling suggests the possibility that the octupole components of 4γ provided the repulsive aspect of gravity. (Components 4G4268x correlate with GCS octupole and with KMS octupole.) Those components interact with individual simple particles and are repulsive. Equation (113) shows such an interaction. Here, x and y might be either of a and b.

$$0(1)\mathrm{I} + 4(1)\mathrm{G2468x} \to 0(1)\mathrm{I} + 4(1)\mathrm{G2468y} \tag{113}$$

Equation (114) shows a phenomenon, which might pertain to the extent that aye and jay bosons co-existed in a dense environment.

$$2(1)\mathrm{J}_0 + 2(1)\mathrm{J}_0 + 0(1)\mathrm{I} \to 2(1)\mathrm{J}_0 + 2(1)\mathrm{J}_0 + 8(1)\mathrm{G2468x} \tag{114}$$

Around the time of the inflationary epoch, octupole attraction correlating with 4G246⟦16⟧ might play a role. (Perhaps, see table 22.)

2.3.4. Just after inflation

The end of the inflationary epoch might correlate with a change, regarding effects of 4γ, from octupole repulsion being dominant to quadrupole attraction being dominant. (This essay does not speculate regarding the extent to which jay bosons continued to have significant effects - except, for example, effects that ongoing modeling correlates with the Pauli exclusion principle or, for example, some phenomena regarding positronium - after the inflationary epoch. Possibly, the density of stuff - other than jay bosons - decreased enough that - in a sense of ongoing modeling - essentially no non-virtual jay bosons existed.) The end of the inflationary epoch might also correlate with a growth of spatial inhomogeneities regarding (at least) aye particles. The quadrupole component of 4γ might help catalyze some of the spatial inhomogeneities. The quadrupole component of 4γ might amplify some of the spatial inhomogeneities.

Proposed modeling suggests the possibility that, for some time just after the inflationary epoch, the aye particle might have been a dominant non-long-range-force component of the universe. Interactions between aye particles would produce components of 2G forces. (See equation (115).) Interactions of 2G with itself produce matter-and-antimatter pairs of simple fermions. Proposed modeling suggests the possibility that attraction based on the (quadrupole) 4G246 component of 4γ contributed to clumping.

$$0\mathrm{I} + 0\mathrm{I} \to 2\mathrm{G} + 2\mathrm{G} \tag{115}$$

2.3.5. Dissimilarities between isomers

We consider a thought experiment regarding isomer zero (or, the isomer that includes ordinary matter) and a so-called isomer alt zero. Here, alt zero is one of one, two, four, and five.

The stuff that correlates with isomer alt zero and the stuff that correlates with isomer zero exhibit similarities with respect to phenomena involving quarks, gluons, and W-family bosons.

Table 31: Ordinary matter, four cold dark matter isomers, and the one other dark matter isomer

Isomers (n)	Aspect - regarding each isomer
0	Is ordinary matter.
3	Evolves similarly to ordinary matter.
1, 2, 4, and 5	Evolves into cold dark matter.

We consider a time at which the densities of stuff are high and the isomers are essentially similar. Similar evolution would occur to the extent that one considers just quarks, gluons, and W-family bosons.

We consider three-quark baryons (real or virtual) that consist of generation three quarks. The charged baryons are more massive than the neutral (or, charge-neutral) baryons. (Consider the masses - per table 21 - of the constituent quarks.)

For the alt zero isomer, generation three leptons are less massive than the tauon that correlates with isomer zero generation three. Interactions that produce generation three leptons (and produce or consume W bosons) facilitate - in the alt zero isomer compared to isomer zero - more transitions from all-generation-three charged baryons to all-generation-three neutral baryons.

Over time, in both isomers, generation three quarks and generation two quarks evolve, via interactions that entangle multiple W bosons, into generation one quarks.

We consider a time when the transitions to all-generation-one quarks have just completed. Densities of stuff have dropped. We consider all-generation-one baryons. Compared to isomer zero, the alt isomer contains more alt neutrons than isomer zero contains neutrons. The mass of the alt isomer generation one charged lepton exceeds the mass of the isomer zero generation one charged lepton (or, the mass of the electron). The (already more abundant, compared to isomer zero) alt one neutrons have difficulties (compared to isomer zero neutrons) decaying into charged baryons.

From then on, the alt isomer has, compared to isomer zero, more neutrons and fewer protons. The alt isomer has, compared to isomer zero, fewer charged leptons. The alt isomer has, compared to isomer zero, fewer charged leptons with masses equal to the mass of the isomer zero electron.

Even to the extent that stuff correlating with isomer alt zero forms some stars, isomer alt zero becomes cold dark matter consisting mainly of alt neutrons and alt hydrogen atoms. Also, the collection of - mostly old - alt isomer photons cools.

We consider isomer zero and isomer three.

Presumably, similar evolution pertains regarding isomer three and isomer zero. For example, isomer three stuff forms stars in numbers similar to isomer zero numbers.

Table (31) pertains.

2.3.6. Filaments and baryon acoustic oscillations

Proposed modeling is compatible with the ongoing modeling notion that ordinary matter baryon acoustic oscillations contributed to the formation of filaments.

Regarding models for which ι_I (as in PRι_IISP) exceeds one, each of the five dark matter isomers has its own baryon-like particles and its own 2(1)G physics. Proposed modeling suggests, for models for which ι_I exceeds one, that dark matter baryon-like acoustic oscillations occurred in the early universe. Proposed modeling suggests that dark matter baryon-like acoustic oscillations contributed (along with ordinary matter baryon acoustic oscillations) to the formation of filaments.

2.3.7. The rate of expansion of the universe

Table 32 posits concepts regarding three eras in the rate of expansion of the universe. (Regarding observations that correlate with the eras that correlate with decrease and recent increase, see references [10], [11], [12], and [13].) We know of no observations that pertain directly to the era of inflation. Ongoing modeling suggests the existence of an era of inflation.

The uses, in table 32, of the word repulsive and the word attractive comport with table 22.

Two thought experiments provide notions that lead to table 32.

We consider one thought experiment. We consider two similar neighboring clumps of stuff. We assume that the clumps are moving away from each other. We assume that the clumps will continue to move away from each other. We assume that, initially, interactions correlating with RSDF $r^{-(n+1)}$ dominate regarding interactions between the two clumps. We assume that the two clumps interact via interactions correlating with RSDF r^{-n}. We assume that no other forces have adequate relevance. We assume that the distance between the objects increases adequately. Eventually, the RSDF r^{-n} force dominates the RSDF $r^{-(n+1)}$ force.

Table 32: Aspects regarding three eras correlating with the expansion of the universe

Aspect	Era: Inflation	Era: Next billions of years	Era: Most recent billions of years
Observed changes in the rate	?	Decrease	Increase
Ongoing modeling KMS model-based changes in the rate	Increase	Decrease	Increase
Proposed modeling PFS model-based changes in the rate	Increase	Decrease	Increase
Drivers, as suggested by PFS modeling and GCS modeling (4G components that dominate between largest objects)	4G2468a, 4G2468b	4G246	4G48
KMS RSDF for the 4G components	r^{-5}	r^{-4}	r^{-3}
Proposed modeling interpretation of KMS modeling for the net force correlating with the components	Repulsive	Attractive	Repulsive

We consider a similar thought experiment. We consider two similar neighboring clumps. We assume that these clumps are less interactive (for example, less massive) than the two clumps in the first thought experiment. Generally, dominance of the RSDF r^{-n} force over the RSDF $r^{-(n+1)}$ force occurs sooner for the two clumps in the second thought experiment than it does for the two clumps in the first thought experiment.

Interactions between galaxy-like clumps transit to 4G4 RSDF r^{-2} dominance quickly compared to the current age of the universe. Mutual attraction occurs. Interactions between adequately larger clumps can still exhibit 4G48 RSDF r^{-3} dominance. Mutual repulsion occurs.

Table 32 suggests correlations between repulsion and 4G2468a, 4G2468b, and 4G48. Table 32 suggests correlations between attraction and 4G246. We suggest these correlations, based on data.

Work elsewhere in this essay reinforces the notions that 4G246 correlates with attraction and that 4G2468a, 4G2468b, and 4G48 correlate with repulsion. (See table 22.)

People suggest that ongoing modeling underestimates recent increases in the rate of expansion. (See, for example, reference [14], reference [15], reference [16], and reference [17]. However, some people note possible objections to some notions of underestimates. See, for example, references [18] and [19].) People suggest phenomenological remedies regarding the modeling. (See, for example, reference [20].)

Proposed modeling suggests a reason for such underestimates.

We consider a thought experiment.

Here, we assume that people use models that correlate with data about the rate of expansion during the era of decreases in that rate. We assume that the models have bases in equations of state and in general relativity.

Proposed modeling correlates dominant effects - for the era of decreasing rate - with the span of one that correlates with 4G246. Proposed modeling correlates dominant effects for the recent era with the span of two that correlates with 4G48.

Applying decreasing-rate era equations of state and general relativity to current era phenomena correlates with underestimating a key factor - 4G48 repulsion - by, conceptually, a factor of two.

2.3.8. Dark matter density of the universe

Ongoing modeling discusses five partial densities of the universe. The symbol Ω_{c} denotes dark matter (or, cold dark matter) density of the universe. The symbol Ω_{b} denotes ordinary matter (or, baryonic matter) density of the universe. The symbol Ω_{ν} denotes neutrino density of the universe. The symbol Ω_{γ} denotes photon density of the universe. The symbol Ω_{Λ} denotes dark energy density of the universe. Each of the five densities correlates with data. Equation (116) pertains regarding the total density of the universe, Ω.

$$\Omega = \Omega_{\mathrm{c}} + \Omega_{\mathrm{b}} + \Omega_{\nu} + \Omega_{\gamma} + \Omega_{\Lambda} \tag{116}$$

Reference [1] provides the data that equations (117), (118), (119), and (120) show.

$$\Omega_{\mathrm{c}} \approx 0.265 \pm 0.007 \tag{117}$$

$$\Omega_{\mathrm{b}} \approx 0.0493 \pm 0.0006 \tag{118}$$

$$\Omega_{\nu} \leq 0.003, \text{ also } \Omega_{\nu} \geq 0.0012 \tag{119}$$

$$\Omega_{\gamma} \approx 0.0000538 \pm 0.0000015 \tag{120}$$

In ongoing modeling, the symbol Ω_{c} correlates with all dark matter. To the extent that proposed modeling PR6ISP modeling comports with nature, the symbol Ω_{c} correlates with all of the three aspects - isomer zero 1R⊗2U hadron-like particles, the four dark matter isomers that we correlate above with the word cold, and the one dark matter isomer that we do not necessarily correlate above with the word cold - that proposed modeling correlates with the term dark matter.

Proposed modeling suggests considering - for each isomer j, with $0 \leq j \leq 5$ - equation (121). (Technically, the isomers share a fraction of Ω_{γ}, but the total Ω_{γ} is small.) The symbol $\Omega_{\mathrm{1R2U,j}}$ denotes the density of the universe that correlates with the 1R⊗2U hadron-like particles that correlate with isomer j. From here on, we de-emphasize the densities of neutrinos and the densities of photons. Equation (122) pertains. Even though isomers evolve differently with respect to quark-based hadrons, we assume that there is adequate similarity in evolution so that equation (123) pertains. Equations (124) and (125) pertain.

$$\Omega_{j} = \Omega_{\mathrm{b},j} + \Omega_{\mathrm{1R2U},j} + \Omega_{\nu,j} + \Omega_{\gamma,j} \tag{121}$$

$$\Omega_{\mathrm{b}} + \Omega_{\mathrm{c}} \approx \sum_{j=0}^{5} \Omega_{j} \tag{122}$$

$$\Omega_{\mathrm{1R2U},j} \approx \Omega_{\mathrm{1R2U,0}}, \text{ for } 0 \leq j \leq 5 \tag{123}$$

$$\Omega_{\mathrm{b}} + \Omega_{\mathrm{c}} \approx \Omega_{\mathrm{b}} + \Omega_{\mathrm{1R2U,0}} + 5(\Omega_{\mathrm{1R2U,0}} + \Omega_{\mathrm{b}}) \tag{124}$$

$$\Omega_{\mathrm{1R2U,0}} \approx (\Omega_{\mathrm{c}} - 5\Omega_{\mathrm{b}})/6 \tag{125}$$

Equation (126) estimates $\Omega_{\mathrm{1R2U,0}}$ for the current state of the universe.

$$\Omega_{\mathrm{1R2U,0}} \approx 0.0031 \tag{126}$$

Except possibly regarding dark energy density (or, Ω_{Λ}), proposed modeling suggests that ratios of the actual values of the various $\Omega\_$ in equation (116) remain constant for essentially the entire history of the universe. (This essay does not speculate - regarding this topic - regarding the very earliest times after the Big Bang. Regarding Ω_{Λ}, see discussion related to equation (129).) PR6ISP proposes no significant mechanisms for transferring stuff between ordinary matter and dark matter. (We assume that net transfers based on components - for which the spans are greater than one - of 2G are negligible.)

We discuss measurements via which people infer densities - of dark matter and ordinary matter - of the universe.

People use data from observations of CMB (or, cosmic microwave background radiation) to infer ratios - of dark matter density of the universe to ordinary matter density of the universe - to which equations (117), (118), (119), and (120) point. A ratio of five-plus to one might pertain for billions of years.

Regarding data based on CMB, measured ratios of dark matter density of the universe to ordinary matter density of the universe would not much change regarding times for which equation (127) pertains. That time range starts somewhat after 380,000 years after the Big Bang and continues through now.

$$\Omega_{\gamma} \ll \Omega_{\mathrm{b}} \text{ and } \Omega_{\nu} \ll \Omega_{\mathrm{b}} \tag{127}$$

Table 33: Opportunities for advances regarding astrophysics

Opportunity
• Describe mechanisms leading to an observed amount of depletion - some of which has bases in hyperfine interactions with hydrogen atoms - of cosmic microwave background radiation.
• Hone scenarios correlating with the formation of galaxies.
• Explain data - that ongoing modeling seems not to explain - about the following.
◦ Large clumps of ordinary matter gas and of dark matter.
◦ Ratios of dark matter to ordinary matter in galaxy clusters.
◦ Amounts of stuff that does and does not pass through - with mainly just gravitational interactions - collisions of galaxy clusters.
◦ Some aspects of interactions between galaxies.
◦ Ratios - within galaxies - of dark matter to ordinary matter.
◦ Dark matter effects within the Milky Way galaxy.

Table 34: Approximate ratios of dark matter effects to ordinary matter effects (with DM denoting dark matter; with OM denoting ordinary matter; with A denoting amount; and with OM CMB denoting cosmic microwave background radiation)

Approximate DMA:OMA	Amounts
5^+:1	Density of the universe
5^+:1	Amount of stuff in some galaxy clusters
1:1 or 1^+:1	Amount of absorption of OM CMB via some interactions with DM atoms or OM atoms.
0^+:1	Amount of stuff in some early galaxies
≈4:1	Amount of stuff in some early galaxies
1:0^+	Amount of stuff in some early galaxies
0^+:1	Amount of stuff in some later galaxies
≈4:1	Amount of stuff in some later galaxies
1:0^+	Amount of stuff in some later galaxies

2.4. Astrophysics

Table 33 lists opportunities for advances regarding astrophysics. Proposed modeling suggests advances regarding each opportunity.

We discuss ratios that proposed modeling PR6ISP models might predict or explain.

Table 34 lists some approximate ratios of dark matter effects to ordinary matter effects that PR6ISP modeling might explain. We designed PR6ISP modeling to explain the five-plus to one ratio that people observe regarding densities of the universe. Here, the five correlates with dark matter isomers of simple elementary particles (that is, of elementary particles other than G-family elementary particles) and the plus correlates with (ordinary matter isomer) hadron-like particles that do not interact with 2γ force components. Galaxy clusters seem to be sufficiently large to comport with similar ratios. (However, galaxy clusters that are remnants of collisions of galaxy clusters might be exceptions. See discussion related to table 35.) Discussion regarding 2(2)G68 correlates with the approximately one to one ratio. (See discussion related to equation (37) and discussion related to equation (128).) DMA:OMA ratios of zero-plus to one, four to one, and one to zero-plus comport with roles of non-monopole components of gravity in scenarios regarding galaxy formation. (See discussion related to table 37.) DMA:OMA ratios of zero-plus to one, four to one, and one to zero-plus comport with scenarios regarding some galaxies for which observations correlate with times well after galaxy formation. (See other discussion related to table 37.)

2.4.1. CMB depletion via hyperfine interactions

People measure specific depletion of CMB and attribute some of that depletion to hyperfine interactions with (ordinary matter) hydrogen atoms. (See reference [21].) The amount of depletion is twice or somewhat more than twice the amount that people expected. At least one person speculates that the amount above expectations correlates with effects of dark matter. (See reference [22].)

Proposed modeling suggests the following explanation. Solution 2(2)G68 (or, 2G68) might correlate with hyperfine interactions. (See discussion related to equation (37). Perhaps, also note equation (128).) Solution 2G68 has a span of two. (See table 17a.) Solution 2G68 does not correlate with interactions with individual simple fermions. (See table 17a.) Half or somewhat less than half of the observed absorption correlates with the ordinary matter isomer of hydrogen atoms. An approximately equal amount of the observed effect correlates with hydrogen-atom isomers that correlate with one dark matter isomer.

$$2G68 \notin 2\gamma,\ \ 2G68 \notin \gamma 2 \tag{128}$$

To the extent that the absorption by ordinary matter is less than half of the total absorption, the following explanations might pertain regarding the difference between less than half and equal to half. One explanation correlates with the notion that the evolution of the relevant non-ordinary-matter isomer might differ from the evolution of the ordinary matter isomer. The non-ordinary-matter isomer might have more hydrogen-atom-like objects than does the ordinary matter isomer. One explanation correlates with 2GΓ solutions with spans of at least two. Each one of solutions 2(6)G46 and 2(6)G468 might pertain. For each one, the solution is not a member of 2γ and is not a member of $\gamma 2$. The number six appears in both the Γ for 2(2)G46 and the Γ for 2(6)G468. Solution 2(2)G46 correlates with a KMS spatial dipole effect. Solution 2(6)G468 correlates with a KMS spatial dipole effect (and with the notion of GCS quadrupole solution).

Proposed modeling might contribute to credibility for assumptions and calculations that led to the prediction for the amount of depletion that correlates with ordinary matter hydrogen atoms. (Regarding the assumptions and calculations, see reference [23].)

2.4.2. Large clumps of ordinary matter gas and of dark matter

Reference [24] discusses observations that point to the notion that - on a large scale - clumping of matter - ordinary matter gas and dark matter - might be less than ongoing modeling models suggest. Observed phenomena have bases in gravitational lensing of light. The article alludes to a dozen observational studies and points to at least two papers - reference [25] and reference [26]. Clumps would be - to use wording from reference [24] - too thin. (Reference [24] suggests a result of too thin by about ten percent. This essay does not explore the topic of quantifying such thinness.) A distribution of galaxies would be - to use wording from reference [17] - too smooth. Reference [17] suggests a notion of ten percent more evenly spread than ongoing modeling predicts.

Proposed modeling suggests that such effects might correlate with the notion that 4(2)G48 repels more stuff than would 4(1)G48. (See table 18a and table 22.) Early formation of clumps correlates with 4(1)G246 attraction. Early clumps correlate with single isomers. Effects of 4(2)G48 repulsion would dilute matter around early clumps more than would effects that ongoing modeling might correlate with, in effect, 4(1)G48 repulsion. Also, effects of dilution might carry into the times for which 4(6)G4 attraction dominates.

2.4.3. Galaxy clusters - ratios of dark matter to ordinary matter

Regarding some galaxy clusters, people report inferred ratios of dark matter amounts to ordinary matter amounts.

References [27] and [28] report ratios of five-plus to one. The observations have bases in gravitational lensing. Reference [29] reports, for so-called massive galaxy clusters, a ratio of roughly 5.7 to one. (Perhaps, note reference [30].) The observations have bases in X-ray emissions.

Proposed modeling PR6ISP modeling is not incompatible with these galaxy cluster centric ratios.

Reference [31] suggests a formula that correlates - across 64 galaxy clusters - dark matter mass, hot gas baryonic mass (or, essentially, ordinary matter mass), and two radii from the centers of each galaxy cluster. The reference suggests that the formula supports the notion of a correlation between dark matter and baryons. This essay de-emphasizes discussing the extent to which proposed modeling comports with this formula. Proposed modeling might suggest a correlation, based on proposed similarities between dark matter and ordinary matter.

2.4.4. Galaxy clusters - collisions

People use the two-word term Bullet Cluster to refer, specifically, to one of two galaxy clusters that collided and, generally, to the pair of galaxy clusters. The clusters are now moving away from each other. Ongoing modeling makes the following interpretations based on observations. For each of the two clusters, dark matter continues to move along trajectories generally consistent with just gravitational interactions during the collision. For each of the two clusters, stars move along trajectories generally consistent with just gravitational interactions during the collision. For each of the two clusters, (ordinary matter) gas somewhat generally moves along with the cluster, but generally lags behind the other two components (dark matter and stars). Regarding such gas, people use the acronym IGM and the two-word

Table 35: Aspects regarding a collision between two galaxy clusters (with the assumption that each of the two galaxy clusters has not undergone earlier collisions)

Aspect
• Up to essentially nearly all ordinary matter IGM (in each galaxy cluster) interacts with ordinary matter IGM (in the other galaxy cluster) and slows down. (The notion of up to essentially all correlates with equally sized colliding galaxy clusters and with a head-on collision.)
• Much of the stuff correlating with ordinary matter stars passes through with just gravitational interactions having significance.
• No more than somewhat less than 20 percent of dark matter significantly interacts non-gravitationally with dark matter and, based on non-gravitational interactions, slows down. (For each galaxy cluster, this dark matter correlates with the IGM correlating with isomer three.)
• At least 80 percent of dark matter passes through with just gravitational interactions having significance.
• Essentially all of the incoming 1R⊗2U passes through the collision with just gravitational interactions having significance.

term intergalactic medium. Ongoing modeling suggests that the IGM component of each original cluster interacted electromagnetically with the IGM component of the other original cluster. Electromagnetic interactions led to slowing the motion of the gas.

If each of the six dark matter or ordinary matter isomers evolved similarly, there might be problems regarding explaining aspects of the Bullet Cluster. One might expect that, in each galaxy cluster, more (than the observed amount of) dark matter would lag. The lag would occur because of one-isomer 2G-mediated interactions within each of the five dark matter isomers. Possibly, for each dark matter isomer, there would not be enough star-related stuff to explain the amount of dark matter that is not lagging. Possibly, across the six (five dark matter and one ordinary matter) isomers, there would not be enough 1R⊗2U dark matter to significantly help regarding explaining the amount of dark matter that is not lagging.

We assume that four dark matter isomers correlate with proposed modeling notions of cold dark matter and that one dark matter isomer exhibits behavior similar to behavior that ordinary matter exhibits. (See discussion related to table 29 and see table 31.)

Proposed modeling suggests that, for each of the two galaxy clusters, essentially all the stuff correlating with isomers one, two, four, and five would pass through the collision with just gravitational interactions having significance. For isomer three, incoming 1R⊗2U would pass through. For isomer zero, incoming 1R⊗2U (which measures as dark matter) would pass through. Thus, at least 80 percent of the incoming dark matter would pass through the collision with just gravitational interactions having significance.

Table 35 lists aspects regarding a collision between two galaxy clusters. Here, we assume that each of the two galaxy clusters has not undergone earlier collisions.

We suggest that these proposed modeling notions might comport with various possible findings about IGM after a collision such as the Bullet Cluster collision. The findings might point to variations regarding the fractions of IGM that, in effect, stay with outgoing galaxy clusters and the fractions of IGM that, in effect, detach from outgoing galaxy clusters.

We discuss possible aspects regarding an outgoing galaxy cluster.

Suppose that, before a collision, ordinary matter IGM comprised much of the ordinary matter in the galaxy cluster. Suppose that, because of the collision, the galaxy cluster has a significant net loss of ordinary matter IGM. After the collision, the galaxy cluster could have a (perhaps somewhat arbitrarily) large ratio of amount of dark matter to amount of ordinary matter.

To the extent that IGM detaches from galaxy clusters after the galaxy clusters collide, the detached IGM might form one or more objects. Some such objects might have roughly equal amounts of dark matter and ordinary matter. The dark matter would correlate with isomer three.

2.4.5. Interactions between galaxies

Reference [32] reports measurements pertaining to external gravitational effects on components of individual galaxies. The article suggests that - compared to expected results based on notions that correlate with the strong equivalence principle and with general relativity - observations point to unexpected effects regarding galaxy rotation curves. The article suggests the possibility of correlating the unexpected effects with the notion of an external field effect and possibly with aspects of MOND (or, Milgromian dynamics or modified Newtonian dynamics).

Table 36: A scenario for the formation and evolution of a galaxy for which the original clump contains essentially just one isomer (with the two-word phrase featured isomer correlating with that one isomer)

Steps
• Early on, stuff correlating with each one of the six isomers expands, essentially independently from the stuff correlating with other isomers, based on repulsion correlating with 4(1)G2468a and 4(1)G2468b. • Then, each isomer starts to clump, essentially independently from the other isomers, based on attraction correlating with 4(1)G246. • With respect to clumps correlating with any one isomer, 4(2)G48 repels one other isomer and repels some stuff correlating with the first-mentioned isomer. • A galaxy forms based on a clump that contains mostly the featured isomer. • The galaxy attracts and accrues, via 4(6)G4 attraction, stuff correlating with the four isomers that the featured isomer does not repel. The galaxy can contain small amounts of stuff correlating with the isomer that the featured isomer repels.

Proposed modeling provides the possibility that the unexpected results correlate with differences in spans between 4G4 (for which the span is six) and (perhaps just) 4G48 (for which the span is two) and (maybe also) other components of 4γ (for which the spans are one).

2.4.6. Galaxies - formation

We discuss scenarios regarding galaxy formation and evolution. We anticipate that such galaxy formation and evolution scenarios will explain galaxy centric data that table 34 shows.

Models for galaxy formation and evolution might take into account the following factors - one-isomer repulsion (which correlates with the 4G2468a and 4G2468b solutions), one-isomer attraction (which correlates with 4G246), two-isomer repulsion (which correlates with 4G48), six-isomer attraction (which correlates with 4G4), dissimilarities between isomers, the compositions of filaments and galaxy clusters, statistical variations in densities of stuff, and collisions between galaxies. Modeling might feature a notion of a multicomponent fluid with varying concentrations of gas-like or dust-like components and of objects (such as stars, black holes, galaxies, and galaxy clusters) for which formation correlates significantly with six-isomer (or 4G4) attraction.

We focus on early-stage galaxy formation and evolution. For purposes of this discussion, we assume that we can de-emphasize collisions between galaxies. We suggest the two-word term untouched galaxy for a galaxy that does not collide, before and during the time relevant to observations, with other galaxies. We emphasize formation scenarios and evolution scenarios for untouched galaxies. (Reference [33] and reference [34] discuss data that pertains regarding a time range from about one billion years after the Big Bang to about 1.5 billion years after the Big Bang. Observations suggest that, out of a sample of more than 100 galaxies or galaxy-like rotating disks of material, about 15 percent of the objects might have been untouched.)

We assume that differences - in early evolution - regarding the various isomers do not lead, for the present discussion, to adequately significant differences - regarding 4G interactions and galaxy formation - between isomers. (We think that this assumption can be adequately useful, even given our discussion regarding the Bullet Cluster. Regarding the Bullet Cluster, see discussion related to table 35.)

We organize this discussion based on the isomer or isomers that originally clump based, respectively, on 4G246 attraction or on 4G246 attraction and 4G4 attraction. Each one of some galaxies correlates with an original clump that correlates with just one isomer. Multi-isomer original clumps are possible. Because of 4G48 repulsion, an upper limit on the number of isomers that an original clump features might be three.

Table 36 discusses a scenario for the formation and evolution of a galaxy for which the original clump contains essentially just one isomer. Regarding this isomer, we use the word featured. We assume that stuff that will become the galaxy is always in somewhat proximity with itself. We assume that no collisions between would-be galaxies or between galaxies occur.

2.4.7. Galaxies - ratios of dark matter to ordinary matter

We continue to explore the realm of one-isomer clumps.

One of two cases pertains. For so-called case A, one isomer of 4G48 spans (or connects) isomers zero and three. (Regarding numbering for isomers, see n in table 31.) For so-called case B, one isomer of 4G48 spans isomer zero and one isomer out of isomers one, two, four, and five. The existence of many spiral galaxies might point to the notion that case A pertains. (Compare the rightmost column in table 37a and the rightmost column in table 37b.) However, we consider the possibility that people might not know of data or current modeling that would adequately point to the one of case A and case B that pertains. We discuss both cases.

Table 37 pertains. (See table 34.) The following sentences illustrate the notion that some statements in table 37 are at least somewhat conceptual. We assume that local densities for the isomers are somewhat the same. We assume that the galaxy remains adequately untouched. For each row in the table, OM stars can form (and become visible) over time, whether or not significant OM star formation occurs early on. The notation DMA:OMA=1:0^+ denotes the notion that the ratio of OMA to DMA might be arbitrarily small. (Table 34 defines the three-letter terms DMA and OMA.) The notion of three or four DM isomers in a halo refers to the notion that one or zero (respectively) of the DM isomers in the halo is the featured isomer. We de-emphasize some aspects regarding 1R⊗2U hadron-like particles.

Table 37 reflects at least two assumptions. Each core clump features one isomer. Each galaxy does not collide with other galaxies. Yet, data of which we know and discussion below seem to indicate that ratios that table 37 features pertain somewhat broadly. We think that galaxies that have core clumps that feature more than one isomer are more likely to appear as elliptical galaxies (and not as spiral galaxies) than are galaxies that have core clumps that feature only one isomer. Such likelihood can correlate with starting as being elliptical. Such likelihood can correlate with earlier transitions - via collisions - from spiral to elliptical.

We explore the extent to which the galaxy formation scenarios comport with observations.

Observations regarding stars and galaxies tend to have bases in ordinary matter isomer 2G phenomena (or, readily observable electromagnetism). (The previous sentence de-emphasizes some observations - regarding collisions between black holes or neutron stars - that have bases in 4G phenomena.) People report ratios of amounts of dark matter to amounts of ordinary matter.

We discuss observations correlating with early in the era of galaxy formation. Table 34 comports with these results. We suggest that visible early galaxies correlate with generalization of label-A0 or with generalization of label-B0. (See table 37.) Label-A3 or label-B3 evolves similarly to label-A0 or label-B0, but is not necessarily adequately visible early on.

- Reference [35] provides data about early-stage galaxies. (See, for example, figure 7 in reference [35]. The figure provides two graphs. Key concepts include redshift, stellar mass, peak halo mass, and a stellar - peak halo mass ratio.) Data correlating with redshifts of at least seven suggests that some galaxies accrue, over time, dark matter, with the original fractions of dark matter being small. Use of reference [36] suggests that redshifts of at least seven pertain to times ending about 770 million years after the Big Bang.

- Reference [37] reports zero-plus to one ratios. The observations have bases in the velocities of stars within galaxies and correlate with the three-word term galaxy rotation curves. Proposed modeling suggests that the above galaxy evolution scenario comports with this data.

We discuss observations correlating with later times. Table 34 comports with these results.

- Reference [38] discusses some MED09 spiral - or, disk - galaxies. A redshift of approximately $z = 1.57$ pertains. (See reference [39].) The redshift correlates with a time of 4.12 billion years after the Big Bang. (We used reference [36] to calculate the time.) Reference [38] reports ratios of amount of dark matter to amount of ordinary matter of approximately four to one. The observations have bases in gravitational lensing. We suggest that each label - other than label-A3 or label-BP - that table 37 shows might pertain. (We note, without further comment, that this example might correlate with the notion that case A pertains to nature and that case B does not pertain to nature. This example features spiral galaxies. Label-A0 suggests a correlation with spiral galaxies. Each other label - pertaining to case A or to case B - either correlates with dark matter galaxies or might suggest a correlation with - at least statistically - evolution into elliptical galaxies. See table 37.)
  - To the extent that such an MED09 galaxy models as being nearly untouched, proposed modeling offers the following possibility. The galaxy began based on a one isomer clump. The clump might have featured the ordinary matter isomer. The clump might have featured a dark matter isomer that does not repel ordinary matter. Over time, the galaxy accrued stuff correlating with the isomers that the original clump did not repel. Accrual led to a ratio of approximately four to one.

Table 37: Aspects regarding untouched galaxies that correlate with original one-isomer clumps (with just one of cases A and B pertaining to all galaxies)

(a) Case A

Label	Featured isomer (n)	Early aspects regarding the galaxy	Possible later aspects regarding the galaxy
A0	0	Forms some ordinary matter stars early on. Starts at DMA:OMA=0^+:1.	Attracts cold dark matter over time. Can get to DMA:OMA≈4:1, with most DM in a halo. Might be a spiral galaxy.
A3	3	Forms some dark matter stars early on. Starts at DMA:OMA=1:0^+.	Attracts the four other DM isomers over time. Some OM stars can form over time. Can settle at DMA:OMA=1:0^+. The three-word term dark matter galaxy pertains.
AX	Any one of 1, 2, 4, and 5	Might form dark matter stars early on. Starts at DMA:OMA=1:0^+.	Attracts the OM isomer and three other isomers over time. OM stars can form over time. Can get to DMA:OMA≈4:1, with three or four DM isomers in a halo. Might become an elliptical galaxy.

(b) Case B

Label	Featured isomer (n)	Early aspects regarding the galaxy	Possible later aspects regarding the galaxy
B0	0	Forms some ordinary matter stars early on. Starts at DMA:OMA=0^+:1.	Attracts isomer three and three cold dark matter isomers over time. Can get to DMA:OMA≈4:1, with three DM isomers in a halo. Might appear to be an elliptical galaxy.
BP	The DM isomer that 4G48 connects to the OM isomer	Might form dark matter stars early on. Starts at DMA:OMA=1:0^+.	Attracts the other DM isomers over time. OM stars can form over time. Can settle at DMA:OMA=1:0^+. The three-word term dark matter galaxy pertains.
B3	3	Forms some dark matter stars early on. Starts at DMA:OMA=1:0^+.	Attracts the OM isomer and three other DM isomers over time. OM stars can form over time. Can get to DMA:OMA≈4:1, with three DM isomers in a halo. Might appear to be an elliptical galaxy.
BY	Any one of the other three DM isomers	Might form dark matter stars early on. Starts at DMA:OMA=1:0^+.	Attracts the OM isomer and three other DM isomers over time. OM stars can form over time. Can get to DMA:OMA≈4:1, with three or four DM isomers in a halo. Might appear to be an elliptical galaxy.

  - To the extent that such an MED09 galaxy models as not being untouched, proposed modeling offers the following possibility. One type of collision merges colliding galaxies. One type of collision features galaxies that separate after exchanging material. For either type of collision, incoming galaxies having approximately four times as much dark matter as ordinary matter might produce outgoing galaxies having approximately four times as much dark matter as ordinary matter.

- Reference [40] discusses the Dragonfly 44 galaxy. A redshift of $z = 0.023$ pertains. The redshift correlates with a time of 13.45 billion years after the Big Bang. (We used reference [36] to calculate the time.) People discuss the notion that ordinary matter accounts for perhaps as little as one part in 10 thousand of the matter in the galaxy. (See reference [41].) The observations have bases in light emitted by visible stars. This case correlates with the three-word term dark matter galaxy. We suggest that label-A3 or label-BP might pertain. (See table 37.)

The following notions pertain regarding other data of which we know. Here, the ratios are ratios of dark matter amounts to ordinary matter amounts. Table 34 seems to comport with these results. (See table 37.)

- Reference [42] discusses six baryon-dominated ultra-diffuse galaxies that seem to lack dark matter, at least to the radii studied (regarding gas kinematics) via observations of light with a wavelength of 21 centimeters. These observations seem not to be incompatible with the early stages of label-A0 or label-B0.

- Reference [43] discusses 19 dwarf galaxies that lack having much dark matter, from their centers to beyond radii for which ongoing modeling suggests that dark matter should dominate. These observations measure r-band light that the galaxies emitted. These observations seem not to be incompatible with the early stages of label-A0 or label-B0.

- People report two disparate results regarding the galaxy NGC1052-DF2. Proposed modeling seems to be able to explain either ratio. Proposed modeling might not necessarily explain ratios that would lie between the two reported ratios.

  - Reference [44] suggests a ratio of much less than one to one. The observation has bases in the velocities of stars - or, galaxy rotation curves. This observation seems not to be incompatible with the early stages of label-A0 or label-B0.
  - Reference [45] suggests that at least 75 percent of the stuff within the half mass radius is dark matter. This ratio seems similar to ratios that reference [38] discusses regarding some MED09 galaxies. (See discussion above regarding MED09 galaxies.) We suggest that each label - other than label-A3 or label-BP - that table 37 shows can pertain.

- The galaxy NGC1052-DF4 might correlate with a ratio of much less than one to one. (See reference [46].) The observation has bases in the velocities of stars - or, galaxy rotation curves. This observation seems not to be incompatible with the early stages of label-A0 or label-B0.

- The compact elliptical galaxy Markarian 1216 has an unexpectedly large amount of dark matter in its core and may have stopped accumulating each of ordinary matter and dark matter approximately 4 billion years after the Big Bang. (See reference [47].) Observations feature the X-ray brightness and temperature of hot gas. This galaxy might correlate with an original clump that features three isomers. One isomer would be the ordinary matter isomer. Around the time that the galaxy stopped accruing material, there was - near the galaxy - essentially nothing left for the galaxy to attract via 4(6)G4.

- The galaxy XMM-2599 stopped producing visible stars by approximately 1.8 billion years after the Big Bang. (See reference [48].) People speculate regarding a so-called quenching mechanism. Proposed modeling suggests that phenomena similar to phenomena that might pertain regarding Markarian 1216 might pertain regarding XMM-2599.

People report other data. Table 34 and table 37 seem not to be incompatible with these results. We are uncertain as to the extents to which proposed modeling provides insight that ongoing modeling does not provide.

- One example features a rotating disk galaxy, for which observations pertain to the state of the galaxy about 1.5 billion years after the Big Bang. (See reference [49].) People deduce that the galaxy originally featured dark matter and that the galaxy attracted ordinary matter.

- One example features so-called massive early-type strong gravitation lens galaxies. (See reference [50].) Results suggest, for matter within one so-called effective radius, a minimum ratio of dark matter to dark matter plus ordinary matter of about 0.38. Assuming, for example, that measurements correlating with material within larger radii would yield larger ratios, these observational results might support the notion that the galaxies accumulated dark matter over time.

- One example pertains to early stages of galaxies that are not visible at visible light wavelengths. (See reference [51].) Observations feature sub-millimeter wavelength light. We might assume that proposed modeling galaxy formation scenarios comport with such galaxies. We are not certain about the extent to which proposed modeling might provide insight regarding subtleties, such as regarding star formation rates, correlating with this example.

- We are uncertain as to the extent to which proposed modeling might provide insight regarding possible inconsistencies - regarding numbers of observed early-stage galaxies and numbers of later stage galaxies - that correlate with various observations and models. (For a discussion of some possible inconsistencies, see reference [52].)

- We are uncertain as to the extent to which proposed modeling might provide insight regarding the existence of two types - born and tidal - of ultra-diffuse galaxies. (See reference [53].)

Observations that we discuss above indicate that some galaxies do not exhibit dark matter halos. Proposed modeling that we discuss above comports with the notion that some galaxies do not exhibit dark matter halos.

2.4.8. Some components of galaxies

We discuss effects, within galaxies, that might correlate with dark matter.

Reference [54] reports, based on a study of 11 galaxy clusters, more instances of more gravitational lensing - likely correlating with clumps of dark matter that correlate with individual galaxies - than ongoing modeling simulations predict. Reference [55] suggests that the number of instances - 13 - compares with an expected number of about one. We suggest the possibility that the clumps might be dark matter galaxies. (See, for example, table 37.) Perhaps some of the dark matter galaxies are dwarf dark matter galaxies. We suggest the possibility that galaxies with significant amounts of ordinary matter gravitationally captured (or at least attracted) such dark matter clumps.

People study globular cluster systems within ultra-diffuse galaxies. Regarding 85 globular cluster systems in ultra-diffuse galaxies in the Coma cluster of galaxies, reference [56] suggests that 65 percent of the ultra-diffuse galaxies are more massive than people might expect based on ongoing modeling relationships, for so-called normal galaxies, between stellar mass and halo mass. We are uncertain as to the extent to which proposed modeling might explain this result. For example, proposed modeling might suggest that phenomena related to isomers might play a role. (See, for example, table 37.) Higher-mass galaxies might tend to feature more dark matter isomers (or tend to feature more material that correlates with such isomers) than do lower-mass galaxies.

Discussion related to table 37 is not incompatible with the notion that visible stars do not include much dark matter.

Discussion related to table 37 is not incompatible with the notion that some black holes that form based on the collapse of stars might originally correlate with single isomers. Discussion above is not incompatible with the notion that supermassive black holes might contain material correlating with more than one isomer. (Perhaps, note references [57] and [58].)

We suggest that proposed modeling might provide insight about other aspects regarding black holes. People suggest gaps in understanding about the formation of intermediate-mass and large-mass black holes. (Perhaps, note reference [59].) Proposed modeling suggests the possibility that the 4G(1)246 attractive component of G-family forces plays key roles in the early formation of some intermediate-mass and large-mass black holes.

Regarding the coalescing of two black holes, proposed modeling suggests that people might be able to estimate the extent to which 4G48 repulsion pertains. Effects of 4G48 repulsion would vary based on the amounts of various isomers that each black hole in a pair of colliding black holes features.

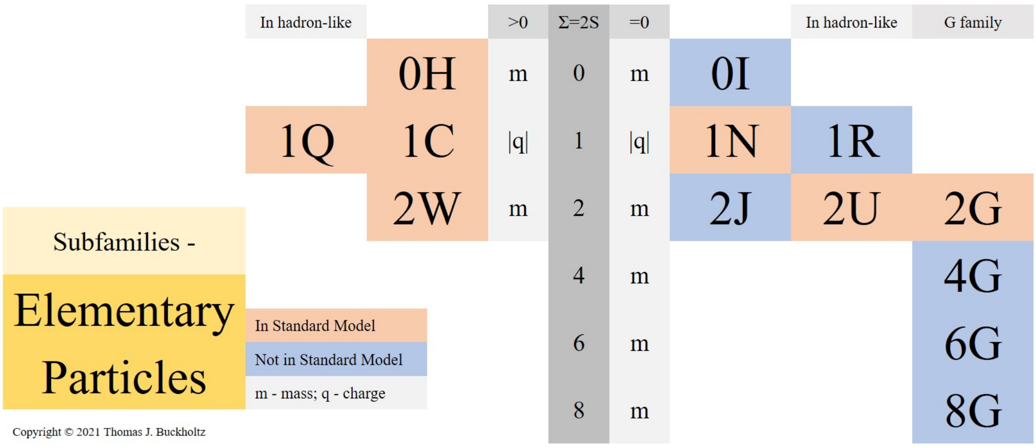

Figure 1: Subfamilies of elementary particles

2.4.9. Dark matter effects within the Milky Way galaxy

People look for possible effects, within the Milky Way galaxy, that might correlate with dark matter.

For one example, data regarding the stellar stream GD-1 suggests effects of an object of 10^6 to 10^8 solar masses. (See reference [60].) Researchers tried to identify and did not identify an ordinary matter object that might have caused the effects. The object might be a clump of dark matter. (See reference [61].) Proposed modeling offers the possibility that the object is an originally dark matter centric clump of stuff.

For other examples, people report inhomogeneities regarding Milky Way dark matter. (See references [61] and [62].) Researchers note that simulations suggest that such dark matter may have velocities similar to velocities of nearby ordinary matter stars. We suggest that these notions are not incompatible with proposed modeling notions of the existence of dark matter stars that would be similar to ordinary matter stars.

3. Results

This unit summarizes results that proposed modeling produces.

3.1. Physics properties

Tables 10 and 11 show an organizing and a uniting of various properties of objects. Examples of ongoing modeling properties include charge, energy, angular momentum, and momentum. The property of isomer (of simple elementary particles) arises from proposed modeling.

Principles for organizing and uniting the properties come from proposed modeling models that feature components of long-range forces. (See, for example, table 6, table 7, and table 8.)

Table 38 explores further organizing and uniting of properties of objects.

3.2. Elementary particles

Table 13 alludes to all known elementary particles and to candidate elementary particles that proposed modeling suggests. Table 14 and table 15 provide additional information about the elementary particles. Figure 1 summarizes some information about elementary particles.

This essay suggests that particles correlating with table 13 might suffice - from the standpoint of elementary particles - to explain data that ongoing modeling does not yet explain and to predict data that ongoing modeling does not necessarily predict. Some of that data correlates with the field of cosmology. Some of that data correlates with the field of astrophysics. Some of that data correlates with the field of elementary particles.

Proposed modeling points to various correlations among properties of elementary particles and strengths of interactions.

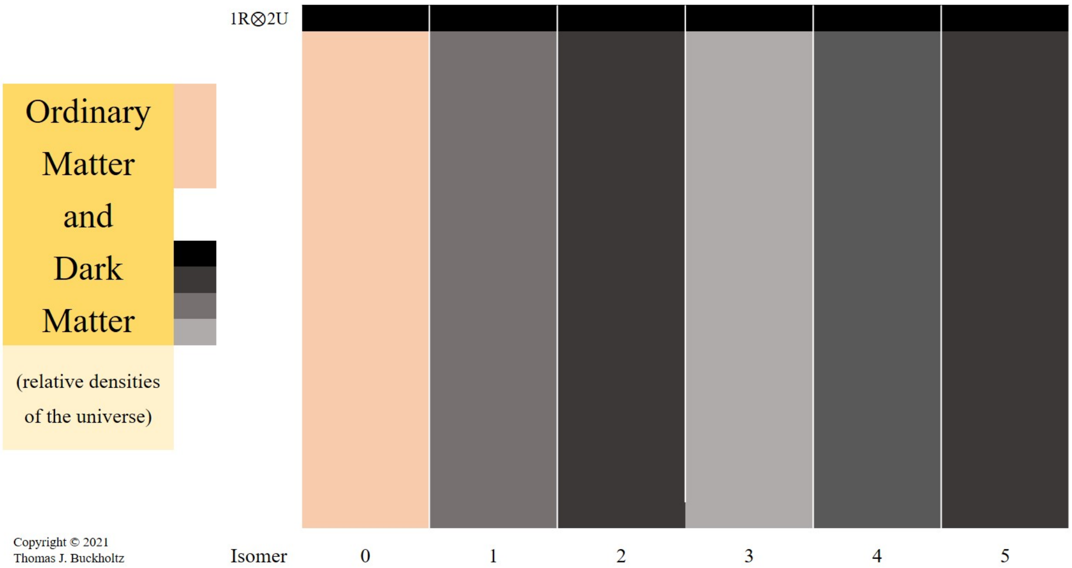

Figure 2: Ordinary matter and dark matter, regarding densities of the universe

3.3. Cosmology

Proposed modeling suggests advances correlating with the opportunities that table 30 lists. Figure 2 depicts some information about the ratio of dark matter density of the universe to ordinary matter density of the universe.

3.4. Astrophysics

Proposed modeling suggests advances correlating with the opportunities that table 33 lists and with data to which table 34 alludes.

3.5. Physics modeling

Proposed modeling suggests perspective about modeling and about notions correlating with the word object. For example, table 10 and table 11 suggest perspective about relationships between models, modeling that purports to discuss distinguishable (or, generally non-entangled) objects, and properties that correlate with objects.

4. Discussion

This unit provides perspective about some physics topics and about proposed modeling.

4.1. Dark energy density

We explore possible explanations for nonzero dark energy density.

Equation (129) shows a ratio of presently inferred density of the universe of dark energy to presently inferred density of the universe of dark matter plus ordinary matter plus (ordinary matter) neutrinos plus (ordinary matter) photons. (Reference [1] provides the five items of data.) Inferences that reference [63] discusses might suggest that inferred dark energy density increases with time. Reference [64] suggests that an inferred density of essentially zero correlates with times around 380,000 years after the Big Bang. We know of no inferences that would not comport with a somewhat steady increase - regarding the inferred ratio correlating with equation (129) - from approximately zero over time since somewhat after the Big Bang.

$$\Omega_\Lambda/(\Omega_c + \Omega_b + \Omega_\nu + \Omega_\gamma) \approx 2.18 \tag{129}$$

Some aspects of ongoing modeling correlate inferred dark energy densities of the universe with phenomena correlating with terms such as vacuum energy, vacuum fluctuations, or quintessence. Proposed modeling is not necessarily incompatible with such ongoing modeling. Nevertheless, we discuss possibilities for proposed modeling that might explain nonzero dark energy density.

For any one of PR1ISP modeling, PR6ISP modeling, and PR36ISP modeling, aspects related to aye (or, 0I) bosons and jay (or, 2J) bosons might lead to phenomena similar to effects that ongoing modeling correlates with vacuum energy, vacuum fluctuations, or quintessence. (See discussion related to equations (86) and (87). Perhaps, also note discussion related to equation (109).)

For PR6ISP modeling, proposed modeling includes the notion of 2(6)G248, whereas ongoing modeling correlates with the notion of 2(1)G248. The difference, in proposed modeling, between 2(6)G248 and 2(1)G248 might correlate with nature's indirectly producing effects, regarding CMB, that people correlate (via ongoing modeling) with some nonzero dark energy density. The difference correlates with interactions between ordinary matter and dark matter.

PR36ISP modeling offers another possibility. (This possibility correlates with a six-fold symmetry that correlates with the instance of $U(1) \times SU(1)$ that table 11b shows.) We assume that the spans of 4(6)G4 and the other 4(>1)GΓ components are orthogonal to the spans of 2(6)G248 and the other 2(>1)GΓ components. The PR36ISP universe correlates with six isomers of a PR6ISP sub-universe. Each PR6ISP sub-universe includes its own isomer of 4(6)G4. We continue to correlate ordinary matter with isomer zero and most dark matter with isomers one through five. We use the numbers six, 12, 18, 24, and 30 to number the five isomers for which 2(6)GΓ components intermediate interactions with isomer zero. We use the three-word term doubly dark matter to correlate with isomers six through 35. Doubly dark matter isomers do not interact with ordinary matter via 4G. Dark matter isomers do not interact with ordinary matter via 2G. Differences between 2(>1)GΓ and 2(1)GΓ correlate with interactions between ordinary matter plus dark matter and doubly dark matter. All interactions - mediated by 2G - that PR6ISP modeling would correlate with interactions between ordinary matter and dark matter isomers become - for PR36ISP modeling - interactions between ordinary matter and doubly dark matter. Dark energy density might correlate with stuff correlating with the 30 doubly dark matter isomers. Modeling suggests an upper bound of approximately five regarding a possible future value for the ratio that correlates with equation (129).

4.2. W boson mass and full magnetic moment

Reference [1] suggests that the full magnetic moment of the W boson might exceed a nominal magnetic moment that correlates with the number two. Reference [1] provides the value that equation (130) shows.

$$\mu_W = 2.22^{+0.20}_{-0.19} \tag{130}$$

We explore the notion that, for the W boson, the $USA16$ aspect (which, for these purposes, correlates with the $USA2$ aspect) correlates generally with magnetic moment and specifically with a full magnetic dipole moment. (See discussion related to equation (48).) We note two calculations.

For charged leptons, ongoing modeling provides a first-order correction to the nominal magnetic dipole moment of $g = 2$. The correction has the form $(g-2)/2 = \alpha/(2\pi)$ or $g \approx 2 + (\alpha/\pi)$. We experiment, based on a possibly somewhat arbitrary assumption. Using $2+(\alpha/\pi)$ (and not using 2) with equation (49) would suggest a W boson rest energy of 80.3932 GeV, which is about 1.2 standard deviations above the measured value that reference [1] provides. The value $g \approx 2 + (\alpha/\pi)$ is not necessarily incompatible with equation (130). A W boson rest energy of 80.3932 GeV might be more - than the rest energy equation (47) suggests - compatible with (future) data. However, the rest energy that equation (47) suggests is not necessarily incompatible with data.

If, instead, one uses 2.22 (from equation (130)), one calculates a W boson rest energy of 66.5 GeV, which is not acceptable.

We know of no currently available path to further explore the accuracy of equation (47).

4.3. High-mass neutron stars

We discuss proposed modeling that might explain some aspects regarding high-mass neutron stars.

The following results have bases in observations. An approximate minimal mass for a neutron star might be $1.1M_\odot$. (See reference [65].) The symbol $M_\odot$ denotes the mass of the sun. An approximate maximum mass for a neutron star might be $2.2M_\odot$. (See references [66] and [67].)

Some ongoing modeling models suggest a maximum neutron star mass of about $1.5M_\odot$. (See reference [67].)

Observations correlate with most known neutron star pairs having masses in the range that equation (131) shows and one neutron star pair having a mass of about 3.4 solar masses. (See references [68] and [69].) Here, M denotes the mass of a pair. The 3.4 number results from the second detection via gravitational waves of a merger of two neutron stars. People assign the name GW190425 to that detection.

$$2.5M_{\odot} \lesssim M \lesssim 2.9M_{\odot} \tag{131}$$

People speculate - based on, at least, the GW190425 result - about needs for new modeling regarding neutron stars. (See references [68] and [67].)

Detection GW190814 suggests that people have inferred the existence of an object for which equation (132) pertains. (See reference [70].) People speculate that the object might have been a high-mass neutron star or might have been a low-mass black hole.

$$M \approx 2.6M_{\odot} \tag{132}$$

We discuss possible bases for high-mass neutron stars.

The span of 4G4 is six.

Some high-mass neutron stars might, in effect, result from mergers of neutron stars, with each merging neutron star correlating with an isomer that differs from the isomer pertaining to each other neutron star that forms part of the merger.

4.4. Physics properties

Table 38 organizes and interrelates properties of elementary particles and other objects. Table 38 includes aspects from table 10 and table 11. Table 38 points to and suggests notions regarding other aspects. Some of the notions regarding such other aspects may prove to be incomplete or not useful.

Equation (133) points to oscillator pairs that correlate with some physics constants. The case of $j = 1$ correlates with m_e (and with other masses, such as m_{Higgs}). The case of $j = 2$ correlates with $\hbar$. The case of $j = 3$ correlates with c. (Perhaps note that, in table 10b, translational momentum correlates with USA: 11-12.) The case of $j = 4$ correlates with q_e (and with other charges).

$$USA(4j-1) \text{ and } USA(4j) \tag{133}$$

Ongoing modeling suggests new notions regarding physics properties.

We consider PR6ISP modeling. We discuss properties - as interpreted via isomer zero observations and experiments - of isomer one simple particles. The notion of $\Sigma G\Gamma$ provides a basis for this discussion.

We consider ground state rest energy. Notions correlating with 4G4 pertain. 4G4 has a span of six. For isomer one objects, isomer zero measures the same passive gravitational rest energies as isomer one measures. For isomer one objects, isomer zero measures the same active gravitational rest energies as isomer one measures. For isomer one objects, when isomer zero measures aspects that correlate with 2G, isomer zero measurements do not necessarily agree with isomer one measurements. Isomer zero measurements attribute charges of zero to isomer one objects that have nonzero isomer one charges. Isomer zero measurements attribute nominal magnetic dipole moments of zero to isomer one objects that have nonzero isomer one nominal magnetic dipole moments. Isomer zero measurements attribute the same nominal magnetic quadruple moments to isomer one objects as do isomer one measurements.

Discussion elsewhere suggests the possibility that - regarding measurements (made via isomer zero 2(1)G techniques) of not necessarily gravitational masses (perhaps, including inertial masses) of isomer one objects - the isomer zero inference of not necessarily gravitational masses (perhaps, including inertial masses) of the isomer one objects might differ from the passive gravitational masses of the isomer one objects by a factor of β. (See, for example, discussion related to equation (107) or aspects related to table 29.)

4.5. Proposed modeling

The following notions were essential to the development of proposed modeling.

There might be a straightforward explanation for three eras in the rate of expansion of the universe.

There might be a straightforward explanation for the ratio of dark matter density of the universe to ordinary matter density of the universe.

Solutions - that were seemingly previously essentially unknown and that ongoing modeling might consider to correlate with the three-word term below ground state - regarding harmonic oscillator mathematics exist and might have use in physics modeling.

People might use observational data about dark matter and objects (especially, but not only just, galaxies) to evaluate the usefulness - regarding elementary particle physics, astrophysics, and cosmology - of proposed modeling.

Table 38: Interrelationships between properties of elementary particles and other objects (with some speculation included)

Oscillators	$\Sigma\Phi$	Aspect
USA: 0	4G	For elementary bosons: $n_{USA0} = 0$ correlates with gravitational mass being nonzero; $n_{USA0} = -1$ correlates with gravitational mass being zero.
USA: 0	2G	For elementary fermions: $n_{USA0} = 0$ correlates with charge being nonzero; $n_{USA0} = -1$ correlates with charge being zero.
USA: 0	-	For objects that model as not entangled: $n_{USA0} = 0$ correlates with travel at speeds less than c; $n_{USA0} = -1$ correlates with travel at the speed c.
USA: 1-2	2G	For objects with nonzero charge: the charge-centric interaction has a strength that is an integer multiple of $(\lvert q_e\rvert/3) \cdot (1/(4\pi\varepsilon_0))^{1/2}$.
USA: 1-2	4G	For objects that exhibit charge: the charge affects gravitation.
USA: 1-4	2G	Modeling might correlate with one or more of the following: ${\mu_0}^{1/2}$ (with μ_0 denoting magnetic permeability in a vacuum), K_{J} (the Josephson constant; see discussion related to equation (97)), and g (an aspect of magnetic moments).
USA: 3-4	4G	For objects with nonzero mass m: the gravitation-centric interaction has a strength that correlates with $m \cdot (G_N)^{1/2}$.
USA: 3-4	4G	For nonzero mass elementary bosons: the mass-centric interaction has a strength that might be an integer multiple of $(m_{0H}/(17)^{1/2}) \cdot (G_N)^{1/2}$.
USA: 3-4	-	For PR6ISP models: six isomers of PR1ISP pertain.
USA: 5-6	4G	For elementary fermions: the number of generations is three.
USA: 7-8	8G	For elementary bosons: the spin is an integer multiple of $\hbar$.
USA: 7-8	8G	For elementary fermions: the spin is $\hbar/2$.
USA: 7-8	4G	For objects that exhibit spin: the spin affects gravitation.
USA: 11-12	2G	The speed, for which we suggest the symbol c_{2G}, of propagation of electromagnetism (in a vacuum) equals c.
USA: 11-12	4G	The speed, for which we suggest the symbol c_{4G}, of propagation of gravitation (in a vacuum) equals c.
USA: 13-14	-	Five (as in $15/3 = g_{SU(4)}/g_{SU(2)}$) might correlate with the five spin states correlating with spin two (The symmetry might not be directly relevant.)
USA: 15-16	2G	The choices for magnitudes of charges for nonzero charge elementary fermions are $\lvert q_e\rvert$, $\lvert 2q_e/3\rvert$, and $\lvert q_e/3\rvert$. The choices correlate with whether elementary fermions exhibit the property of color charge.
USA: 15-16	4G	For objects that pulsate: the pulsation (or, ringing) energy affects gravitation.
UTA: 0	-	For elementary particles and other objects: $n_{UTA0} = 0$ correlates with modeling that correlates with the two-word phrase not entangled; $n_{UTA0} = -1$ correlates with modeling that correlates with the word entangled.
UTA: 1-2	2U	For elementary fermions that exhibit color charge: the number of color charges is three.
UTA: 3-4	4G	For an object, UTA: 3-4 correlates with total energy.
UTA: 3-4	-	For PR36ISP models: six isomers of PR6ISP pertain.
UTA: 5-6	4G	For an object, UTA: 5-6 correlates with freeable total energy.
UTA: 5-6	4G	For some objects (for example, an ideal gas) and some modeling, UTA: 5-6 correlates with an integer (for which an instance of $SU(2)$ symmetry might be relevant) times $(1/2)k_{\mathrm{B}}T$, in which k_{B} is the Boltzmann constant and T is the temperature.

The following notions might pertain regarding proposed modeling.

People might find that some aspects of proposed modeling are incomplete or are not compatible with data. We suggest that people might be able to adjust proposed modeling - to remedy such lacks of completeness or compatibility - without abandoning much of proposed modeling. Some incompleteness might feature the extents to which neutrinos and arcs model as being Dirac fermions or Majorana fermions.

5. Concluding remarks

Proposed modeling might provide impetus for people to tackle broad agendas that our work suggests. Proposed modeling might provide means to fulfill aspects of such agendas. Proposed modeling might fulfill aspects of such agendas.

Opportunities might exist to develop more sophisticated modeling than the modeling that we present. Such a new level of work might provide more insight than we provide.

Proposed modeling suggests applied mathematics techniques that might have uses other than uses that we make.

Proposed modeling might suggest - directly or indirectly - opportunities for observational research, experimental research, development of precision measuring techniques and data analysis techniques, numerical simulations, and theoretical research regarding elementary particle physics, astrophysics, and cosmology.

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