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Theory that predicts and explains data about elementary particles, dark matter, early galaxies, and the cosmos

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Abstract

We develop and apply new physics theory. The theory suggests specific unfound elementary particles. The theory suggests specific constituents of dark matter. We apply those results. We explain ratios of dark matter amounts to ordinary matter amounts. We suggest details about galaxy formation. We suggest details about inflation. We suggest aspects regarding changes in the rate of expansion of the universe. The theory points to relationships between masses of elementary particles. We show a relationship between the strength of electromagnetism and the strength of gravity. The mathematics basis for matching known and suggesting new elementary particles extends mathematics for harmonic oscillators.

Keywords: Beyond the Standard Model, Dark matter, Dark energy, Inflation, Galaxy evolution, Rate of expansion of the universe, Quantum gravity, Harmonic oscillator, Mathematical physics

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1. Introduction: context for and summary of results

This unit provides an overview of theory that this essay proposes. This unit discusses context and scope for the proposed theory. This unit discusses relationships between data, proposed theory, and ongoing theory. This unit provides perspective about this essay.

1.1. Overview

This unit discusses highlights about proposed theory.

We propose new physics theory. The new theory includes modeling that matches all known elementary particles and suggests new elementary particles. We use the two-word term ongoing theory to denote established theory and some candidate theory that other people suggest. We use the two-word term proposed theory to denote new theory that we suggest.

The following items point to topics that proposed theory addresses. Each item notes aspects that underlie proposed theory or that come from proposed theory.

- Extensions to harmonic-oscillator mathematics. Minor changes in assumptions lead to harmonic oscillator states that people might consider to lie below traditional ground states. The resulting math has applications to elementary particle physics.

- Mathematics-based modeling pertaining to elementary particles, astrophysics, and cosmology. Extended harmonic-oscillator math provides bases for modeling pertaining to elementary particles, dark matter, dark energy forces, and observations that physicists report. Modeling features solutions to equations featuring isotropic pairs of isotropic quantum harmonic oscillators.

- Elementary particles. A model outputs solutions correlating with all known elementary particles and a list of suggested elementary particles.

- Astrophysics (dark matter). A combination of the list of elementary particles and one additional assumption suggests a well-specified candidate description for dark matter. That description explains various observed ratios of dark matter effects to ordinary matter effects.

- Cosmology. The list of elementary particles includes a description of gravity. Applications of the description of gravity include quantum gravity and classical gravitation. The description explains eras regarding the rate of expansion of the universe. The list of elementary particles provides a specification for an inflaton. The inflaton provides candidate explanations for aspects of inflation and of phenomena immediately after the inflationary epoch. The list of elementary particles provides a candidate explanation for baryon asymmetry.

- Astrophysics (galaxy formation). A combination of dark matter aspects of proposed theory and gravitational aspects of proposed theory leads to galaxy formation scenarios that match observed data.
- Fundamental aspects of physics. The work relates a ratio of the masses of two elementary particles to a ratio of the strength of electromagnetism to the strength of gravity. Other formulas interrelate the masses of other elementary particles.

1.2. Context for and scope of proposed theory

This unit discusses context for, aspects of, and the scope of proposed theory.

Physics includes issues that have remained unresolved for decades. For one example, describe elementary particles that people have yet to find. For another example, describe dark matter. For each of those examples, resolution does not necessarily depend on considering models pertaining to translational motion.

Ongoing theory has bases in developing theories of motion without necessarily having descriptions of objects that move. Examples of such theories feature epicycles, elliptical orbits, and the principle of stationary action. Ongoing theory has bases in adding quantization to classical modeling of the motion of objects.

We pursue an approach that catalogs fundamental objects and their properties. The proposed theory approach features, from its beginning, quantized concepts. The approach does not originally address translational motion.

The proposed theory approach and the ongoing theory approach dovetail via symmetries that ongoing theory correlates with kinematics conservation laws. We discuss results that we develop based on elementary particles that proposed theory suggests and on kinematics models that ongoing theory provides.

Proposed theory matches, explains, or predicts phenomena that ongoing theory does not explain or predict. For example, we suggest - with some specificity - descriptions of new elementary particles and of dark matter.

1.3. Proposed theory, physics data, and ongoing theory

This unit provides an overview of proposed theory. This unit discusses relationships between proposed theory, physics data, and ongoing theory.

Generally, proposed theory suggests complements (or, additions) to ongoing theory. We suggest additions to the list of elementary particles. We suggest descriptions for dark matter. We suggest new symmetries and, therewith, at least one new conservation law. We suggest new approximate symmetries and, therewith, new somewhat conservation laws. Some of our suggestions point to possibilities for new interpretations regarding known data.

Generally, proposed theory tends to rely on ongoing theory concepts regarding objects, internal properties of objects, motion-centric properties, interactions, and kinematics and dynamics theories.

Nearby below, we summarize some aspects of and results from proposed theory. We provide perspective for understanding, evaluating, and using proposed theory. We discuss overlaps, similarities, differences, possible synergies, and possible conflicts between proposed theory, physics data, and some aspects of ongoing theory.

1.3.1. Elementary particles

This unit summarizes - regarding elementary particles - aspects of and relationships between proposed theory, physics data, and ongoing theory.

People try two approaches for suggesting new elementary particles. People try to explain observed phenomena by suggesting new elementary particles. Perhaps, dark matter has bases in WIMPs or axions. Perhaps, gravity correlates with gravitons. Perhaps, some possible violation of CP symmetry suggests that nature includes axions. People try to determine patterns that would suggest new particles. Perhaps, supersymmetry pertains and predicts new elementary particles.

Explaining phenomena has succeeded in the past. Explaining protons led to predicting and discovering quarks. Explaining, within the context of gauge theory, the non-zero masses of the W and Z bosons led to predicting and discovering the Higgs boson.

Proposing patterns has succeeded in the past. The proposing, in 1869 by Mendeleev, of organizing principles related to properties of chemical elements led to the periodic table for elements. (Note reference

[1].) The table matched all the then-known elements and suggested elements that people subsequently discovered.

Physics might benefit from new candidates for sets of organizing principles for elementary particles. Currently, ongoing theory sets of candidate principles (such as principles that correlate with supersymmetry) seem to be unverified or to lack specificity regarding properties of particles.

Proposed theory includes a mathematics-based modeling technique that, in effect, outputs the list of known elementary particles, suggests new elementary particles, and suggests organizing principles for an elementary particle analog to the periodic table for chemical elements. The modeling technique does not require making a choice among ongoing theory kinematics theories.

We think that the set of candidate elementary particles explains some and perhaps most or all of the phenomena that people currently consider when people use known phenomena to point to the possible existence of new elementary particles. Examples of those phenomena include dark matter and baryon asymmetry.

While one mathematics modeling basis outputs the entire set of known and suggested elementary particles, we find it convenient to divide the set into two subsets. We use the two-word phrase simple particles to point to all of the elementary particles that we do not correlate with the two-word term root forces. We use the two-word term root forces to include bases for phenomena such as electromagnetic fields, gravity, and non-residual aspects of the strong force. We do not separate the notion of boson particles from a broader (than just root forces) concept of forces. For example, sometimes, modeling based on the notion of a strong force provides advantages over modeling based on the notion of gluon particles. This use of the word root reflects the notion that some mathematical modeling that has bases in aspects of root forces outputs solutions that correlate with known and suggested simple particles. This use of the word root does not necessarily correlate with notions of root forces being more fundamental - regarding physics or nature - than simple particles.

We think that people can use the set of elementary particles in the context of ongoing theory classical physics and in the context of ongoing theory quantum physics. We think that people can use the set of elementary particles in the contexts of modeling based on each of Newtonian kinematics, special relativity, and general relativity.

People might treat some outputs from the modeling technique as candidates for new simple particles or new root forces. Some or all of the candidates might represent opportunities for research to detect or infer phenomena. The candidates might not conflict with verified aspects of ongoing theory.

1.3.2. Rate of expansion of the universe

This unit summarizes - regarding the rate of expansion of the universe - aspects of and relationships between proposed theory, physics data, and ongoing theory.

People suggest the concept of dark energy pressure to explain observed changes in the rate of expansion of the universe. Ongoing theory concepts that people use to try to model aspects of the rate of change include the Hubble parameter (or, Hubble constant), equations of state (or, relationships between density and pressure), and general relativity. People suggest possible incompatibilities between observations and ongoing theory modeling. (See, for example, reference [2], reference [3], reference [4], and communication 71a. However, some people note possible objections to some notions of incompatibility. See, for example, references [5] and [6].) People suggest phenomenological remedies regarding the modeling. (See, for example, reference [7].) People sometimes use the three-word term dark energy forces in discussions that include notions of dark energy pressure.

Each of proposed theory and ongoing theory uses terms such as gravity and gravitation. Proposed theory includes concepts of components of root forces that are related to electromagnetism and gravitation. For example, regarding electromagnetism, one component correlates with interactions with charge and another component correlates with interactions with nominal magnetic dipole moment. The existence of these components is appropriate because proposed theory accommodates modeling that does not include translational motion. Some objects have non-zero charge and zero nominal magnetic dipole moment. Some objects have zero charge and non-zero nominal magnetic dipole moment. People correlate the word monopole with the interaction with charge. People correlate the word dipole with the interaction with nominal magnetic dipole moment. Ongoing theory sometimes decomposes aspects of electromagnetism into an electric field and a magnetic field. However, ongoing theory notions of photons do not necessarily reflect such a decomposition. Similar concepts pertain regarding gravity. Proposed theory uses the six-word term monopole gravity and dark energy forces (or, monopole gravity plus dark energy forces). The monopole gravity component of gravitation correlates well with a Newtonian notion of gravity associated with a non-rotating object that models as existing at a point or as having spherical symmetry. The dark energy force components correlate with - among other phenomena - changes in the rate of expansion of the universe. An example of such other phenomena features aspects correlating with gravity associated with a rotating object. Ongoing theory includes modeling that does not similarly decompose notions of gravity. For example, general relativity does not necessarily separate notions that might correlate with monopole gravity from notions that might correlate with dark energy forces.

Proposed theory regarding spin-two root forces points to a candidate explanation for observed eras in the rate of expansion of the universe. The first era correlates with a rate that increases with time. The word octupole characterizes the dominant force components for this era. The dominant force components repel objects from each other. The second era correlates with a rate that decreases with time and, if we assume data that references [8], [9], [10], and [11] provide, that ends some billions of years later. The word quadrupole characterizes the dominant force component for this era. The dominant force component attracts objects to each other. The third era correlates with a rate that increases with time and has lasted some billions of years. The word dipole characterizes the dominant force component for this era. The dominant force component repels objects from each other. For each era, dominance refers to interactions between somewhat similar large neighboring objects. Interactions between smaller neighboring objects transit, generally comparatively quickly, to dominance by the monopole component of gravity.

We correlate with the three-word term dark energy forces the spin-two octupole, quadrupole, and dipole components that we just mentioned.

We think that proposed theory provides a candidate means to close gaps between observations and ongoing theory. We think that proposed theory is not incompatible with the ongoing theory notion that the Einstein field equations can be compatible with repulsion. (Reference [12] discusses the notion that the Einstein field equations can be compatible with repulsion.)

1.3.3. Dark matter and galaxies

This unit summarizes - regarding dark matter and galaxies - aspects of and relationships between proposed theory, physics data, and ongoing theory.

People suggest various explanations for observations that, starting in the 1880s, suggest that the Milky Way galaxy does not have enough ordinary matter to keep observed stars in their orbits; that, starting in the 1930s, suggest that galaxy clusters do not contain enough ordinary matter to bind observed galaxies into the clusters; and that, starting in the 1930s, suggest that a significant fraction of observed galaxies do not have enough ordinary matter to keep observed stars in their orbits. While people discuss theories that might not require nature to include dark matter, most observations and theoretical work assume that dark matter exists. (People use the term MOND - or, modified Newtonian dynamics - to describe one set of theories that might obviate needs to assume that nature includes dark matter.) People use terms such as WIMPs (or, weakly interacting massive particles), axions, and primordial black holes to name candidate explanations for dark matter. Some of the candidates are not completely well-specified. For example, searches for axions span several orders of magnitude of possible axion mass. People suggest that dark matter could have characteristics similar to ordinary matter. (See, for example, reference [13].) People suggest that dark matter might include components that include quarks or that might experience Yukawa-like potentials. (See, for example, references [14] and [15].) People suggest that nature might include dark matter photons. (See, for example, reference [16].)

Proposed theory suggests that nature includes objects that behave like WIMPs but are not elementary particles. These objects would be similar to protons, neutrons, and other hadrons, except that the quark-like components would be fermion elementary particles that have zero charge. These hadron-like particles would interact with gravity. These hadron-like particles would have no non-zero-charge internal components and would not interact with light. We know of no reason why these particles would be incompatible with ongoing theory.

Assuming that the WIMP-similar hadron-like particles exist in nature, a question remains as to the extent to which these particles comprise all dark matter. We think that, today, ongoing theory would not resolve that question.

People infer a ratio of dark matter density of the universe to ordinary matter density of the universe. That ratio is five-plus to one. (See data that reference [17] provides.) People also infer ratios, for some galaxies and for some galaxy clusters, of dark matter amounts to ordinary matter amounts.

We think that ongoing theory does not provide bases for explaining, from fundamental principles, those observed ratios.

Proposed theory includes three cases. We denote the cases by symbols of the form PRnISe. The three relevant values of n are one, six, and 36. The symbol PR abbreviates the one-element term physics-relevant. The symbol ISe abbreviates the four-word phrase isomers of the electron. For each case, we

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assume that nature embraces n isomers of charged simple particles. We assume that each isomer of charged simple particles interacts, via charge and nominal magnetic dipole moment, with its own isomer of so-called PR1ISe-like photons. For n equal to six and n equal to 36, each isomer of charged simple particles does not interact, via charge and nominal magnetic dipole moment, with isomers, other than its own isomer, of PR1ISe-like photons. The PR36ISe case suggests an alternative explanation for dark energy density. From a standpoint of observations, distinguishing between the case of PR6ISe and the case of PR36ISe might prove difficult. For the moment, we de-emphasize the PR36ISe case.

We introduce the word span. We say that the span of each isomer of charged simple particles is one, as in one isomer of charged simple particles. The span of each isomer of PR1ISe-like photons is one, as in one isomer of charged simple particles. For n equal to six, one isomer of the monopole component of gravity interacts with all six isomers of charged simple particles. We say that the span of the monopole component of gravity is six, as in six isomers of charged simple particles. (A span of six does not pertain regarding dark energy forces. For example, the span for each of six isomers of the quadrupole component of dark energy forces is one.) One isomer of charged simple particles correlates with ordinary matter. The other five isomers of charged simple particles correlate with dark matter.

PR1ISe does not provide bases for explaining, from fundamental principles, observed ratios of dark matter effects to ordinary matter effects.

PR6ISe provides bases for explaining some observed ratios. For example, regarding densities of the universe, the five dark matter isomers explain the five in the ratio five-plus to one. The WIMP-similar hadron-like particles explain the plus in the ratio five-plus to one. For example, PR6ISe seems to explain galaxy-related observed ratios of dark matter amounts to ordinary matter amounts.

PR6ISe suggests the following scenario for the formation and early evolution of galaxies.

The scenario features, for each galaxy, the notion of an original clump. Clumping takes place based on the quadrupole component of the gravitational force. The quadrupole component is attractive and has a span of one, as in one isomer of charged simple particles. For each of many galaxies, the initial clump correlates with one isomer of PR6ISe-span-one phenomena. Sometimes, an original clump features, based on the attractive monopole component of root force, more than one isomer of PR6ISe-span-one phenomena. With respect to each isomer in the clump, the repulsive dipole component of gravity drives away from the original clump one isomer of PR6ISe-span-one phenomena. Thus, for essentially all galaxies, the original clump correlates with no more than three isomers of PR6ISe-span-one phenomena.

From a standpoint of observations, three types of one-isomer original clump galaxies exist. Some (perhaps one-sixth of the) one-isomer original clump galaxies feature an ordinary matter original clump. Some (perhaps two-thirds of the) one-isomer original clump galaxies feature a dark matter original clump that does not repel ordinary matter. Some (perhaps one-sixth of the) one-isomer original clump galaxies feature a dark matter original clump that repels ordinary matter. We suggest that some ongoing theory notions of dark matter galaxy correlate with galaxies for which dark matter original clumps repel ordinary matter.

Observations of early galaxies correlate with galaxies for which the original clump contains significant amounts of ordinary matter. Aside from dark matter galaxies, galaxies for which the original clump features just one isomer of PR6ISe-span-one phenomena might attract and accumulate matter such that eventually (assuming that disturbances, such as collisions with other galaxies, do not occur) the galaxies contain approximately four times as much dark matter that has bases in PR6ISe-span-one phenomena as ordinary matter.

We think that data supports the galaxy formation and evolution scenario. Reference [18] discusses a dark matter galaxy. Reference [19] reports, regarding galaxies about 10 billion years ago, data that seems to support the notion of ordinary matter intensive original clumps. Figure 7 in reference [20] seems to support (especially via data pertaining to redshifts of at least seven) the notion of ordinary matter intensive original clumps. Observations that reference [21] reports might support the notion of approximately four to one ratios. The observation that reference [22] reports might correlate with a three-isomer original clump galaxy.

The galaxy formation and evolution scenario seems to comport with data. For each of many known galaxies, the scenario can comport with the ongoing theory notion of a dark matter halo. For some ordinary matter intense galaxies, the scenario does not comport with some ongoing theory assumptions about roles, in galaxy formation, of dark matter halos.

We think that PR6ISe is not incompatible with inferred galaxy cluster related ratios of dark matter amounts to ordinary matter amounts.

PR6ISe seems to offer an explanation for one piece of data regarding details of the Milky Way galaxy. (Regarding the piece of data, see discussion, in reference [23], regarding data regarding the stellar stream

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1.3.4. Depletion of CMB

This unit summarizes - regarding one observation of depletion of cosmic microwave background radiation - aspects of and relationships between proposed theory, physics data, and ongoing theory.

Results that reference [24] reports about depletion of CMB (or, cosmic microwave background radiation) might dovetail with the existence of isomers of hydrogen atoms. Observations correlate with twice as much depletion as ongoing theory attributes to depletion by ordinary matter hydrogen atoms. PR6ISe modeling suggests that one isomer of dark matter analogs to hydrogen atoms provide for half of the depletion. Proposed theory 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 [25].)

1.3.5. Other topics

This unit summarizes - regarding various topics - aspects of and relationships between proposed theory, physics data, and ongoing theory.

Regarding proposed theory, people might assume that the following aspects are non-traditional or think that the following aspects are controversial. However, we think that proposed theory shows that these aspects comport with known phenomena, do not contradict known phenomena, do not violate ongoing theory theories for realms in which people have validated the theories, offer ways to strengthen and further understand some ongoing theory, and offer theories that are synergistic with ongoing theory.

- Proposed theory points to a formula that possibly links a ratio of the masses of two elementary particles and a ratio of the strengths of two components of root forces. The elementary particles are the tauon and the electron. The force components are electrostatic (or, monopole) repulsion between two electrons and monopole gravitational attraction between (the same) two electrons. We think that this numeric relationship comports with measurements and points to a possibility for extending physics theory. The formula suggests a tauon mass and a standard deviation for the tauon mass. Based on 2019 data, eight calculated standard deviations fit within one experimental standard deviation of the experimental nominal tauon mass.

- Proposed theory points to (at least approximate) numerical relationships between the ratios of the masses of the Higgs, Z, and W bosons. These relationships might suggest possibilities for extending physics theories related to the weak mixing angle.

- Proposed theory suggests that people might be able to distinguish observationally between the coalescing of two black holes that interact with each other significantly via the dipole component of dark energy force and the coalescing of two black holes that do not interact with each other significantly via the dipole component of dark energy force.

- Proposed theory suggests resolution regarding the possible mismatch between the elementary particle Standard Model notion that all neutrinos might have zero rest mass and interpretations, of data, that people associate with the notion that at least one neutrino flavor (or, generation) has non-zero rest mass. Proposed theory suggests that spin-four components of root forces couple to lepton number (and not to rest mass) and underlie phenomena that people interpret as implying that at least one neutrino has non-zero rest mass. Proposed theory suggests that ongoing theories might interpret those phenomena as correlating with a specific value for a would-be sum of neutrino rest masses. That value is $3\alpha^2 m_\epsilon$. The symbol α denotes the fine-structure constant. The symbol m_ϵ denotes the mass of an electron. That value comports with ongoing theory interpretations of data, as summarized by reference [17]. Proposed theory suggests the possibility that all neutrinos have zero rest mass. While this work may prove controversial, we offer the possibility that it comports with data and resolves an underlying tension regarding ongoing theory. People might consider the notion that interactions mediated by the spin-four components produce an effect that correlates with a notion of an index of refraction - regarding neutrino motion - that is other than one.

- Proposed theory suggests details about simple particles and root forces involved during the inflationary epoch.

- Proposed theory points to a possibility for modeling lepton anomalous magnetic dipole moments via a sum of two terms. Each term correlates with components of root forces. For each of those components, the spin exceeds one.

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Table 1: Goals for QPT (or, quantum particle theory)

QPT should include theory that ...
• Points to all known elementary particles and possibly to all unknown elementary particles.
• Outputs representations correlating with the elementary particles.
• Outputs information about properties of the elementary particles.
• Outputs types of interactions in which elementary particles participate.
• Dovetails with conservation laws pertaining to motion.
• Dovetails with established ongoing theories of motion.
• Helps explain data that ongoing theory seems not to explain.

- We think that possibilities exist for adding, to the elementary particle Standard Model, new elementary particles that proposed theory suggests. Some of the new elementary particles correlate with symmetries that correlate with current Standard Model elementary particles. Examples include new non-zero-mass spin-one simple bosons, which would correlate with an $SU(2) \times U(1)$ symmetry similar to the $SU(2) \times U(1)$ symmetry that people correlate with the W and Z bosons. So far, proposed theory does not fully explore the feasibility of adding, to the Standard Model, the particles that proposed theory suggests. For example, we do not explore Lagrangian terms for candidate particles. Also, we do not explore the extent of compatibility between the Standard Model and PR6ISe modeling.

1.4. Perspective about this essay

This unit discusses some aspects of this essay.

We try to provide perspective regarding theories and models. Aspects of perspective regarding individual theories and models include correlations with data, limits of applicability, opportunities to make improvements, unresolved aspects, and alternatives. Reference [26] suggests standards regarding such perspective. Aspects of perspective regarding collections of theories or models include synergies between theories and models and include possible discord between theories and models.

We try to structure this essay to facilitate learning. We use an approach that blends known data, ongoing theory, development of new theory, and mathematics. We sometimes show results before we discuss theory that outputs the results. We sometimes use tables to list concepts that are not numeric.

2. Methods: perspective regarding quantum particle theory

This unit discusses perspective about our development and use of quantum particle theory.

We use the three-word term quantum particle theory to describe a core of our work. The acronym QPT abbreviates the three-word term quantum particle theory.

Table 1 suggests goals for QPT. Interactions might change, regarding objects in general, each of internal properties and motion.

Our work contributes to each of the goals that table 1 lists. This essay shows development of QPT via steps that roughly track the goals.

Ongoing theory does not necessarily achieve the first few goals. Development of ongoing theory has tended to produce theories of motion without necessarily completely knowing the nature of objects that move or without necessarily completely cataloging types of objects that move.

Goals that table 1 lists correlate with potential synergy between proposed theory and ongoing theory. Together, proposed theory and ongoing theory seem to explain data that ongoing theory seems not to explain.

Table 2 notes hunches, concepts and steps that underlie this essay's development of QPT. (Regarding the correlation between spin and number of particles, see table 8c.) The acronym PDE abbreviates the three-word term partial differential equation. The three-letter term ALG stands for the word algebraic.

3. Results: elementary particles

This unit lists all known elementary particles and all elementary particles that proposed theory suggests. This unit discusses properties that known elementary particles exhibit and that suggested elementary particles might exhibit.

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Table 2: Hunches, notions, and steps underlying development of QPT (with the word particles denoting the two-word term elementary particles)

Hunches, notions, and steps
• A correlation between spin and number of particles points to useful steps forward.
• So-called PDE modeling, based on math that dovetails with that correlation, can be useful.
• PDE modeling features use of partial differential equations pertaining to harmonic oscillators.
• PDE modeling correlates allowed spins mathematically with three spatial dimensions.
• PDE modeling uses information about some particles to output aspects of other particles.
• So-called ALG modeling features ladder operators pertaining to harmonic oscillators.
• ALG modeling uses symmetries pertaining to harmonic oscillators.
• ALG modeling has bases in models that dovetail with the excitement of boson states.
• ALG modeling outputs representations that correlate with particles.
• ALG modeling points to symmetries that correlate with properties of particles.
• ALG modeling augments, regarding particle properties, PDE modeling.
• ALG modeling proposes new property-centric conservation laws.
• ALG modeling points to symmetries that correlate with properties of interactions.
• ALG modeling embraces symmetries correlating with kinematics conservation laws.
• ALG modeling helps bridge between proposed theory and ongoing theory.
• ALG modeling bridging includes aspects correlating with motion.
• ALG modeling includes a feature that we call double-entry bookkeeping.
• PDE modeling also includes aspects of double-entry bookkeeping.

3.1. A table of known and suggested elementary particles

This unit shows a table of elementary particles that ongoing theory recognizes or proposed theory suggests.

Proposed theory points to all elementary particles that ongoing theory recognizes and suggests new elementary particles.

Table 3 catalogs elementary particles that ongoing theory recognizes or proposed theory suggests. Our use here of the two-word term elementary particles parallels use of that term in ongoing theory. Each row in the table 3a correlates with one value of spin S. Here, S denotes spin, in units of $\hbar$. (Technically, S correlates with the S in the ongoing theory expression $S(S+1)\hbar^2$.) The definition $\Sigma = 2S$ provides for numbers Σ that are non-negative integers. The value of Σ appears as the first element of each two-element symbol $\Sigma\Phi$. The letter value of Φ denotes a so-called family of elementary particles. The symbol $\Sigma\Phi$ denotes a so-called subfamily of elementary particles. Free elementary particles can model - regarding motion - as if they do not interact with other objects. Unfree elementary particles model as if they occur in confined environments. Examples of confined environments include hadrons and atomic nuclei. Free elementary particles can model as if they can occur in confined environments and can model as if they occur outside of confined environments. The expression $m\dot{=}0$ denotes a notion of zerolike mass. Some ongoing theory models do or might correlate $m\dot{=}0$ elementary fermions with small positive masses. Some ongoing theory models do or might correlate $m\dot{=}0$ elementary fermions with zero masses. The expression $m\dot{>}0$ correlates with mass being positive in all ongoing and proposed models. A number (n) denotes a number of elementary particles. A number ((n)) denotes a number of modes. Table 3b provides additional information regarding items that table 3a lists. Table 6c alludes to possible candidate elementary particles that table 3 does not include and that this essay de-emphasizes.

We use the two-word term simple particle to pertain to each entry in table 3 other than G-family entries and U-family entries. We correlate the two-element term root force with each G-family entry in table 3 and with the U-family entry in table 3. This use of the word root reflects the notion that some mathematics-based modeling, which has bases in aspects of root forces, outputs solutions that correlate with known and suggested simple particles. (See discussion related to equation (15). There might not be a need to try to correlate a physics meaning with such use of the word root.) Modeling for each one of the G-family forces points to components for that force. Particle counts in table 3 de-emphasize modeling that would count, for example, a down quark with green color charge as differing from a down quark with red color charge.

We discuss the free simple particles for which $m\dot{>}0$ pertains. The 0H particle is the Higgs boson. The three 1C particles are the three charged leptons - the electron, the muon, and the tauon. The two 2W particles are the two weak interaction bosons - the Z boson and the W boson.

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Table 3: Elementary particles (or simple particles and root forces)

(a) Simple particles and root forces (with notation featuring names of families)

Spin	Σ	Free $m\dot{>}0$	Free $m\doteq0$	Unfree $m\dot{>}0$	Unfree $m\doteq0$
0	0	0H (1)	0I (1)	0P (1), 0K (1)	
1/2	1	1C (3)	1N (3)	1Q (6)	1R (6)
1	2	2W (2)	2G ((2))	2T (4)	2U (8)
2	4		4G ((2))		
3	6		6G ((2))		
4	8		8G ((2))		

(b) Simple particles and root forces (with notation featuring names of elementary particles; with * denoting that people might have yet to find the elementary particles; and with TBD denoting the three-word phrase to be determined)

Spin	Σ	Free $m\dot{>}0$	Free $m\doteq0$	Unfree $m\dot{>}0$	Unfree $m\doteq0$
0	0	Higgs boson (1)	Aye* (1)	Pie* (1), Cake* (1)	
1/2	1	Charged leptons (3)	Neutrinos (3)	Quarks (6)	Arcs* (6)
1	2	Z and W bosons (2)	Photon ((2))	Tweaks* (4)	Gluons (8)
2	4		Graviton* ((2))		
3	6		TBD* ((2))		
4	8		TBD* ((2))		

We discuss the free simple particles for which $m\doteq0$ pertains. The 0I, or so-called aye, particle is a possible zerolike-mass relative of the Higgs boson. Some aspects of ongoing theory suggest a so-called inflaton elementary particle. Proposed theory suggests that the aye particle is a candidate for the inflaton. The three 1N particles are the three neutrinos. Some aspects of ongoing theory suggest that at least one neutrino mass must be positive. At least one positive mass might explain neutrino oscillations and some astrophysics data. Some aspects of ongoing theory, such as some aspects of the Standard Model, suggest that all neutrino masses are zero. Proposed theory suggests that effects of 8G forces might explain neutrino oscillations and the relevant astrophysics data. For example, proposed theory suggests that components of 8G forces lead to effects that ongoing astrophysics theory would correlate with a sum of neutrino masses of $3\alpha^2 m_\epsilon$. The symbol α denotes the fine-structure constant. The symbol m_ϵ denotes the mass of an electron. The amount $3\alpha^2 m_\epsilon$ falls within the range that ongoing astrophysics theory attributes to observed data. (See equations (92) and (93).) Components of 8G do not interact with the property of mass. Proposed theory suggests the possibility that neutrinos have zero mass.

We discuss G-family forces. The expressions free and $m\doteq0$ pertain. Each G-family force exhibits two modes. Our discussion tends to focus on circularly polarized modes. One mode correlates with left circular polarization. One mode correlates with right circular polarization. For 2G, ongoing theory suggests classical physics models and quantum physics models. The word electromagnetism can pertain. Proposed theory suggests modeling that provides for 2G aspects that include and complement ongoing theory electromagnetism. Regarding gravitation, ongoing theory suggests classical physics models. Proposed theory suggests modeling for 4G aspects that include and complement ongoing theory gravitation. Proposed theory regarding 4G includes classical physics aspects and quantum physics aspects. Proposed theory regarding 4G includes aspects that ongoing theory correlates with the three-word term dark energy forces. In proposed theory, quantum interactions, involving simple fermions, mediated by 4G can correlate with a notion of somewhat conservation of fermion generation. In proposed theory, classical interactions with objects can scale with the rest energy of the objects. Ongoing theory does not include 6G aspects and does not include 8G aspects. Proposed theory suggests that 8G interacts with lepton number minus baryon number. Regarding G-family forces, a lack of use of the two-word term simple particles dovetails with modeling that suggests, in some sense, more than one component for each one of some ΣG. For example, 2G includes one component that correlates with interactions with charge and one component that correlates with interactions with nominal magnetic dipole moment. This notion of components is appropriate because aspects of proposed theory can address the topics of properties and interactions without necessarily selecting an ongoing theory or ongoing theory model that correlates with

Table 4: Some possible correlations between observed phenomena, ongoing theory, and proposed theory

Phenomenon	Ongoing theory	Proposed theory
	Quantum vacuum	Aye
	Inflaton	Aye
Dark energy forces	Dark energy pressure	Components of 4G forces
Neutrino oscillations	At least one non-zero neutrino rest mass	Components of 8G forces
Some astrophysics data	At least one non-zero neutrino rest mass	Components of 8G forces
Nuclear physics	Attractive residual strong force	Pie
Nuclear physics	Repulsive residual strong force	Cake
Baryon asymmetry		Charged tweaks

Table 5: Some possible correlations between root forces and phenomena

Proposed theory	Phenomena	Ongoing theory
2G	Charge, nominal magnetic moment	Charge, nominal magnetic moment
4G	Rest energy	Rest energy
6G	Freeable energy	Internal energy above ground state energy
8G	Spin, 3LB number	Spin (internal angular momentum)
2U	Color charge	Color charge

motion.

We discuss the unfree simple particles for which $m\grave{>}0$ pertains. The 0P, or so-called pie, possible particle might correlate with an attractive component of the residual strong force. The 0K, or so-called cake, possible particle might correlate with a repulsive component of the residual strong force. The six 1Q particles are the six quarks. The four 2T, or so-called tweak, possible particles are analogs to the weak interaction bosons. The charge of one non-zero-charge 2T particle is two-thirds the charge of the W boson. The charge of one non-zero-charge 2T particle is one-third the charge of the W boson. The non-zero-charge tweak particles may have played roles in the creation of baryon asymmetry. The non-zero charge tweak particles might correlate with ongoing theory notions of - as yet hypothetical - leptoquarks.

We discuss the unfree simple particles for which $m\grave{=}0$ pertains. The six 1R, or so-called arc, possible particles are zero-charge zerolike-mass analogs of the six quarks. Hadron-like particles made from arcs and gluons contain no charged particles and measure as dark matter.

We discuss U-family forces. The eight 2U particles are the eight gluons. In each of ongoing theory and proposed theory, gluons correlate with the strong interaction and bind quarks into hadrons. Proposed theory suggests that gluons bind arcs into hadron-like particles.

Table 4 summarizes some possible correlations between observed phenomena, ongoing theory, and proposed theory. For each row in the table, proposed theory suggests that the item in the third column might explain aspects correlating with the other two columns.

Table 5 summarizes possible correlations between root forces and phenomena. For other than 2G, 4G, and 2U, ongoing theory does not necessarily correlate, with a root force, an item listed under ongoing theory. Proposed theory suggests that interactions correlating with 6G can decrease or increase the rest energy of an object. Proposed theory suggests the relevance of a concept for which we use the two-element term 3LB number. (In the symbol 3LB, the number 3 correlates with a factor of three. The letter L correlates with the word lepton. The letter B correlates with the word baryon.) We define 3LB number in terms of the two on-going theory two-word terms lepton number and baryon number. (See discussion related to equation (42).)

3.2. Modeling leading to the table of known and suggested elementary particles

This unit discusses concepts and methods that lead to the table of known and suggested elementary particles.

3.2.1. Summary of methods: quantum particle theory

This unit discusses aspects that correlate with the development of quantum particle theory.

We extend discussion related to tables 1 and 2.

Mathematics and ongoing theory include partial differential equations pertaining to isotropic harmonic oscillators. A partial differential equation correlating with an isotropic multidimensional quantum harmonic oscillator includes an operator that correlates with r^{-2} and an operator that correlates with

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r^2. (See equations (3) and (4).) The symbol r denotes a radial spatial coordinate. The r^{-2} operator in equation (4) might model aspects correlating with the square of an electrostatic potential. The potential correlates with r^{-1}. The force correlates with r^{-2}. The r^{-2} operator might model aspects correlating with the square of a gravitational potential. The r^{-2} operator might model aspects correlating with each G-family force ΣG. (See table 22.) The r^{-2} operator might model aspects correlating with excitations that pertain for each G-family force ΣG and that, thereby, have relevance for each G-family force component ΣGΓ. (See discussion that includes equation (36).) The r^2 operator in equation (3) might model aspects correlating with the square of a strong interaction potential. This strong interaction potential would correlate with excitations related to the 2U subfamily (or, gluons) and with interactions within hadron-like particles. (Ongoing theory includes within the two-word term strong force the notion of a residual strong force. The three-word term residual strong force pertains to interactions between hadron-like particles. Proposed theory suggests correlating the residual strong force with so-called 0P - or, pie - simple bosons and so-called 0K - or, cake - simple bosons.) Ongoing theory includes the concept of asymptotic freedom. The potential correlates with r^1. The force correlates with r^0.

PDE modeling might point to results pertaining to other than the G family and the U family. For example, the next two sentences might pertain. Operator aspects that correlate with r^0 might correlate with simple fermions. Operator aspects that correlate with r^0 might correlate with aspects of the weak interaction. (Here, the expression r^0 does not correlate with non-residual aspects of the strong interaction.)

Table 6 outlines steps that our modeling takes. For each step, the leftmost two columns list items that correlate with inputs to the step. The next column notes modeling concepts that are key to taking the step. The rightmost two columns list items that correlate with outputs from the step. In table 6a, the first step uses the notion that correlates aspects of PDE modeling with potentials that we associate with root forces. The steps output a list of elementary particles. In table 6b, steps output masses. Table 6c shows possible steps that this essay might discuss but generally de-emphasizes. The notion that one item, which might point to axions, in table 6c might not have physics relevance does not necessarily preclude the notion that other aspects of proposed theory might point to possible axions. However, this essay does not necessarily point to other possibilities that might correlate with axions. Table 6d discusses symbols that appear in tables 6a, 6b, and 6c.

We discuss objects and properties.

Each of ongoing theory and proposed theory includes the notion of an object. Models for an object may include notions of internal properties upon which all observers would agree. One such property is charge (or, charge that people would observe in the context of a frame of reference in which the object does not move). Models for objects may include notions of kinematics properties upon which observers might legitimately disagree. One such notion is velocity, relative to observers, of an object. Models can include notions of interactions between objects. An interaction might change - for an object - at least one of some internal properties and some kinematics properties.

Table 7 lists some properties that people attribute to objects. Proposed QPT tends to work from table 7a toward table 7d. In contrast, development of aspects of ongoing theory, including QFT (or, quantum field theory), has emphasized - from early on in the development of ongoing theory - aspects correlating with table 7d. In table 7a, the column labeled λ correlates with aspects of equation (36) and of table 26. The symbol q_ϵ denotes the charge of an electron. The symbol c denotes the speed of light. In table 7b, the use of the symbol S does not correlate with notions of spin. (Compare with, for example, table 7a.) In table 7c, the notion of isomers correlates with the topic of dark matter and with aspects of table 55. The symbol NR denotes the two-word phrase not relevant.

We discuss the notion of double-entry bookkeeping.

Ongoing theory includes modeling, for photons, that features mathematics correlating with two harmonic oscillators. Ongoing theory correlates modeling for each of two polarization modes with one harmonic oscillator. Each mode can correlate with a spatial dimension that is orthogonal to both the direction of motion of the photon and to the spatial dimension correlating with the other mode.

Proposed theory ALG modeling has bases in a hunch that modeling photons based on four harmonic oscillators has uses. The hunch has bases in the ongoing theory notion of modeling based on four dimensions. Generally, proposed theory associates the one-element term TA-side with modeling that correlates with temporal aspects. The one-element term SA-side correlates with modeling that correlates with spatial aspects. The hunch points to equation (24) and to a concept to which we apply the two-element term double-entry bookkeeping. The term refers to ALG modeling that maintains a numeric balance between TA-side aspects and SA-side aspects. The balance reflects a notion that a sum pertaining to TA-side aspects equals a sum pertaining to SA-side aspects.

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Table 6: Steps, regarding modeling

(a) Steps that output elementary particles

From free	From unfree	Via	To free	To unfree
ΣG	2U	PDE	0H, 1C, 2W	
0H, 1C, 2W		$m\grave{>}0 \rightarrow m\doteq0$	0I, 1N, 2G	
1C, 1N, 2W		$\lvert\iota_Q\rvert = 3$ or $0 \rightarrow \lvert\iota_Q\rvert = 2$ or 1 or 0		1Q, 1R, 2T
	2U	$SU(3) \rightarrow SU(3) \uplus I$		0P, 0K

(b) Steps that output masses

From free	From unfree	Via	To free	To unfree
ΣG		ALG, PDE	0H, 0I, 2W	
ΣG		ALG, PDE	2T	
Ongoing		m_π		0P, 0K

(c) Possible steps that the modeling de-emphasizes

From free	From unfree	Via	To free	To unfree
	2U	ALG		~~(≳4)U~~
	~~(≳4)U~~	$SU(3) \rightarrow SU(3) \oplus I$	~~axion or ?~~	
0H, 0I		$\lvert\iota_Q\rvert = 3$ or $0 \rightarrow \lvert\iota_Q\rvert = 2$ or 1 or 0		~~?~~, ~~?~~

(d) Explanations regarding some symbols

Discussion
• $m\grave{>}0 \rightarrow m\doteq0$ denotes extending results for $m\grave{>}0$ to results for $m\doteq0$.
• The symbol ι_Q denotes charge, in units of one-third the negative of the charge of an electron (or, in units of the negative of the charge of a down quark).
• $\lvert\iota_Q\rvert = 3$ or $0 \rightarrow \lvert\iota_Q\rvert = 2$ or 1 or 0 denotes extending results for $\lvert\iota_Q\rvert = 3$ or 0 to results for $\lvert\iota_Q\rvert = 2$ or 1 or 0. The results correlating with the word from pertain to free particles. The results correlating with the word to pertain to unfree particles.
• $SU(3) \rightarrow SU(3) \uplus I$ denotes extending modeling to, in effect, include the identity operator, which operator-centric modeling regarding $SU(3)$ lacks.
• The word ongoing denotes aspects of ongoing theory that model the attractive component of the residual strong force via modeling that includes notions of virtual pions.
• The symbol m_π denotes the mass (or masses) of pions.
• The notation ~~X~~ denotes the notion that this essay generally de-emphasizes the concept X.

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Table 7: Some properties of objects

(a) Invariant properties

Symbol	Definition	Concept	Related symbol (ongoing theory)	λ
ι_Q	$= 3Q$	charge, in units of $\|q_\epsilon\|/3$	Q - charge, in units of $\|q_\epsilon\|$	2
m		rest mass, in units of energy$/c^2$	m - rest mass	4
j	$1 \leq j \leq 3$	generation, for simple fermions	1 or 2 or 3	6
ι_S	$= 2S$	spin, in units of $\hbar/2$	S - spin (nonnegative), in units of $\hbar$	8
ι_L	$= 3L$	lepton number, in units of $3L$	L - lepton number (integer)	8
ι_B	$= 3B$	baryon number, in units of $3B$	B - baryon number (integer $\times$ 1/3)	8
ι_{3LB}	$= 3(L - B)$	3LB number		8

(b) Other properties (ongoing theory)

Symbol	Definition	Concept	Related symbol (ongoing theory)
		color charge	r or b or g
		entropy	S - entropy ($k_b \ln \Omega$)

(c) Other invariant properties (proposed theory)

Symbol	Definition	Concept	Related symbol (ongoing theory)
ι_I	= NR, 1, 6, or 36	number of isomers of charged particles	-

(d) Observer-centric properties

Symbol	Concept	Related symbol (ongoing theory)
E	energy, in units of energy	E
$\overrightarrow{P}$	momentum, in units of momentum	$\overrightarrow{P}$
$\overrightarrow{J}$	angular momentum, in units of angular momentum	$\overrightarrow{J}$

Proposed theory PDE modeling also exhibits aspects that we correlate with the two-word term double-entry bookkeeping. Here, the balance refers to effects of a TA-side quantum operator and to effects of an SA-side quantum operator. (See, for example, equation (17).)

3.2.2. Patterns regarding properties of known elementary particles

This unit discusses patterns that might pertain regarding elementary particles and regarding properties of elementary particles.

We posit that there might be an analog - to the periodic table for chemical elements - for elementary particles.

The periodic table reflects properties of chemical elements. One relevant property is the types of chemical interactions in which an element participates. One relevant property is the atomic weight. A usual display of the periodic table features an array with columns and rows. Elements listed in a column participate in similar interactions. For a row, the atomic weight of an element is usually greater than the atomic weight for each element to the left of the subject element. Atomic weights in one row exceed atomic weights in rows above the subject row.

We look for patterns regarding the known elementary particles. (See table 3.)

Table 8 reflects a hunch that the number of elementary particles in a subfamily dovetails with the spin of the elementary particles in the subfamily. Table 8b explains notation that table 8a uses. The spin S correlates with an overall angular momentum for which the expression $S(S+1)\hbar^2$ pertains. The spin S does not depend on a choice of an axis. Each of the three columns that correlate with the one-word label unfree correlates with a magnitude of charge that differs from the magnitude of charge pertaining to the other two columns labeled unfree.

Table 9 lists some quantities that are always integers. The quantities pertain for each elementary particle. The quantities can pertain for objects that contain more than one elementary particle. In terms of measurements, equation (1) pertains. Here, q_ϵ is the charge of an electron. The symbol ε_0 denotes the vacuum permittivity. We propose the two-element term 3LB number.

$$\iota_Q = 1 \text{ correlates with } (|q_\epsilon|/3)/(4\pi\varepsilon_0)^{1/2} \tag{1}$$

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Table 8: Known elementary particles

(a) Elementary particles

$\iota_S = 2S$	Free	Free	Unfree	Unfree	Unfree
	$m \grave{>} 0$	$m \doteq 0$	$m \grave{>} 0$	$m \grave{>} 0$	$m \doteq 0$
0	$0H^0$:1				
1	$1C^3_j$:2	$1N^0_j$:{1 or 2}	$1Q^2_j$:2	$1Q^1_j$:2	
2	$2W^0$:1				
2	$2W^3$:2	$2G^0$:(2)			$2U^0$:8
4		{$4G^0$:(2)}			

(b) Notation

Notation	Note	Discussion
ι_S		Spin, in units of $\hbar/2$
S		Spin, in units of $\hbar$
	Free (unimpeded)	Can move independently of other objects
	Unfree	Found only in systems that include other objects
$m \grave{>} 0$	Non-zero mass	The mass is at least the mass of an electron
$m \doteq 0$	Zerolike mass	Models (in some models) as having zero mass
$\iota_S\Phi^{\vert\iota_Q\vert}_{\_}$	$\iota_S\Phi$	A subfamily of the Φ family of elementary particles
	$\vert\iota_Q\vert$	|Charge| in units of one-third the charge of a positron
	$\vert x\vert$	The absolute value of x
	_	Generation, for fermions, with $1 \leq j \leq 3$; NR for bosons
	NR	Not relevant
:n	$n = 1$ or 2	n particles plus antiparticles
	{1 or 2}	Majorana fermion or Dirac fermion, respectively
	8	Number of gluons
:(2)		One particle with two modes
$\{\iota_S\Phi^{\iota_Q}_{\_}\}$		Hypothetical subfamily (hypothesized, but not yet found)
	{$4G^0$:(2)}	Graviton (hypothesized, but not yet found)

(c) Subfamilies for which $m \grave{>} 0$

Subfamily and (if not NR) generation	Particles	$\sum n$ (per :n)
0H	Higgs boson	1
$1C_j$	j-th generation of charged leptons	2
$1Q^2_j$	j-th generation of $\vert\iota_Q\vert = 2$ quarks	2
$1Q^1_j$	j-th generation of $\vert\iota_Q\vert = 1$ quarks	2
2W	Z and W (W^{-3} and W^{+3}) bosons	3

(d) Subfamilies $m \doteq 0$

Subfamily and (if not NR) generation	Particles	$\sum n$ (per :n)
$1N_j$	j-th generation of neutrinos	{1 or 2}
2G	Photon	(2)
{4G}	Graviton (hypothetical)	(2)
2U	Gluons	8

Table 9: Some quantities that are always integers

Symbol	Concept (integer)	Definition	Related symbol (ongoing theory)
ι_S	spin, in units of $\hbar/2$	$= 2S$	S - spin (nonnegative), in units of $\hbar$
ι_Q	charge, in units of $\vert q_\epsilon\vert/3$	$= 3Q$	Q - charge, in units of $\vert q_\epsilon\vert$
ι_L	lepton number, in units of $3L$	$= 3L$	L - lepton number (integer)
ι_B	baryon number, in units of $3B$	$= 3B$	B - baryon number (integer times 1/3)
ι_{3LB}	3LB number	$= 3(L - B)$	

Equation (2) pertains for $m \grave{>} 0$. The hunch maybe useful.

$$\iota_S + 1 = \sum n \tag{2}$$

3.2.3. PDE aspects of quantum particle theory, plus the existence of simple particles

This unit discusses mathematics underlying PDE modeling. This unit develops aspects of quantum particle theory. This unit uses quantum particle theory to match the known simple particles and to predict new simple particles.

Equations (3) and (4) correlate with an isotropic quantum harmonic oscillator. Here, r denotes the radial coordinate and has dimensions of length. The parameter η_{SA} has dimensions of length. The parameter η_{SA} is a non-zero real number. The magnitude $|\eta_{SA}|$ correlates with a scale length. The positive integer D correlates with a number of dimensions. Each of ξ_{SA} and ξ'_{SA} is a constant. The symbol $\Psi(r)$ denotes a function of r and, possibly, of angular coordinates. The symbol ${\nabla_r}^2$ denotes a Laplacian operator. In some ongoing theory applications, Ω_{SA} is a constant that correlates with aspects correlating with angular coordinates. Our discussion includes the term Ω_{SA} and, otherwise, tends to de-emphasize some angular aspects. We associate the term SA-side with this use of symbols and mathematics. We anticipate that the symbols used correlate with spatial aspects of some physics modeling. We anticipate that TA-side symbols and mathematics pertain for some physics modeling.

$$\xi_{SA}\Psi(r) = (\xi'_{SA}/2)(-(\eta_{SA})^2{\nabla_r}^2 + (\eta_{SA})^{-2}r^2)\Psi(r) \tag{3}$$

$${\nabla_r}^2 = r^{-(D-1)}(\partial/\partial r)(r^{D-1})(\partial/\partial r) - \Omega_{SA}r^{-2} \tag{4}$$

Including for $D = 1$, each of equation (3), equation (4), and the function Ψ pertains for the domain that equation (5) shows. (We de-emphasize exploration of possible solutions for $D \leq 0$.)

$$0 < r < \infty \tag{5}$$

We consider solutions of the form that equation (6) shows. (For $\nu_{SA} < 0$, this work pertains for the domain that equation (5) defines. For $\nu_{SA} \geq 0$, this work might pertain for the domain $0 \leq r < \infty$. For $\nu_{SA} \geq 0$ and $r = 0$, angular aspects, Y, of $\Psi \propto \phi(r)Y$(angular coordinates) might be undefined. People might ignore that lack of definition, based on the notion that, for cases in which Y is undefined, $\phi(0) = 0$.)

$$\Psi(r) \propto (r/\eta_{SA})^{\nu_{SA}} \exp(-r^2/(2(\eta_{SA})^2)), \text{ with } (\eta_{SA})^2 > 0 \tag{6}$$

Equations (7) and (8) characterize solutions. The parameter η_{SA} does not appear in these equations.

$$\xi_{SA} = (D + 2\nu_{SA})(\xi'_{SA}/2) \tag{7}$$

$$\Omega_{SA} = \nu_{SA}(\nu_{SA} + D - 2) \tag{8}$$

Table 10 provides details that lead to equations (7) and (8). We consider equations (3), (4), and (6). The table assumes, without loss of generality, that $(\xi'_{SA}/2) = 1$ and that $\eta_{SA} = 1$. More generally, we assume that each of the four terms $K\_$ and each of the two terms $V\_$ includes appropriate appearances of $(\xi'_{SA}/2)$ and η_{SA}. The term V_{+2} correlates with the rightmost term in equation (3). The term V_{-2} correlates with the rightmost term in equation (4). The four $K\_$ terms correlate with the other term to the right of the equals sign in equation (4). The sum of the two $K_0\_$ terms correlates with the factor $D + 2\nu_{SA}$ in equation (7).

Equation (9) correlates with the domains of D and ν_{SA} for which normalization pertains for $\Psi(r)$. For $D + 2\nu_{SA} = 0$, normalization pertains in the limit $(\eta_{SA})^2 \to 0^+$. Regarding mathematics relevant to normalization for $D + 2\nu_{SA} = 0$, the delta function that equation (10) shows pertains. Here, x^2 correlates with r^2 and 4ϵ correlates with $(\eta_{SA})^2$. Reference [27] provides equation (10). The difference in domains, between $-\infty < x < \infty$ and equation (5), is not material here. (Our use of this type of modeling features normalization. Considering normalization leads to de-emphasizing possible concerns, about variations - as a function of angular coordinates - as r approaches zero, regarding Y(angular coordinates). Considering normalization leads to de-emphasizing possible concerns, regarding singularities as r approaches zero, regarding some $\Psi(r)$.)

$$D + 2\nu_{SA} \geq 0 \tag{9}$$

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Table 10: Terms correlating with an SA-side PDE equation (assuming that $(\xi'_{SA}/2) = 1$ and $\eta_{SA} = 1$)

Term/ $\exp(-r^2/2)$	Symbol for term	Change in power of r	Non-zero unless ...	Notes
$-r^{\nu_{SA}+2}$	K_{+2}	$+2$	-	Cancels V_{+2}
$(D+\nu_{SA})r^{\nu_{SA}}$	K_{0a}	0	$D+\nu_{SA}=0$	-
$\nu_{SA}r^{\nu_{SA}}$	K_{0b}	0	$\nu_{SA}=0$	-
$-\nu_{SA}(\nu_{SA}+D-2)r^{\nu_{SA}-2}$	K_{-2}	-2	$\nu_{SA}=0$ or $(\nu_{SA}+D-2)=0$	Cancels V_{-2}
$\Omega_{SA}r^{\nu_{SA}-2}$	V_{-2}	-2	$\Omega_{SA}=0$	Cancels K_{-2}
$r^{\nu_{SA}+2}$	V_{+2}	$+2$	-	Cancels K_{+2}

Table 11: Some applications of modeling that people can base on the mathematics that underlies PDE modeling (with * denoting an application that generally is not necessary for the discussion - in this essay - of elementary particles, astrophysics, and cosmology)

Application	ν_{SA}	Focus
Simple particles that nature embraces	$\nu_{SA}<0$	One simple particle
Interaction vertices that modeling might include *	$\nu_{SA}<0$	Multiple elementary particles
Modeling for some aspects of excitations *	$\nu_{SA}\geq 0$	Multi-object system
Modeling for some aspects of dynamics *	$\nu_{SA}\geq 0$	Multi-object system

$$\delta(x) = \lim_{\epsilon\to 0^+}(1/(2\sqrt{\pi\epsilon}))e^{-x^2/(4\epsilon)} \tag{10}$$

We use the one-element term volume-like to describe solutions for which $D+2\nu_{SA}>0$. Here, assuming that we ignore angular coordinates or that a zero value of a factor pertaining to angular coordinates does not pertain, $\Psi(r)$ is non-zero for all $r>0$. The term volume-like pertains regarding behavior with respect to coordinates that underlie modeling. We use the one-element term point-like to describe solutions for which $D+2\nu_{SA}=0$. Here, $\Psi(r)$ is effectively zero for all $r>0$. The term point-like pertains regarding behavior with respect to coordinates that underlie modeling.

Table 11 notes some applications of modeling that people can base on the mathematics that underlies PDE modeling. (Regarding the half-integer ν_{SA}, see discussion related to equation (6).) Applications for which the table shows an asterisk are generally not necessary for our work regarding elementary particles, astrophysics, and cosmology. We assume that ongoing theory kinematics and dynamics modeling generally suffices. Applications for which the table shows an asterisk pertain to proposed possible alternatives to some ongoing theory kinematics and dynamics modeling.

We discuss modeling correlating with the first row in table 11. (For modeling correlating with other rows in the table, see, for example, discussion related to table 65 and discussion related to table 66.)

Some applications feature the numbers of dimensions that equations (11) and (12) show. Equation (11) correlates with a notion of three spatial dimensions. Equation (12) correlates with a notion of one temporal dimension.

$$D^*_{SA} = 3 \tag{11}$$

$$D^*_{TA} = 1 \tag{12}$$

We anticipate using equations (13) and (14). Here, each of $2S$ and $2S_{TA}$ is a nonnegative integer. (We de-emphasize using the symbol S_{SA} instead of the symbol S.) The case that features equation (13), $\sigma_{SA}=+1$, and $S=\nu_{SA}$ is a restating of equation (8). The case that features equation (13) and $\sigma_{SA}=-1$ correlates with some aspects of proposed theory modeling. (See discussions related to equations (21) and (160).) Similar concepts pertain regarding equation (14) and σ_{TA}.

$$\Omega_{SA} = \sigma_{SA}S(S+D^*_{SA}-2) = \sigma_{SA}S(S+1),\ \text{for}\ \sigma_{SA}=\pm 1 \tag{13}$$

$$\Omega_{TA} = \sigma_{TA}S_{TA}(S_{TA}+D^*_{TA}-2) = \sigma_{TA}S_{TA}(S_{TA}-1),\ \text{for}\ \sigma_{TA}=\pm 1 \tag{14}$$

The following notions pertain.

- The symbol S can correlate with ongoing theory notions of spin divided by $\hbar$. The symbol $\hbar$ denotes the reduced Planck's constant.
- For some solutions - which comport with equation (13) - to equation (8), $D \neq D^*_{SA}$.
- Solutions for which $\nu_{SA} = -1/2$ can correlate with notions of fields for simple fermions.
- Solutions for which $\nu_{SA} = -1$ can correlate with notions of fields for simple bosons.
- Solutions for which $\nu_{SA} = -3/2$ can correlate with notions of particles for simple fermions.
- TA-side PDE solutions are radial with respect to t, the TA-side analog to the SA-side radial coordinate r.
- For some solutions, $D \neq D^*_{TA}$.

Along with mathematics correlating with three dimensions and $D^*_{SA} = 3$ and with mathematics correlating with one dimension and $D^*_{TA} = 1$, we anticipate needing mathematics correlating with two dimensions and a case that we denote by $D'' = 2$. (Discussion above does not adequately cover the topic of notions of particles for simple bosons. The case of $D'' = 2$ is relevant to notions of particles for simple bosons.)

Table 12 shows some relationships between some PDE parameters. The symbol XA can denote either SA or TA. Here, we correlate with D'' the symbols S'', ν'', Ω'', and σ''. Each of S'', ν'', Ω'', and σ'' does not necessarily correlate with uses of S, ν_{SA}, Ω_{SA}, σ_{SA}, S_{TA}, ν_{TA}, Ω_{TA}, or σ_{TA} in models regarding simple particles. For $\Omega'' = 0$, the table uses the letters NR to denote that the sign of σ'' is not relevant.

We explore bounds regarding the simple particles that proposed theory suggests.

The order of rows in table 12b correlates with non-decreasing values of Ω_{SA}. A value of spin S correlates with the value of Ω_{SA}. Proposed theory posits that each simple particle correlates with a field. No larger values of S comport with equation (15). (For example, for fermion fields, $S = 3/2$ would correlate with $\Omega_{SA} = 15/4$ and with a negative value, -5, for D.) Equation (16) correlates with a limit that pertains regarding simple particles. (Our assumptions regarding the existence of simple particles include excluding solutions for which $\sigma_{SA} = -1$. See table 12d. If we included solutions for which $\sigma_{SA} = -1$, table 12d indicates a possibility for indefinitely large values of S.) We do not expect that nature embraces simple particles with spins other than zero, one-half, and one.

$$S \geq 0 \text{ and } D \geq 1 \tag{15}$$

$$0 \leq S \leq 1 \tag{16}$$

Table 12c shows TA-side relationships. Each row correlates with a similar row in table 12b. Here, similarity refers to the information in the columns for which the labels include the two-word term simple particles. For each pair of similar rows, $D + 2\nu_{TA} = D + 2\nu_{SA}$ pertains. For $D + 2\nu_{TA} = D + 2\nu_{SA} \neq 0$, we require that $\xi'_{TA} = \xi'_{SA}$. Equation (17) pertains.

$$0 = A^{PDE} = A^{PDE}_{TA} - A^{PDE}_{SA} \tag{17}$$

For each of simple fermion field and simple fermion particle, modeling correlates with $D + 2\nu_{TA} = 0 = D + 2\nu_{SA}$. The one-element term point-like pertains with respect to TA-side aspects and to SA-side aspects. For the case of $S = 0$ boson fields, modeling correlates with $D + 2\nu_{TA} = 1 = D + 2\nu_{SA}$. The one-element term volume-like pertains with respect to TA-side aspects and to SA-side aspects. For the case of $S = 1$ boson fields, modeling correlates with $D + 2\nu_{TA} = -1 = D + 2\nu_{SA}$. Normalization does not pertain.

Nature includes simple bosons - at least the Z and W bosons - for which $S = 1$. Table 12b lacks items that would correlate with particles for $S = 0$ simple bosons or with particles for $S = 1$ simple bosons. Table 12b notes that solutions for $S = 1$ boson fields do not normalize.

We explore modeling that uses concepts from each of PDE modeling and ALG modeling. The following notions pertain. The notions provide for PDE solutions - for fields for simple bosons and for particles for simple bosons - that normalize.

- For simple fermions, each of fields and particles correlates with the expression $D + 2\nu = 0$. For simple bosons, we expect that modeling regarding simple particles correlates with the equations $D'' = 2$, $\nu'' = -1$ and $D + 2\nu'' = 0$. (See table 12e.)

Table 12: Relationships between some PDE parameters

(a) Relationships relevant to D^*_{XA} and D''

D^*_{XA}	D''	ν_{XA}	ν''	$D^*_{XA} + 2\nu_{XA}$	$D''+2\nu''$
1		$-1/2$		0	
1		-1		-1	
1		$-3/2$		-2	
	2		-1		0
3		$-1/2$		2	
3		-1		1	
3		$-3/2$		0	

(b) SA-side relationships, for $\sigma_{SA} = +1$ (with * denoting a possible cause for concern regarding a lack of normalization)

ν_{SA}	D	S	Ω_{SA}	σ_{SA}	D	$D + 2\nu_{SA}$	Re simple particles:	$2S + 1$
-1	$3 - \Omega$	0	0	$+1$	3	1	Boson field ($\iota_S = 0$)	1
$-1/2$	$(5 - 4\Omega)/2$	$1/2$	$3/4$	$+1$	1	0	Fermion field ($\iota_S = 1$)	2
$-3/2$	$(21 - 4\Omega)/6$	$1/2$	$3/4$	$+1$	3	0	Fermion particle ($\iota_S = 1$)	2
-1	$3 - \Omega$	1	2	$+1$	1	-1*	Boson field* ($\iota_S = 2$)	3

(c) TA-side relationships, for $\sigma_{TA} = +1$ (with * denoting a possible cause for concern regarding a lack of normalization)

ν_{TA}	D	S_{TA}	Ω_{TA}	σ_{TA}	D	$D + 2\nu_{TA}$	Re simple particles:	$2S_{TA} + 1$
-1	$3 - \Omega$	0	0	$+1$	3	1	Boson field ($\iota_S = 0$)	1
$-1/2$	$(5 - 4\Omega)/2$	$3/2$	$3/4$	$+1$	1	0	Fermion field ($\iota_S = 1$)	2
$-3/2$	$(21 - 4\Omega)/6$	$3/2$	$3/4$	$+1$	3	0	Fermion particle ($\iota_S = 1$)	2
-1	$3 - \Omega$	1	2	$+1$	1	-1*	Boson field* ($\iota_S = 2$)	3

(d) SA-side relationships, for $\sigma_{SA} = -1$

ν_{SA}	D	S	Ω_{SA}	σ_{SA}	D	$D + 2\nu_{SA}$	$2S + 1$
$-1/2$	$(5 - 4\Omega)/2$	$1/2$	$-3/4$	-1	4	3	2
$-1/2$	$(5 - 4\Omega)/2$	$3/2$	$-15/4$	-1	10	...	...
$-1/2$	$(5 - 4\Omega)/2$	...	...	...	...	...	...
-1	$3 - \Omega$	0	0	-1	3	1	1
-1	$3 - \Omega$	1	-2	-1	5	3	3
-1	$3 - \Omega$	2	-6	-1	9	...	...
-1	$3 - \Omega$	...	...	...	...	...	...
$-3/2$	$(21 - 4\Omega)/6$	$1/2$	$-3/4$	-1	4	1	2
$-3/2$	$(21 - 4\Omega)/6$	$3/2$	$-15/4$	-1	6	...	...
$-3/2$	$(21 - 4\Omega)/6$	...	...	...	...	...	...

(e) Relationships between some parameters, for $D'' = 2$

D''	ν''	$D'' + 2\nu''$	D	S''	Ω''	σ''	D	$D + 2\nu''$	$2S'' + 1$
2	-1	0	$3 - \Omega''$	1	1	$+1$	2	0	3
2	-1	0	$3 - \Omega''$	0	0	NR	3	1	1
2	-1	0	$3 - \Omega''$	1	-1	-1	4	2	3
2	-1	0	$3 - \Omega''$	2	-4	-1	7	5	5
2	-1	0	$3 - \Omega''$	3	-9	-1	12	10	7
2	-1	0	$3 - \Omega''$	4	-16	-1	19	17	9
2	-1	0	$3 - \Omega''$	5	-25	-1	28	26	11
2	-1	0	$3 - \Omega''$	6	-36	-1	39	37	13
2	-1	0	$3 - \Omega''$	7	-49	-1	52	50	15
2	-1	0	$3 - \Omega''$	8	-64	-1	67	65	17
2	-1	0	$3 - \Omega''$	9	-81	-1	84	82	19

Table 13: PDE symbols and, for modeling related to physics dynamics, dimensions correlating with terms

Symbol	Discussion	Dimensions - square of ...	Related constant
ξ'_{SA}	$\xi'_{SA}\Omega_{SA} \propto S(S+1)\hbar^2$	Angular momentum	$\hbar^2$
$\xi'_{SA}(\eta_{SA})^{-2}$		Momentum	
$\xi'_{TA}(\eta_{TA})^{-2}$		Energy	
$(\eta_{SA})^2/(\eta_{TA})^2$		Velocity	c^2
$\xi'_{SA}(\eta_{SA})^{+2}$		Angular momentum times length	
$\xi'_{TA}(\eta_{TA})^{+2}$		Energy times square of time	

- We anticipate applying the following three notions.
- $D_{XA} = 1$ correlates with one XA-side one-dimensional harmonic oscillator. Here, XA is one of TA and SA. We label that oscillator as the XA0 oscillator. $D_{XA} = 3$ correlates with three XA-side one-dimensional harmonic oscillators. We label those oscillators as the XA0 oscillator, XA1 oscillator, and XA2 oscillator.
- Equation (18) correlates with equations (3) and (4). Here, XA can be either one of TA and SA.

$$(\xi'_{XA}/2)\sum_{\iota=0}^{D_{XA}-1} -(\eta_{XA})^2(\frac{d}{dr_{XA\iota}})^2 + (\eta_{XA})^{-2}(r_{XA\iota})^2 \tag{18}$$

- Use of equation (18) allows separation of the terms into clusters. Equation (18) is a sum of D_{XA} terms. Each one of the D_{XA} terms appears in exactly one cluster. For $D_{XA} = 1$, there is one term (which correlates with the XA0 oscillator) and one cluster (which contains the one term). For $D_{XA} = 3$, we use two clusters. One cluster correlates with the XA0 oscillator. One cluster correlates with the XA1-and-XA2 oscillator pair. In the cases of these clusterings (and other possible clusterings), we apply - for each two-oscillator cluster - an analog to equations (3) and (4).
- Regarding modeling particles for $\iota_S = 0$ simple bosons, the TA-side D is three. (See table 12c.) The SA-side D is three. (See table 12b.) Modeling can feature the cluster TA1-and-TA2, the cluster TA0-and-SA0, and the cluster SA1-and-SA2. For each of the three clusters, modeling can correlate with $D'' = 2$, $\nu'' = -1$, and $D + 2\nu'' = 0$.
- Regarding modeling particles for $\iota_S = 2$ simple bosons, the TA-side D is one. (See table 12c.) The SA-side D is one. (See table 12b.) Modeling can feature the cluster TA0-and-SA0. Modeling can correlate with $D'' = 2$, $\nu'' = -1$, and $D + 2\nu'' = 0$.
- Regarding modeling fields for all simple bosons, the following two possibilities pertain.
  - One can use, for $\iota_S = 0$, results that tables 12b and 12c show. One can use, for $\iota_S = 2$, the notion of mapping the $D = 1$ solutions - that tables 12b and 12c show - into the three dimensions that correlate with $D = 3$. Here, each one of the SA-side solution and the TA-side solution normalizes. Use of $D = 3$ is not necessarily incompatible with the notion of $D = 3$ for each of the SA-side and TA-side aspects of the case for which $\iota_S = 0$.
  - One can use the notion that equation (13) pertains with $\sigma_{SA} = +1$. Regarding equation (8), $D = D^*_{SA} = 3$ and $\nu_{SA} = S$. Regarding equation (14), $\sigma_{TA} = +1$. Regarding the TA-side analog to equation (8), $D = D^*_{TA} = 1$, and $\nu_{TA} = S + 1$.

We discuss some aspects of proposed theory modeling.

Table 13 notes aspects of PDE mathematics that can pertain for dynamics modeling and $\nu_{SA} \geq 0$. (For other possible physics applications, for $\nu_{SA} < 0$ and $\nu_{SA} \geq 0$, see table 11.) In table 13, the associations that the first row shows provide a basis for the remaining rows. The row that notes $\xi'_{SA}(\eta_{SA})^{+2}$ might point to a series - momentum, angular momentum, and angular momentum times length.

PDE-based modeling might correlate with some aspects of unification of the strong, electromagnetic, and weak interactions. We consider modeling for which $2\nu_{SA}$ is a non-negative integer. Based on the r^{-2} spatial factor, the V_{-2} term might correlate with the square of an electrostatic potential. Based on the r^2 spatial factor, the V_{+2} term might correlate (at least, within hadrons) with the square of a potential correlating with the strong interaction. The sum $K_{0a} + K_{0b}$ might correlate with the strength of the weak interaction. (The effective range of the weak interaction is much smaller than the size of a hadron.

Perhaps, the spatial characterization r^0 correlates with an approximately even distribution, throughout a hadron, for the possibility of a weak interaction occurring.) Based on the V_{-2} term, we expect that ξ'_{SA} includes a factor $\hbar^2$.

Electrostatics includes each of interactions that attract objects to each other and interactions that repel objects from each other. One might consider the possibility that, in some modeling, the term proportional to Ω_{SA}/r^2 might seem to allow for repulsion, but not for attraction. (See equations (3) and (4).) However, when equations (17), (19), and (20) pertain, one can swap the Ω_{SA}/r^2 term and the Ω_{TA}/t^2 term in equation (17). The swap leads, in effect, to a new Ω_{SA}/r^2 that has the opposite sign as the old Ω_{SA}/r^2. The new Ω_{SA}/r^2 would correlate with attraction. For some aspects of modeling, equations (21) and (22) pertain.

$$(t/\eta_{TA})^2 = (r/\eta_{SA})^2 \tag{19}$$

$$\xi'_{TA} = \xi'_{SA} \tag{20}$$

$$t^2/(2(\eta_{TA})^2) + r^2/(2(\eta_{SA})^2) = tr/(|\eta_{TA}| \cdot |\eta_{SA}|) \tag{21}$$

$$v_c = |\eta_{SA}|/|\eta_{TA}| \tag{22}$$

A swap, regarding the TA-side $(\eta_{TA})^{-2}t^2$ term and the SA-side $(\eta_{SA})^{-2}r^2$ term, could lead to modeling that pertains to some aspects of repulsion. (See, for example, table 30.) Absent this swap, modeling regarding hadrons in a multi-hadron atomic nucleus, might correlate with the attractive component of the residual strong force. With this swap, modeling regarding hadrons in a multi-hadron atomic nucleus, might correlate with the repulsive component of the residual strong force.

We note some aspects that this essay de-emphasizes.

This essay de-emphasizes thoroughly discussing the extent to which r, as used regarding QPT modeling pertaining to the existence of simple particles, correlates with coordinates that people might use for spatial aspects of ongoing theory dynamics modeling regarding motion within systems. This essay de-emphasizes thoroughly discussing the extent to which r, as used regarding QPT modeling pertaining to the existence of simple particles, correlates with coordinates that people might use for spatial aspects of ongoing theory kinematics modeling. Similar notions pertain regarding t, as used regarding QPT modeling pertaining to the existence of simple particles. This essay de-emphasizes exploring the extent to which allowing for variation, regarding η_{SA} or η_{TA}, with respect to ongoing theory notions of time or proper time leads to useful models regarding diffusion.

3.2.4. A table of free simple particles

This unit shows a table of known free simple particles and proposed free simple particles.

Table 14 lists all known free simple particles and all free simple particles that proposed theory suggests. (Compare with table 8.) QPT work leading to table 12 does not depend on making assumptions regarding $m\grave{>}0$ and $m\dot{=}0$. QPT assumes that a partial symmetry between $m\grave{>}0$ and $m\dot{=}0$ pertains. In table 14a, the $m\dot{=}0$ column reflects that partial symmetry. Regarding $\iota_S = 2S$, ongoing theory might suggest a possibility for adding photons. Table 3 might correlate with this notion. However, our development classifies 2G as other than a simple particle. Our PDE modeling correlates 2G, in effect, with inputs to modeling that, in effect, outputs table 14a. Equation (23) explains the notation $|\iota_Q|\acute{=}3$. For the case of $|\iota_Q|\acute{=}3$ and $m\dot{=}0$, only $|\iota_Q| = 0$ pertains.

$$|\iota_Q|\acute{=}n \text{ denotes } |\iota_Q| = n \text{ or } 0 \tag{23}$$

3.2.5. ALG representations for free elementary particles

This unit discusses ALG modeling. This unit discusses ALG representations for free elementary particles. This unit discusses symmetries that correlate with ALG modeling and with some conservation laws. The unit discusses the notion of somewhat conservation of fermion generation.

We discuss aspects of ALG modeling.

Ongoing theory describes photon states via two harmonic oscillators. Ongoing theory features four space-time dimensions. Why not describe photon states via four harmonic oscillators?

Proposed theory describes photon states via four harmonic oscillators. A first hunch might be that doing so correlates with non-zero longitudinal polarization and a photon rest mass that would be non-zero. However, mathematics allows a way to avoid this perceived possible problem. A second hunch

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Table 14: Known and proposed free simple particles

(a) Subfamilies for known and proposed simple particles

$\iota_S = 2S$	Free $\lvert\iota_Q\rvert\acute{=}3$ $m\grave{>}0$	Free $\lvert\iota_Q\rvert\acute{=}3$ $m\grave{=}0$
0	$0\mathrm{H}^0$:1	$0\mathrm{I}^0$:1
1	$1\mathrm{C}^3_j$:2	$1\mathrm{N}^0_j$:{1 or 2}
2	$2\mathrm{W}^0$:1	
2	$2\mathrm{W}^3$:2	

(b) Subfamilies and generations for known free simple particles for which $m\grave{>}0$

Subfamily and (if not NR) generation	Particles	$\sum n$ (per $:n$)
$0\mathrm{H}^0$	Higgs boson	1
$1\mathrm{C}^3_j$	j-th generation of charged leptons	2
$1\mathrm{Q}^2_j$	j-th generation of $\lvert\iota_Q\rvert = 2$ quarks	2
$1\mathrm{Q}^1_j$	j-th generation of $\lvert\iota_Q\rvert = 1$ quarks	2
	$2\mathrm{W}^0$:1 - Z boson	1
	$2\mathrm{W}^3$:2 - W boson	2
2W	Z and W (W^{-3} and W^{+3}) bosons	3

(c) Subfamilies and generations for known and proposed free simple particles for which $m\grave{=}0$

Subfamily and (if not NR) generation	Particles	$\sum n$ (per $:n$)
0I	Inflaton	1
$1\mathrm{N}_j$	j-th generation of neutrinos	{1 or 2}

Table 15: Excitations for the left circular polarization mode of a photon

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	n							
SA	-1	n, $@_0$						

might be that using four oscillators adds no insight. However, using four oscillators leads to a framework for expressing aspects of proposed theory and leads to insight about a family of phenomena that includes photons.

We consider the left circular polarization mode of a photon. We denote the number of excitations of the mode by n. Here, n is a nonnegative integer. One temporal oscillator pertains. We label that oscillator TA0. The excitation number $n_{TA0} = n$ pertains. Here, $n_{TA0} = n \geq 0$ pertains. Harmonic oscillator mathematics correlates a value of $n + 1/2$ with that oscillator. Three spatial oscillators pertain. Here, $n_{SA0} = -1$, $n_{SA1} = n$, $n_{SA2} = @_0$. Oscillator SA0 correlates with longitudinal polarization and has zero amplitude for excitation. (See equation (26).) Oscillator SA1 correlates with left circular polarization. Oscillator SA2 correlates with right circular polarization. The symbol @_ denotes a value of _ that, within a context, never changes. For left circular polarization, $@_0$ pertains for oscillator SA2. The sum $n + 1/2$ correlates with each of the one TA-side oscillator and the three SA-side oscillators. For the SA-side oscillators, the sum equals $(-1 + 1/2) + (n + 1/2) + (0 + 1/2)$.

Table 15 shows excitations for the left circular polarization mode of a photon. For the right circular polarization mode, one exchanges the values of n_{SA1} and n_{SA2}. The result is $n_{SA1} = @_0$, $n_{SA2} = n$.

The representation that table 15 shows is invariant with respect to observer. In ongoing theory, each observer would measure both left circular polarization and the same value of n. Observers might disagree with respect to measured values of energy or momentum.

The following concepts and generalizations pertain.

- The above discussion correlates with the two-word term ALG modeling. ALG is an abbreviation for the word algebraic. Elsewhere, we discuss PDE modeling. (See discussion related to equation (17).) PDE abbreviates the three-word term partial differential equation.

- For ALG modeling, equation (24) pertains. Each of A^{ALG}_{TA} and A^{ALG}_{SA} correlates with the concept of an isotropic quantum harmonic oscillator. The word isotropic (or, the two-word term equally weighted) also pertains to the pair consisting of A_{TA}^{ALG} and A_{SA}^{ALG}. The one-element term double-entry pertains. For example, increasing a TA-side excitation number by one requires either decreasing a different TA-side excitation by one or increasing one SA-side excitation by one. The two-element term double-entry bookkeeping pertains.

$$0 = A^{ALG} = A_{TA}^{ALG} - A_{SA}^{ALG} \tag{24}$$

- The above discussion extends the domain correlating with equation (25) from $n \geq 0$ to $n \geq -1$. Here, a^+ denotes a harmonic oscillator raising operator. The symbol $|\_ >$ correlates with the notion of quantum state. The $|n>$ denotes the notion that the state correlates with n excitations. Proposed theory includes equation (26). Equations (27) and (28) pertain regarding a lowering operator.

$$a^+|n >= (1+n)^{1/2}|n+1> \tag{25}$$

$$a^+|-1>= 0|0> \tag{26}$$

$$a^-|n>= n^{1/2}|n-1> \tag{27}$$

$$a^-|0>= 0|-1> \tag{28}$$

- We posit that equations (29) and (30) extend equation (24). Here, the number, n, correlating with excitations satisfies $n \geq 0$.

$$a^+ A_{TA}^{ALG} = a^+ A_{SA}^{ALG} \tag{29}$$

$$a^- A_{TA}^{ALG} = a^- A_{SA}^{ALG} \tag{30}$$

- One can sum any positive number of values of A^{ALG}. The sum is always zero. We suggest that the expression $A^{ALG} = 0$ provides a basis for modeling that avoids ongoing theory concerns about unlimited sums of ground state energies.

- Some aspects of ALG modeling include notions that people might consider to correlate with the three-word term below ground state. For example, consider the SA-side representation for the ground state of the left circular polarization mode. The proposed theory ground state sum is one-half. People might think that the ground state sum for a three-dimensional isotropic quantum harmonic oscillator should be three-halves, as in $3 \cdot (0 + 1/2)$. Regarding equation (6), applications for which $\nu_{SA} < 0$ pertains can exhibit aspects correlating with the term below ground state. Applications for which $\nu_{SA} \geq 0$ pertains do not exhibit aspects correlating with the term below ground state.

We discuss symmetries that correlate with mathematics for isotropic harmonic oscillators.

Table 16 shows symbols that we use and groups to which proposed theory refers. Aside from the appearance of items using the aspect $n\_ = -1$ or the symbol A0−, information in the table comports with standard relationships between mathematics of group theory and mathematics for isotropic quantum harmonic oscillators. The leftmost column shows the relevant number of oscillators. For each row, the symbol XA can be TA, in which case all of the oscillators are TA-side oscillators, or SA, in which case all of the oscillators are SA-side oscillators. The symbol $S1G$ denotes a group with one generator. The number of generators for $U(1)$ is two. One generator correlates with integer increases regarding the number of excitations that pertain for the oscillator for which the table shows $n\_ = 0$. One generator correlates with integer decreases regarding the number of excitations that pertain for the oscillator for which the table shows $n\_ = 0$. The number of generators for $SU(j)$ is $j^2 - 1$. The symbol π correlates with the concept of permutations. The symbol $\pi_{a,b}$ denotes two possibilities. Regarding the two oscillators, for one possibility, a pertains to the first oscillator and b pertains to the second oscillator. For the other possibility, a pertains to the second oscillator and b pertains to the first oscillator. The symbol χ correlates with the concept of choice. The symbol χ_a pertains to one oscillator and correlates with the equation $n_{XA\_} = a$. The symbol κ correlates with the concept of a continuous set of choices. For example, regarding two oscillators XA1 and XA2, equations (31) and (32) describe the continuum of possibilities correlating with

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Table 16: Number of oscillators, symbols, groups, and contributions to $\widehat{A}^{ALG}_{XA}$

Oscillators	Symbol	Group	Generators	$\widehat{A}^{ALG}_{XA}$
2	A0−	-		-1
2	[blank], $\kappa_{0,-1}$	-	-	0
2	$\pi_{@_0,@_{-1}}$	-	-	0
2	A0+	-	-	1
1	χ_{-1}	$S1G$	1	$-1/2$
1	χ_0	$S1G$	1	$1/2$
2	$\pi_{0,-1}$	$U(1)$	2	0
2	$\pi_{0,@_0}$	$U(1)$	2	1
j	$\kappa_{-1,\cdots,-1}$	$SU(j)$, $j \geq 2$	j^2-1	$-j/2$
j	$\kappa_{0,\cdots,0}$	$SU(j)$, $j \geq 2$	j^2-1	$j/2$
2	$\kappa'_{0,0}$	$SU(2) \times U(1)$	NR	1

Table 17: Excitations for a photon

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	n							
SA	-1	$\pi_{n,@_0}$						

$\kappa_{0,-1}$. Here, each of d and e is a complex number. Regarding $SU(j)$, each of the symbols $\kappa_{-1,\cdots,-1}$ and $\kappa_{0,\cdots,0}$ correlates with a continuous set of choices involving amplitudes pertaining to j oscillators. Equation (33) pertains regarding the symbol $\kappa'_{0,0}$. In ongoing theory, the notion of $\kappa'_{0,0}$ has relevance to aspects of the weak interaction. For proposed theory, we show that $\kappa'_{0,0}$ pertains to aspects of the weak interaction. A number of generators for $\kappa'_{0,0}$ is not necessarily relevant for this essay. The symbol A0− denotes $\pi_{@_{-1},@_{-1}}$. The symbol A0+ denotes $\pi_{@_0,@_0}$. The symbol $\widehat{A}^{ALG}_{XA}$ denotes the contribution that the relevant oscillators make toward a total A^{ALG}_{XA}. The symbol [blank] - in the second row of table 16 - denotes the concept that, in tables such as table 15, one can interpret a blank cell as correlating with $\kappa_{0,-1}$.

$$d|n_{XA1} = 0,\, n_{XA2} = -1> \quad + \; e|n_{XA1} = -1,\, n_{XA2} = 0> \tag{31}$$

$$|d|^2 + |e|^2 = 1 \tag{32}$$

$$\kappa'_{0,0} = \kappa_{0,0} \times \pi_{0,-1} \tag{33}$$

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 $\not|$ denotes the four-word phrase does not divide evenly. For some aspects of physics modeling, equation (34) correlates with ending the series $SU(3)$, $SU(5)$, $\cdots$ at the item $SU(7)$. For some aspects of physics modeling, the series $SU(3)$, $SU(5)$, $SU(7)$, and $SU(17)$ might pertain.

$$g_3|g_5,\; g_3|g_7,\; g_5|g_7 \quad g_5\not|g_9,\; g_7\not|g_9,\; g_7\not|g_{11} \quad g_3|g_{17},\; g_5|g_{17},\; g_7|g_{17} \tag{34}$$

We anticipate invoking the mathematical notion of ending a series $SU(3)$, $SU(5)$, $\cdots$ at the item $SU(7)$. Sometimes, we correlate an ending with physics data. Sometimes, we correlate an ending with symmetries related to kinematics conservation laws.

We return to discussion that relates to and extends table 15.

Table 17 shows excitations for a photon. For each mode, we posit that the $U(1)$ symmetry that correlates with the permutation (appropriate to the mode) of $\pi_{n,@_0}$ correlates with the $U(1)$ symmetry that the elementary particle Standard Model associates with photons. One generator correlates with excitation. One generator correlates with de-excitation.

We attempt to represent elementary particles other than photons.

For this discussion, we de-emphasize addressing the following questions. To what extent do answers to the following questions differ between simple bosons and simple fermions? To what extent does $n_{SA0} = -1$ correlate with zero longitudinal polarization? To what extent does $n_{SA0} = -1$ correlate with zero rest

Table 18: Ground state for weak interaction bosons

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0			0, 0				
SA	$n_Z = 0$	$n_{W^{-3}} = 0$, $n_{W^{+3}} = 0$						

Table 19: Excitations for the Higgs boson

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	n							
SA	n							

mass? To what extent does $n_{SA0} = -1$ correlate with being able to excite a state via using an arbitrarily small amount of energy squared? To what extent does $n_{SA0} = -1$ correlate, for free environments, with travel at the speed of light? To what extent does $n_{SA0} = -1$ correlate with inabilities to interact with phenomena, such as the Higgs boson, that proposed theory modeling associates with the SA0 oscillator?

We generalize from work above. We assume that the oscillator pair SA1-and-SA2 correlates with charge or with interactions with charge. We note that ongoing theory interrelates photons and weak interaction bosons.

Table 18 posits a ground state for weak interaction bosons. The relevant bosons are the Z and W bosons. The table correlates the negative charge state of the W boson with the SA1 oscillator. The table correlates the positive charge state of the W boson with the SA2 oscillator. (One might correlate negative charge with SA2 and positive charge with SA1. We do not explore this possibility further. This essay does not explore the possibility of a link between such an assignment regarding charge and the assignment of photon circular polarization modes.) Elsewhere, we discuss a reason, within the bounds of $A^{ALG} = 0$, for placing $\kappa_{0,0}$ with the TA5-and-TA6 oscillator pair. (See table 38.)

We discuss W-family excitations. To describe n excitations of the same state of one of the bosons, we use $n_{TA0} = n = n_{SA\_}$, with SA_ correlating with the one boson. An isolated interaction that excites or de-excites the boson conserves the generation of the fermion that participates in the interaction. For example, an interaction between an electron (or, generation-one charged lepton) and a W^{+3} boson produces a generation-one neutrino. We say that conservation of generation pertains. We consider some interactions in hadrons (such as protons and neutrons). Here, we consider an entangled emission and absorption of a pair of W bosons, with one W boson being a W^{-3} and the other W boson being a W^{+3}. Ongoing theory results suggest that conservation of fermion generation need not pertain for the relevant quarks. (A transition from the state that table 18 shows to the state characterized by $n_{TA0} = 2$, $n_{SA0} = 0$, $n_{SA1} = 1$, and $n_{SA2} = 1$ would violate equation (29). The TA-side raising operations would produce a factor of $(1+0)^{1/2}(1+1)^{1/2}$, which equals $2^{1/2}$. The SA-side raising operations would produce a factor of $(1+0)^{1/2}(1+0)^{1/2}$, which equals 1.) Equations (29) and (30) imply that one of oscillators TA5 and TA6 participates. There are three generations of quarks. Three is the number of generators of $SU(2)$. We posit that an approximate $SU(2)$ symmetry pertains. (See table 16.) We use the four-word term somewhat conservation of generation (or, the five-word term somewhat conservation of fermion generation). Ongoing theory seems to correlate this proposed theory notion of non-conservation of generation with the ongoing theory notion of CP violation. (See, for example, reference [28].) We note the possibility that, in appropriate settings, one might be able to detect non-conservation, induced by W-family effects, of lepton generation. (Reference [28] suggests that people may be on the verge of observing evidence of lepton CP violation.) Such a setting might need to be adequately conducive to multiple nearby interactions involving W bosons. Here, the word nearby pertains regarding both ongoing theory notions of temporal aspects and ongoing theory notions of spatial aspects.

We discuss an ongoing theory W-family symmetry. Ongoing theory associates $SU(2)\times U(1)$ symmetry with the weak interaction. For proposed theory, we associate $U(1)$ symmetry with excitation and de-excitation regarding each of the three SA-side oscillators. This aspect has parallels to the $U(1)$ symmetry that pertains for photons. We associate $SU(2)$ symmetry with a combination of $n_{W^{-3}} = 0$ and $n_{W^{+3}} = 0$. For the W-family, the $SU(2)$ and $U(1)$ symmetries combine to form $\kappa'_{0,0}$ (or, $SU(2) \times U(1)$).

We extend proposed theory ALG modeling to include the Higgs boson.

Table 19 shows excitations for the Higgs (or, 0H) boson. The ground state value $n_{SA0} = 0$ correlates with the non-zero mass of the Higgs boson. The lack of an SA1-and-SA2 entry correlates with the Higgs boson having zero charge and not interacting with charge.

A number of SA-side oscillators seems to correlate with each of spin and numbers of particles. For

Table 20: Representations for ground states for photons, weak interaction bosons, and the Higgs boson

(a) Representation for the Higgs boson

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0							
SA	0							

(b) Representation for weak interaction bosons (with $\pi_{0,@_0,@_0}$ spanning the two items showing the symbol *)

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0			$\kappa_{0,0}$				
SA	*	*						

(c) Representation for photons

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0							
SA	-1	$\pi_{0,@_0}$						

each of 0H, 2W, and 2G, equation (35) pertains. In the equation, N_{SA} denotes a number of relevant SA-side oscillators. Also, for 0H and 2W, $2S+1$ provides the number of particles, if one counts matter particles and antimatter particles separately.

$$N_{SA} = 2S + 1 \tag{35}$$

Table 20 shows representations for 0H, 2W, and 2G ground states.

We extend work above to include representations for all known and suggested free simple particles and root forces. (See table 3.) We de-emphasize excitations. We emphasize representations for ground states. For elementary bosons, doing so correlates with, for example, modeling that does not preclude the 0I boson or the 2U (or, gluon) particles. Elsewhere, we discuss the notion that boson excitements correlate with a concept of channels. (See discussion to which discussion related to table 26 points.) For simple fermions, a state is either occupied or not occupied.

Table 21 shows representations for 0I, 1C, and 1N simple particles. Each state for which the one-word term boson (or, the result that $2S$ is an even integer) pertains comports with equation (35). For fermions (or, for particles for which $2S = 1$), equation (35) pertains, given two assumptions. One assumption is that we do not count the SA5-and-SA6 oscillator pair, which correlates with $SU(2)$ symmetry, three generators for that group, and three generations of simple particles. One assumption is that each of $n_{SA1} = -1$ and $n_{SA2} = -1$ disables one oscillator and, in effect, leads to the result $N_{SA} = 2$. For each of charged leptons and neutrinos, states are either populated or not populated. Each of charged leptons and neutrinos exhibits a TA5-and-TA6 approximate $SU(2)$ symmetry. That symmetry correlates with somewhat conservation of fermion generation. For each of charged leptons and neutrinos, the SA1-and-SA2 appearance of a $U(1)$ symmetry may seem surprising. Unlike for elementary bosons, multiple excitations for a single state do not pertain. However, multicomponent objects can include more than one identical (for this discussion) fermion. For example, an atom can contain more than one electron.

Table 14 provides a roadmap for developing representations for non-zero spin simple particles for which we do not show representations above. A representation for each unfree non-zero spin simple particle equals the representation for the corresponding free simple particle. For example, a representation for the $1Q_j^2$ quarks equals the representation for the $1C_j^3$ charged leptons.

Table 22 shows representations for 4G, 6G, and 8G root forces. Each representation comports with equation (35). Paralleling results regarding the 2W subfamily, the appearance of $\kappa_{0,0}$ in table 22a correlates with somewhat conservation of fermion generation. (While this leaves the possibility that occurrences of multiple close-by interactions could explain neutrino oscillations, proposed theory offers another explanation. See discussion related to equation (92). The proposed theory treatment seems to explain observed data.) Regarding table 22b, we are uncertain as to whether it would make a significant difference if the * regarding TA3-and-TA4 pertained instead to TA7-and-TA8.

3.2.6. Kinematics conservation laws

This unit shows modeling regarding conservation of energy, momentum, and angular momentum.

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Table 21: Representations for 0I, 1C, and 1N simple particles

(a) Representation for 0I bosons

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	-1							
SA	-1							

(b) Representation for charged leptons

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0			$\kappa_{0,0}$				
SA	0	$\pi_{0,-1}$		$\kappa_{0,0}$				

(c) Representation for neutrinos

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	-1			$\kappa_{-1,-1}$				
SA	-1	$\pi_{0,-1}$		$\kappa_{-1,-1}$				

Table 22: Representations for 4G, 6G, and 8G root forces

(a) Representation for 4G bosons

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0			$\kappa_{0,0}$				
SA	-1	$\pi_{@_0,@_0}$	$\pi_{0,@_0}$					

(b) Representation for 6G bosons (with * denoting participation in one instance of $\kappa_{0,0,0,0}$)

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0		*	*				
SA	-1	$\pi_{@_0,@_0}$	$\pi_{@_0,@_0}$	$\pi_{0,@_0}$				

(c) Representation for 8G bosons (with * denoting participation in one instance of $\kappa_{0,0,0,0,0,0}$)

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0		*	*	*			
SA	-1	$\pi_{@_0,@_0}$	$\pi_{@_0,@_0}$	$\pi_{@_0,@_0}$	$\pi_{0,@_0}$			

Table 23: Symmetries correlating with kinematics conservation laws

Conservation law	Ongoing theory	Proposed theory
Conservation of energy	$S1G$	TA-side $SU(5)$
Conservation of linear momentum	$SU(2)$	SA-side $SU(2)$
Conservation of angular momentum	$SU(2)$	SA-side $SU(2)$

In ongoing theory, the electromagnetic field carries information that correlates with events that excited the field. Via de-excitations, people measure energies, momenta, and polarizations. People infer information about excitation events.

We want to discuss the extent to which proposed theory models for ΣG (or, G-family) fields reflect encoded information.

We start by exploring modeling related to energy, momentum, and angular momentum.

Ongoing theory discusses models for objects, internal properties (such as spin and charge) of objects, motion-centric properties (such as linear momentum) of objects, and interactions (or, forces) that affect internal properties of objects or motion of objects.

We discuss symmetries that ongoing theory and proposed theory correlate with conservation laws related to motion.

Table 23 summarizes symmetries correlating with kinematics conservation laws. Ongoing theory correlates an $S1G$ symmetry with conservation of energy. The one-element term $S1G$ denotes a symmetry correlating with a group for which one generator pertains. Proposed theory considers this $S1G$ symmetry to be a TA-side symmetry. Proposed theory considers that this $S1G$ symmetry correlates with the TA0 oscillator. Ongoing theory correlates an $SU(2)$ symmetry with conservation of linear momentum and an $SU(2)$ symmetry with conservation of angular momentum. Proposed theory considers that each one of these $SU(2)$ symmetries is an SA-side symmetry.

The following concepts pertain.

- We extend the notion of free to include free objects other than the free simple particles and free root forces to which table 3 alludes. The notion of free correlates with an object having a well-specified definition and with the object modeling, under some circumstances, as if conservation of energy, momentum, and angular momentum pertain for the object.

- Models for the kinematics of free objects need to include the possibility that all three conservation laws pertain. The relevance of all three conservation laws correlates with modeling that correlates with the notion of a distinguishable object and with the notion of a free environment. (Free objects can exist as components of, let us call them, larger objects that are free. For one example, an electron can exist as part of an atom. For another example, a hadron can exist as part of an atomic nucleus that includes more than one hadron. In such contexts, modeling of the kinematics of the electron or hadron does not necessarily need to embrace all three conservation laws. The two-word term confined environment can pertain.)

- Models regarding the kinematics of unfree objects do not necessarily need to embrace all three kinematics conservation laws. Unfree objects model as existing in the contexts of larger free objects. The two-word term confined environment pertains.

- For an ALG model to embrace conservation of linear momentum and conservation of angular momentum, one, in effect, adds (to a model for an object) four SA-side oscillators and expresses two instances of $SU(2)$ symmetry. Double-entry bookkeeping suggests adding four TA-side oscillators. Proposed theory suggests that, for each of the eight added oscillators, $n\_ = n_{TA0}$. For at least some modeling, proposed theory suggests combining the four TA-side oscillators with the TA0 oscillator to correlate with an $SU(5)$ symmetry. For such modeling, proposed theory suggests that the TA-side $SU(5)$ symmetry correlates with conservation of energy. (See table 23.)

- Table 24 shows representations of kinematics conservation laws for free objects. The choice of oscillator pairs XA11-and-XA12 and XA13-and-XA14 correlates with the possibilities for other uses for oscillators XA0-through-XA10. (See discussion related to equation (63).) Here, we know of no correlation between oscillator pair SA11-and-SA12 and spin (for example, a spin of six). Here, we know of no correlation between oscillator pair SA13-and-SA14 and spin (for example, a spin of seven).

Table 24: Conservation of energy, momentum, and angular momentum for free objects

(a) The case $n_{TA0} = 0$ (with $\kappa_{0,0,0,0,0}$ spanning the three items showing the symbol *)

Side	0	1 and 2	3 and 4	5 and 6	7 and 8	9 and 10	11 and 12	13 and 14
TA	*						*	*
SA	0						$\kappa_{0,0}$	$\kappa_{0,0}$

(b) The case $n_{TA0} = -1$ (with $\kappa_{-1,-1,-1,-1,-1}$ spanning the three items showing the symbol *)

Side	0	1 and 2	3 and 4	5 and 6	7 and 8	9 and 10	11 and 12	13 and 14
TA	*						*	*
SA	-1						$\kappa_{-1,-1}$	$\kappa_{-1,-1}$

- Special relativity correlates with boost symmetry, which correlates with an additional $SU(2)$ symmetry. We suggest the possibility for using the oscillator pair SA15-and-SA16 to represent boost symmetry or a lack of boost symmetry. When boost symmetry applies, we suggest maintaining the notion of double-entry bookkeeping but not extending the TA-side symmetry from $SU(5)$ to $SU(7)$. Boost correlates with modeling and not with kinematics conservation laws.
- A contrast between tables 20b, 21, and 22 and table 24 pertains. Some information in tables 20b, 21, and 22 correlates with symmetries and conservation laws (or with approximate symmetries and somewhat conservation laws) that pertain regarding quantum excitations. Some information in table 24 correlates with conservation laws that pertain regarding kinematics.
- The following modeling can pertain regarding combining two free objects to form one free object.
  - Each of the two original objects contributes two SA-side $SU(2)$ symmetries.
  - Two of the original SA-side $SU(2)$ symmetries can pertain regarding modeling for the motion of the new object. The other two SA-side $SU(2)$ symmetries are available for modeling internal aspects of the new object. Neither of the original two objects continues to exhibit both conservation of momentum and conservation of angular momentum. For example, for a system consisting of a star and planet, neither the star nor the planet exhibits conservation of momentum. In this context, kinematics modeling for each of the two original objects might correlate with unfree modeling. In this context, each leftover internal $SU(2)$ symmetry can correlate with modeling for one of the original objects, for fields that model interactions between the two original objects, for combinations of objects and fields, or for something else. Here, the notion of something else might correlate with, for example, aspects of two-body modeling that features the concept of reduced mass.
  - Similarly, one of the original two TA-side $SU(5)$ symmetries can pertain regarding modeling for the motion of the new object. The other TA-side $SU(5)$ symmetry is available for modeling internal aspects of the new object.

3.2.7. G-family forces

This unit discusses aspects regarding G-family forces and regarding components of G-family forces. This unit shows modeling that links free simple bosons and G-family forces.

We explore modeling that encodes, regarding 2G modes, information about excitations of the overall 2G field. We consider the left circular polarized mode. Modeling for some excitations correlates with aspects of table 15.

We might also consider an excitation that models - at least conceptually - as combining an excitation of the left circular mode of 4G and the right circular mode of 2G. The combination yields a left circular polarization spin-1 excitation. The combination correlates with 2G.

Equation (36) provides notation that we use for such combinations. The symbol ΣG denotes a subfamily of the G-family of solutions to equation (24). The symbol Γ denotes a set of even integers selected from the set $\{2, 4, 6, 8\}$. We use the symbol λ to denote an element of Γ. Each value of λ correlates with the oscillator pair SA($\lambda - 1$)-and-SAλ. (Elsewhere, we discuss aspects correlating with the limit $\lambda \leq 8$. See discussion related to table 26.) For the above example of subtracting spin-1 from spin-2, the notation $\Gamma = 24$ pertains and equation (37) pertains.

$$\Sigma\mathrm{G}\Gamma \tag{36}$$

Table 25: G-family solutions that may be relevant

Other	Monopole	Dipole	Quadrupole	Octupole
0G∅	2G2	ΣG24	ΣG246	ΣG2468
	4G4	ΣG26	ΣG248	
	6G6	ΣG28	ΣG268	
	8G8	ΣG46	ΣG468	
		ΣG48		
		ΣG68		

$$\Sigma = |-2+4| = 2 \tag{37}$$

Table 25 points to possibly relevant solutions. The label monopole correlates with the existence of one mathematical solution for each item in the column labeled monopole. The label dipole correlates with the existence of two mathematical solutions for each item in the column labeled dipole. For example, for $\Gamma = 24$, each one of the solutions 2G24 and 6G24 pertains. The label quadrupole correlates with the existence of four mathematical solutions for each item in the column labeled quadrupole. G-family physics does not include phenomena that might correlate with the symbol 0G. For each of two quadrupole items, the one 0GΓ mathematical solution is not relevant to G-family physics. (The solutions may be relevant to physics other than G-family physics. See, for example, table 36.) For example, the solution 0G246, which correlates with $|-2-4+6|$, is not relevant to G-family physics. The label octupole correlates with the existence of eight mathematical solutions for the one item in the column labeled 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.

So far, the terms monopole through octupole correlate with numbers of solutions and - as yet - might not correlate with physical phenomena.

So far, proposed theory 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 Newtonian physics modeling, with force laws. Ongoing theory correlates the word monopole with a potential energy that varies as r^{-1} and with the RSDF of r^{-2}. Here, r denotes the distance from the center of the one relevant object. RSDF abbreviates the five-word term radial spatial dependence of force. Here, we de-emphasize angular aspects of forces. (Discussion related to table 28 shows relationships between some solutions that table 25 lists and aspects of ongoing theory. For example, 2G2 correlates with interactions with charge. 2G24 correlates with interactions with nominal magnetic dipole moment.)

Table 26 shows representations for the G-family solutions that table 25 lists. The solutions correlate with symmetries pertaining to ground states. For the case of Σ being two, excitations comport with the type of ΣG excitations to which table 17 alludes. For the cases of Σ being four, six, or eight, excitations comport with the type of ΣG excitations to which table 22 alludes. In table 26. the rightmost seven columns comport with double-entry bookkeeping. For example, a TA-side $SU(3)$ symmetry alludes to two additional TA-side oscillators for each of which $n_{TA\_} = 0$. Those two oscillators plus the TA0 oscillator correlate with $\kappa_{0,0,0}$ (or, with $SU(3)$ symmetry). The symbol A0+ correlates with an oscillator pair for which, for each of the two oscillators, the symbol $@_0$ pertains. (Perhaps, see table 16.) The column regarding span pertains regarding aspects of dark matter. (See table 57.) Regarding each $\Sigma > 0$ solution that the table shows, the radial behavior of the potential is $r^{n_{SA0}}$. The RSDF is $r^{n_{SA0}-1}$.

The TA-side $SU(\_)$ symmetries that table 26 shows pertain regarding kinematics and do not pertain regarding excitations. (See discussion regarding table 24.) One might think of these symmetries as correlating with oscillators TA0, TA11, TA12, TA13, and TA14.

Regarding elementary particle physics, we note three notions that might correlate with a limit of $\lambda \leq 8$. Possibly, each one of the three notions is relevant.

The limit might correlate with a scaling law. For the Γ of 2468⟦10⟧, the one-element phrase hexadecimal-pole would pertain. Here, the symbol ⟦10⟧ denotes the number ten. Assuming Newtonian modeling, the RSDF (or, radial spatial dependence of force) would be r^{-6}. We consider interactions between two similar, neighboring, non-overlapping, somewhat spherically symmetric objects. A ΣG2468⟦10⟧ force would scale like $(\upsilon^3\rho)^2/(\upsilon r)^6$, in which υ is a non-dimensional scaling factor that correlates with linear size (or, a length), ρ is the relevant object property for the case for which $\upsilon = 1$, and r is the distance between the centers of the objects. The factor υ^3 provides for scaling for an object that has three spatial dimensions.

Table 26: Information, including TA-side symmetries, regarding G-family solutions

ΣΦΓ	Span (for n≥6)	TA-side $SU(\_)$ symmetry	TA 0	SA 0	SA 1 and 2	SA 3 and 4	SA 5 and 6	SA 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	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$

Table 27: Σγ solutions (or, G-family solutions for which Σ appears in the list Γ)

Σ	Monopole	Dipole	Quadrupole	Octupole
2	2G2	2G24	2G248	
4	4G4	4G48	4G246	4G2468a, 4G2468b
6	6G6		6G468	
8	8G8			8G2468a, 8G2468b

The force would be independent of υ. That independence might suggest, from a standpoint of physics, that $\varrho = 0$ pertains.

The limit might correlate with a TA-side $SU(9)$ symmetry. Based on thinking that leads to table 26, 10G⟦10⟧ correlates with a TA-side $SU(9)$ symmetry. Here, the symbol ⟦10⟧ denotes a Γ that contains just the number ten. We posit that remarks regarding equation (34) pertain. Here, we de-emphasize the notion that 16G⟦16⟧ might be relevant to physics. (See discussion related to table 69.) The solution 16G⟦16⟧ would correlate with TA-side $SU(17)$ symmetry.

The limit might correlate with the notion of channels. Discussions related to equation (61) and to equation (67) suggest that a λ that exceeds eight is not relevant regarding G-family physics.

Each one of the following two sentences might pertain. Detecting effects of ΣGΓ components for which each of $\Sigma \geq 10$ and $\lambda \leq 8$ pertains would be difficult. Regarding nature, the series 2GΓ, 4GΓ, ... ends with 8GΓ.

We de-emphasize possibilities that solutions ΣGΓ for which $\Sigma \geq 10$ correlate with G-family physics. (Discussion regarding equation (49) points to mathematical modeling relevance, to physics that is not G-family physics, of solutions ΣGΓ for which $\Sigma \geq 10$.)

Table 27 lists G-family solutions ΣGΓ for which both Σ does not exceed eight and Σ appears in the list Γ. The expressions $|-2+4-6+8|$ and $|-2-4-6+8|$ show that two solutions comport with the notion of 4G2468. The expressions $|+2+4-6+8|$ and $|-2-4+6+8|$ show that two solutions comport with the notion of 8G2468. 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 (38).) 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 (39).)

$$\Sigma\gamma = \{\Sigma \mathrm{G} \Gamma | \Sigma \in \Gamma\} \tag{38}$$

$$\gamma\lambda = \{\Sigma \mathrm{G} \Gamma | \lambda \in \Gamma, \Sigma \notin \Gamma\} \tag{39}$$

Proposed theory correlates the two-word term monopole gravity (or, the four-word term monopole component of gravity) with the 4G4 solution. Proposed theory correlates the three-word term dark energy

Table 28: Interpretations regarding some components of $\Sigma\gamma$ forces for which $\Sigma \leq 4$

(a) Interactions

Components	Interactions with ...
2G2	Charge
2G24	Magnetic dipole moment
2G248	Magnetic dipole moment for which the axis changes over time
4G4	Mass
4G48	Mass that rotates
4G246	Quadrupole moment of mass
4G2468a, 4G2468b	Quadrupole moments of mass that rotates

(b) An interpretation

Aspect	Interpretation
$8 \in \Gamma$	Rotation

forces with the 4G48, 4G246, 4G2468a, and 4G2468b solutions. Solutions 4G48, 4G246, 4G2468a, and 4G2468b correlate with some effects for which ongoing theory might use the three-word term dark energy forces (or, the three-word term dark energy pressure). Solutions 4G48, 4G246, 4G2468a, and 4G2468b correlate also with - regarding ongoing theory - effects for which people might not use the term dark energy forces.

Table 28 discusses aspects of table 27. Here, we use wording that dovetails with classical physics. Some of the wording might not dovetail with quantum physics. Here, we use wording that dovetails with Newtonian modeling. Solution 2G248 correlates with a interactions with an object for which a non-zero magnetic dipole moment pertains, an axis of rotation pertains regarding the orientation of the axis of the magnetic dipole moment, and the axis of rotation does not match the axis correlating with the magnetic dipole moment. The notion of a vector cross product between a vector correlating with the axis of dipole moment and a vector correlating with the axis of rotation pertains. For the earth, the 2G248 interaction correlates with the non-alignment of the axis of rotation and the axis of the magnetic field. We posit that $8 \in \Gamma$ - or the number eight appearing in the list Γ - correlates with non-zero rotation. One of 4G2468a and 4G2468b interacts with rotational aspects of quadrupole distributions of mass based on an axis of maximal moment of inertia. The other one of 4G2468a and 4G2468b interacts with rotational aspects of quadrupole distributions of mass based on an axis of minimal moment of inertia.

Statements above regarding 2G and 4G dovetail with concepts that equations (40) and (41) symbolize. In proposed theory, modeling regarding quantum states and excitations does not necessarily involve modeling pertaining to translational motion. Equation (40) pertains. (See table 22.) Equation (41) correlates with linking G-family physics to models for forces and translational motion. (See discussion above regarding 2G and 4G and see, for example, table 26.) Another aspect of such linking correlates with kinematics conservation laws. (See discussion related to table 23.)

$$\Sigma\text{G} \leftrightarrow \text{quantum excitations} \tag{40}$$

$$\Sigma\text{G}\Gamma \leftrightarrow \text{a bridge between quantum excitations and kinematics forces} \tag{41}$$

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

We combine aspects of equation (34), table 23, and table 26. We posit that TA-side aspects of table 23 and TA-side aspects of table 26 combine. For example, for 8G8, a TA-side $SU(11)$ symmetry would pertain. (In table 23, seven TA-side oscillators pertain. In table 26, five TA-side oscillators pertain. The tables share their respective $n_{TA0} = 0$ values. Seven plus five minus one is 11.) For example, for 4G4, a TA-side $SU(7)$ symmetry would pertain. For example, for 2G2 or 2G24, a TA-side $SU(5)$ symmetry would pertain. We posit a limit that correlates with aspects of equation (34). We posit that each component that appears in table 26 and has a TA-side symmetry of None or $SU(3)$ can interact with simple particles. (Here, combining the TA-side symmetry that table 26 shows with the conservation of energy symmetry produces, respectively, $SU(5)$ or $SU(7)$.) We posit that each component that appears in table 26 and has a TA-side symmetry of $SU(5)$ or $SU(7)$ does not interact with simple particles. (Here, combining the TA-side symmetry that table 26 shows with the conservation of energy symmetry

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Table 29: Representations for 2U bosons and hypothetical 4U bosons

(a) Representations for 2U bosons (with $\kappa_{-1,-1,-1}$ spanning the two items showing the symbol *)

Side	0	o, e	o', e'	$\cdots, \cdots$	5, 6	$\cdots, \cdots$	9, 10	11, 12	13, 14
TA	-1				$\kappa_{-1,-1}$				
SA	*	*							

(b) Representations for hypothetical 4U bosons (with $\kappa_{-1,-1,-1}$ spanning the two items showing the symbol *)

Side	0	o, e	o', e'	$\cdots, \cdots$	5, 6	$\cdots, \cdots$	9, 10	11, 12	13, 14
TA	-1				$\kappa_{-1,-1}$				
SA	*	$\pi_{@_0,@_{-1}}$	*						

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.

For example, 2G68 can interact with an atom but not with an isolated electron. (Table 26 shows, regarding 2G68, a TA-side $SU(5)$ 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 discussion related to table 5.) Generally, $8 \in \lambda$ can correlate with interactions regarding spins of objects. (See discussion related to table 5 and see table 28b.)

3.2.8. *The U family and simple bosons related to U-family forces*

This unit shows representations correlating with U-family bosons. This unit correlates some simple bosons with aspects of U-family mathematics but not with U-family forces.

Table 29 shows representations for 2U forces and for possible 4U root forces. Each representation comports with equation (35). Each representation includes symmetries that comport with somewhat conservation of fermion generation. Here, o denotes a positive odd integer and e denotes the positive even integer that is one greater than o. Here, o' denotes a positive odd integer other than o. Here, e' denotes the positive even integer that is one greater than o'. We are not completely certain as to the extent to which proposed theory should correlate the numbers o and o' with numbering pertaining to ALG representations regarding simple particles and G-family forces.

We note some possibilities regarding correlating values of o or o' with numbering pertaining to ALG representations regarding simple particles and G-family forces. Gluons interact with quarks and arcs. One might consider correlating o with seven, based on the notion that G-family modeling correlates the SA7-and-SA8 oscillator pair with ι_{3LB} and, thereby, with quarks and arcs. To the extent that modeling treats color charge as an internal property of quarks and arcs, one might consider correlating o with five. Also, o equals five correlates with the notion (that table 29a shows) of somewhat conservation of generation and, thereby, with somewhat conservation of freeable energy. Table 7a reflects a choice of o equals five.

Elsewhere, we correlate 0G solutions with all simple bosons except the pie (or, 0P) and cake (or, 0K) bosons. (See table 36 and discussion related to equation (49).)

We correlate aspects of ΣU solutions with the pie (or, 0P) and cake (or, 0K) bosons.

Table 30 alludes to modeling that correlates the cake and pie particles with U-family forces. Tables 6a and 6d discuss the notion of $SU(3) \uplus I$. Table 30 focuses on the identity operator aspect of the notion of $SU(3) \uplus I$. Discussion related to equation (19) explains the relevant notion of a swap that correlates with the SA-side aspect that the table shows regarding the 0K simple boson. Proposed theory suggests that cake particles correlate with the ongoing theory notion of a Pauli exclusion force that repels hadrons from each other. Proposed theory suggests that pie particles correlate with the ongoing theory notion of Yukawa potential that, in atomic nuclei, attracts hadrons to each other. Whereas, 2U particle interactions correlate with color charges, 0K particles and 0P particles - in effect - interact with clear (or, white) color charge.

Table 31 suggests representations for the 0K and 0P bosons. Each one of the cake simple particle and pie simple particle does not interact with simple fermions.

The mass of the pie simple boson might approximate the masses of pions. We do not explore theory that might correlate with the mass of pie simple bosons.

Table 30: Possible correlations between U-family mathematics and simple bosons that do not belong to the U-family of root forces

Subfamily	Concept	Aspect	SA-side aspect	0Φ	0Φ mass	Residual strong force
2U	$SU(3) \uplus I$	I operator	$-(\eta_{TA})^{-2}t^2$	0K	$m \grave{>} 0$	Repulsive
2U	$SU(3) \uplus I$	I operator	$+(\eta_{SA})^{-2}r^2$	0P	$m \grave{>} 0$	Attractive

Table 31: Representations for 0K and 0P simple bosons

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA	0							
SA	0							

The effective range of the repulsive force is less than the effective range of the attractive force. The mass of the cake simple boson might exceed the mass of the pie simple boson. (See discussion related to equation (111).) The mass of the cake boson might approximate the masses of kaons. We do not explore theory that might correlate with the mass of the cake boson.

Discussion regarding nuclear physics might suggest a role for 4U forces. (See discussion somewhat related to equation (160).) Discussion related to equation (114) might suggest that nature does not include detectable 6U or 8U forces.

3.2.9. Unfree arc simple fermions and unfree tweak simple bosons

This unit discusses the possible existence of arcs (or, 1R unfree simple fermions) and tweaks (or, 2T unfree simple bosons).

Proposed theory suggests a symmetry regarding ι_Q. The symmetry suggests, regarding non-zero-spin simple particles, that each of the cases $\iota_Q = 2$ and $\iota_Q = 1$ is similar to the case $\iota_Q = 3$.

Table 32 shows, the free and unfree simple particles - other than the pie and cake particles - that propose theory suggests. (Compare with table 8 and with table 14.) For the zero-charge unfree particles that table 32 shows, the number of tick marks in a symbol $\Sigma\Phi^0-$ equals $|\iota_Q|$.

3.3. Modeling regarding some properties of elementary particles

This unit discusses concepts and methods that point to results regarding some properties of elementary particles.

3.3.1. Conservation of lepton number minus baryon number

This unit shows modeling that correlates with conservation of lepton number minus baryon number.

Equation (42) shows a quantity, N_{L-B} (or, lepton number minus baryon number). The symbol L correlates with the ongoing theory notion of lepton number. The symbol B correlates with the ongoing theory notion of baryon number. For a matter lepton, $L = +1$ and $B = 0$. For an antimatter lepton, $L = -1$ and $B = 0$. For a matter quark, $L = 0$ and $B = 1/3$. For an antimatter quark, $L = 0$ and $B = -1/3$. Other than possibly for charged T-family bosons, for simple bosons and root forces, $0 = L = B = N_{L-B}$. In ongoing theory, N_{L-B} is a conserved quantity. Equation (42) defines the symbol ι_{3LB}.

$$N_{L-B} = L - B \text{ and } \iota_{3LB} = 3(N_{L-B}) \tag{42}$$

We suggest correlating, with ι_{3LB}, the two-element term 3LB number. People might want to use the four-element term conservation of 3LB number.

Table 32: Free and unfree simple particles, other than the pie and cake particles

$\iota_S = 2S$	Free $\lvert\iota_Q\rvert \doteq 3$ $m \grave{>} 0$	Free $\lvert\iota_Q\rvert \doteq 3$ $m \doteq 0$	Unfree $\lvert\iota_Q\rvert \doteq 2$ $m \grave{>} 0$	Unfree $\lvert\iota_Q\rvert \doteq 2$ $m \doteq 0$	Unfree $\lvert\iota_Q\rvert \doteq 1$ $m \grave{>} 0$	Unfree $\lvert\iota_Q\rvert \doteq 1$ $m \doteq 0$
0	$0H^0$:1	$0I^0$:1				
1	$1C_j^3$:2	$1N_j^0$:{1 or 2}	$1Q_j^2$:2	$1R_j^{0''}$:{1 or 2}	$1Q_j^1$:2	$1R_j^{0'}$:{1 or 2}
2	$2W^0$:1		$2T^{0''}$:1		$2T^{0'}$:1	
2	$2W^3$:2		$2T^2$:2		$2T^1$:2	

Table 33: Values, for objects, of ι_{3LB}, L, and B

Concepts
• For free objects, the minimum magnitudes of some non-zero quantities are $\|q_\epsilon\|$ for charge and three for $\|\iota_{3LB}\|$.
• For unfree objects, the minimum magnitudes of some non-zero quantities are $\|q_\epsilon\|/3$ for charge and one for $\|\iota_{3LB}\|$.
• Each of the quantities charge, ι_{3LB}, L, and B is additive with respect to components of a multicomponent object.

Proposed theory includes the notion of conservation of ι_{3LB}.

Each of equations (43), (44), (45), and (46) shows an interaction that would involve the $2\mathrm{T}^{+1}$ simple particle; transform a matter quark into another simple fermion; and conserve ι_{3LB}, L, and B. Here, for fermions, the notation $1\Phi^{\iota Q}_{\iota_{3LB};3L,3B}$ pertains. Here, for bosons, equations show notation of the form $2\Phi^{\iota Q}_{\iota_{3LB};3L,3B}$ and might suggest that each of L, conservation of L, B, and conservation of B is appropriate. However, discussion related to equation (47) indicates that none of L, conservation of L, B, and conservation of B is relevant to the relevant boson physics. Each of the first three equations correlates with transforming a matter quark into an antimatter simple fermion. Among those equations, the notion of $2\mathrm{T}^{+1}_{-2;\_,\_}$ pertains. There are two forms of $2\mathrm{T}^{+1}_{-2;\_,\_}$, namely $2\mathrm{T}^{+1}_{-2;0,+2}$ and $2\mathrm{T}^{+1}_{-2;-3,-1}$. The two forms, $2\mathrm{T}^{+1}_{-2;0,+2}$ and $2\mathrm{T}^{+1}_{-2;-3,-1}$, show the same ι_{3LB}, but do not correlate with the same L or with the same B. The fourth equation correlates with transforming a matter quark into a matter fermion. Each one of the second, third, and fourth equations might correlate with the ongoing theory notion of leptoquark.

$$1\mathrm{Q}^{+2}_{-1;0,+1} \to 1\mathrm{Q}^{+1}_{+1;0,-1} + 2\mathrm{T}^{+1}_{-2;0,+2} \tag{43}$$

$$1\mathrm{Q}^{+2}_{-1;0,+1} + 2\mathrm{T}^{+1}_{-2;-3,-1} \to 1\mathrm{C}^{+3}_{-3;-3,0} \tag{44}$$

$$1\mathrm{Q}^{-1}_{-1;0,+1} + 2\mathrm{T}^{+1}_{-2;-3,-1} \to 1\mathrm{N}^{0}_{-3;-3,0} \tag{45}$$

$$1\mathrm{Q}^{-1}_{-1;0,+1} + 2\mathrm{T}^{+1}_{+4;+3,-1} \to 1\mathrm{N}^{0}_{+3;+3,0} \tag{46}$$

More generally, equation (47) shows possible charged 2T simple bosons that convert simple fermions between matter and antimatter. Equation (48) shows possible 2T charged simple bosons that would not convert simple fermions between matter and antimatter. For each of the four possible charged simple bosons, the notation does not show a number $3L$ and does not show a number $3B$.

$$2\mathrm{T}^{\pm1}_{\mp2;} \text{ and } 2\mathrm{T}^{\pm2}_{\pm2;} \tag{47}$$

$$2\mathrm{T}^{\pm1}_{\pm4;} \text{ and } 2\mathrm{T}^{\pm2}_{\mp4;} \tag{48}$$

This essay de-emphasizes the possibilities that equation (48) shows.

Regarding equation (47), each of the four possibilities, of which one possibility is $2\mathrm{T}^{+1}_{-2;}$, correlates with two possible L-and-B pairs. We assume that charged 2T bosons are ambiguous with respect to each of L and B.

Generally, interactions conserve ι_{3LB}, do not necessarily conserve L, and do not necessarily conserve B. Non-conservation of L and B correlates with involvement - in the interactions - of $2\mathrm{T}^{\pm}$ bosons. One might deploy the five-word phrase somewhat conservation of lepton number and the five-word phrase somewhat conservation of baryon number.

Table 33 notes concepts regarding values, for objects, of ι_{3LB}, L, and B. Here, we consider that a proton or other hadron with no more than three quarks can correlate with the notion of free. The following notion also pertains. For a hadron-like particle that includes no more than three quarks and arcs, the restrictions to integer charge and integer baryon number preclude the presence of both quarks and arcs.

Table 34 shows changes, to representations, to reflect conservation of lepton number minus baryon number. Non-zero charge T-family bosons provide the only way to change either the lepton number or the baryon number of a fermion.

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Table 34: Changes, to representations, to reflect conservation of ι_{3LB} and to reflect somewhat conservation laws regarding baryon number and lepton number

(a) Changes regarding non-zero charge T-family bosons and regarding simple fermions

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA					$\pi_{0,-1}$			
SA					$\pi_{0,-1}$			

(b) Changes regarding other simple particles and regarding long range forces

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA					$\pi_{0,-1}$			
SA								

Table 35: Change to representations, to reflect conservation of charge

Side	0	1, 2	3, 4	5, 6	7, 8	9, 10	11, 12	13, 14
TA		$\pi_{0,-1}$						
SA								

3.3.2. Conservation of charge

This unit shows modeling that correlates with conservation of charge.

Table 35 shows changes, to representations, to reflect conservation of charge. All interactions conserve charge.

3.3.3. Simple bosons that are related to G-family solutions

This unit correlates some simple bosons with zero-spin solutions that correlate with G-family mathematics but not with G-family force components.

Table 36 posits correlations between free simple bosons and the $\Sigma = 0$ solutions that correlate with table 26. We posit that the W boson correlates with 0G246 and not with 0G268. This assumption correlates with the notion of isomers of charged simple particles. (See discussion related to equation (117).) To the extent that table 36 pertains, G-family solutions point to all free simple bosons and all components of G-family forces. Here, $j_{\lambda\in\Gamma}$ denotes the number of elements in Γ (as in $\Sigma G\Gamma$).

Each of the $\Sigma = 0$ items that table 26 lists has a TA-side symmetry of none or $SU(3)$. Each one of the aye, W, Z, and Higgs bosons can interact with simple particles.

Table 36 uses all of 0G solutions for which the largest value of λ is eight. The next opportunity for 0G solutions correlates with the range $2 \le \lambda \le [\![14]\!]$. For that range, there are four solutions that correlate with 0G. Equation (49) shows the solutions. Here, we do not put brackets around values of λ that exceed eight.

$$(14-10-6+2) \pm (12-8-4); \quad 14-12-10+8+6-4-2; \quad 14-12+10-8-6+4-2 \tag{49}$$

Proposed theory suggests that $2T^{0''}$ and $2T^{0'}$ correlate with the first two solutions that equation (49) shows. The last two solutions that the equation shows would correlate, in some order, with $2T^2$ and $2T^1$. We use these results to estimate masses for 2T simple bosons. (See discussion related to equation (104).)

3.3.4. ALG modeling regarding rest energy and freeable energy

This unit suggests ALG modeling pertaining to rest energy and freeable energy.

Table 36: Possible correlations between 0G solutions and free simple bosons that do not belong to the G-family of forces

Solution	Boson	Subfamily	$j_{\lambda\in\Gamma}$
0G∅	0I (or aye)	0I	0
0G246	W	2W	3
0G268	Z	2W	3
0G2468	H^0 (or, Higgs)	0H	4

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Table 37: Proposed theory symmetries correlating with a kinematics symmetry and with models for motion

Side	Kinematics symmetry	Symmetry for models for motion
TA	$SU(5)$	$S1G \times SU(2) \times SU(2) \times U(1)$

Some modeling points to quantities that come in integer units and that add. Examples of additive quantities include charge and lepton number minus baryon number. Related integer forms are, respectively, ι_Q and ι_{3LB}. For each of ι_Q and ι_{3LB}, modeling correlates with $U(1)$ symmetry.

Possibly, people can develop useful similar modeling regarding other quantities.

For example, modeling pertaining to a combination of the 4G property of rest energy and the 6G property of freeable internal energy might correlate with aspects of equation (50). Here, $SU(4)$ might pertain regarding oscillators SA3 through SA6. For some modeling, work above correlates $SU(2)$ with the SA3-and-SA4 oscillator pair. Perhaps, the other $SU(2)$ correlates with the SA5-and-SA6 oscillator pair. Perhaps, for some modeling, the $U(1)$ correlates with an additive quantity.

$$SU(4) \supset SU(2) \times SU(2) \times U(1) \tag{50}$$

Table 37 previews an aspect of extending proposed theory modeling from modeling regarding kinematics symmetries to modeling regarding motion. Here, modeling regarding motion can include kinematics modeling for free objects and can include dynamics modeling for unfree objects that exist within larger objects that might model as being free. This TA-side aspect comports with ongoing theory notions that an $S1G$ symmetry pertains regarding models for motion. In effect, table 37 extends table 23.

3.3.5. PDE modeling for some objects that can shed energy

This unit discusses aspects of proposed theory modeling regarding some objects, including non-zerolike mass simple fermions that are other than generation-one fermions, that can shed energy.

For PDE modeling regarding some objects that can shed energy, equation (51) and the following concepts might pertain. (See discussion related to equation (50).)

$$E^2 - f_{TA} + (P_{J_{TA}}c)^2 = A_{TA}^{PDE} = A_{SA}^{PDE} = (mc^2)^2 - f_{SA} + (Pc)^2 + (P_{J_{SA}}c)^2 \tag{51}$$

In equation (51), the expression $(mc^2)^2 - f_{SA}$ correlates with one SA-side $SU(4)$ symmetry. Equation (50) pertains. The term $(mc^2)^2$ correlates with the SA3-and-SA4 oscillator pair and one $SU(2)$ symmetry. The term $-f_{SA}$ correlates with the SA5-and-SA6 oscillator pair and one $SU(2)$ symmetry. The term f_{SA} is the square of a freeable energy. For $f_{SA} > 0$, f_{SA} might, for example, correlate with models for transitions of quarks from higher-mass generations to quarks of lower-mass generations. For $f_{SA} > 0$, f_{SA} might correlate with models for beta decay via the weak interaction. The relevant $U(1)$ symmetry correlates with a conservation law. (See equation (50).) For example, lowering the square of rest energy $(mc^2)^2$ correlates with lowering the square of relevant freeable energy f_{SA}. The relevant $U(1)$ symmetry correlates with a value that can add across similar systems.

In equation (51), the term $+(P_{J_{SA}}c)^2$ might correlate with an energy that correlates with observed angular momentum. The terms $+(Pc)^2$ and $+(P_{J_{SA}}c)^2$ might correlate with oscillators SA11 through SA14 and with a combination of conservation of angular momentum and conservation of momentum.

In equation (51), the expression $-f_{TA} + (P_{J_{TA}}c)^2$ correlates with the TA-side $SU(4)$ symmetry. The TA-side $SU(4)$ symmetry correlates with the proposed theory notion of an $SU(5)$ symmetry that correlates with conservation of energy. The TA-side $SU(4)$ symmetry also correlates with the ongoing theory notion of an $S1G$ symmetry that correlates with conservation of energy. (See table 37.) Presumably, $f_{TA} \geq 0$ pertains.

Equations (52) and (53) show a reinterpretation of equation (51). For $f_{TA|SA} = 0$, equation (51) comports with special relativity.

$$E^2 = (mc^2)^2 - f_{TA|SA} + (Pc)^2 \tag{52}$$

$$f_{TA|SA} = -f_{TA} + f_{SA} + (P_{J_{TA}}c)^2 - (P_{J_{SA}}c)^2 \tag{53}$$

For each of a binary star system and a hydrogen atom, $+(P_{J_{TA}}c)^2$ correlates with an ability to transit to a state of lower rest mass. The term $-(P_{J_{SA}}c)^2$ correlates with an ability to transit to a state of higher rest mass.

Table 38: Concepts relevant to some simple particles for which $\Sigma = 1$ or $\Sigma = 2$ (with $\chi_{-1,0}$ denoting - for n_{SA0} - a choice of minus one or zero; with the fourth column providing information correlating with the relevant symmetry; and with the three-element item SCons of generation abbreviating the four-word term somewhat conservation of generation)

XA_	SA-side	Symmetry	Some information ($\Sigma = 1$ or $\Sigma = 2$)	TA-side
0	$\chi_{-1,0}$	-	-	-
1-2	charge (ι_Q)	$U(1)$	-	conservation of ι_Q
3-4	rest energy	$SU(2)$	three $\lvert\iota_Q\rvert$, as in $\Sigma\Phi^{\iota_Q}$ (if $n_{SA0} = 0$)	freeable energy
3-4	rest energy	$SU(2)$	three $\lvert\iota_Q\rvert = 0$ particles (if $n_{SA0} = -1$)	-
5-6	freeable energy	$SU(2)$	three generations (if $\Sigma = 1$)	SCons of generation
7-8	spin (ι_S)	$U(1)$	-	conservation of ι_{3LB}

Regarding equation (53), the term $-(P_{J_{SA}}c)^2$ might correlate with the term - in equation (4) - that is proportional to Ω_{SA}/r^2. In equation (3), the sign of the relevant term would be positive, just like the sign of the term that is proportional to r^2. The Ω_{SA}/r^2 term might correlate with a notion of, in effect, an ability to store freeable energy. The term $+(P_{J_{TA}}c)^2$ might correlate with the term - in the TA-side analog to equation (4) - that is proportional to Ω_{TA}/t^2.

3.3.6. Relationships regarding three charges and three generations for some simple particles

This unit discusses relationships, pertaining to some simple particles, regarding numbers of charges, numbers of generations, and relevant symmetries.

Table 38 explores aspects - regarding simple particles - of modeling that correlates with equations (52) and (53). Table 38 does not discuss the Higgs, aye, pie, and cake simple bosons.

Table 38 comports with and helps explain table 32. Table 38 comports with a notion of a lack of multiple Higgs-like simple bosons and a lack of multiple aye-like simple bosons.

3.3.7. Modeling regarding refraction and similar phenomena

This unit discusses proposed theory modeling regarding the refraction of light. This unit discusses modeling regarding the existence of neutrino oscillations. This unit points to modeling regarding gluons.

We explore modeling regarding contexts in which a zerolike rest mass elementary particle interacts with its surroundings. The equation $n_{SA0} = -1$ correlates with the notion of zerolike rest mass. Known examples include photons in refractive media and gluons in hadrons. Similar considerations might pertain for neutrinos.

Mathematically, there are four cases to consider. The case of free and $n_{TA0} = 0$ pertains for G-family forces. The case of free and $n_{TA0} = -1$ pertains for (at least) neutrinos. The case of unfree and $n_{TA0} = -1$ pertains for gluons. The case of unfree and $n_{TA0} = 0$ is not necessarily physics-relevant. (Proposed theory does not predict the existence of unfree simple particles for which $n_{TA0} \neq n_{SA0}$.)

Each of equations (54) and (55) offers, based on using the range $-1 < n_{SA0} < 0$, a possible basis for modeling regarding the zerolike rest mass elementary particle. (We contrast $-1 < n_{SA0} < 0$ with $n_{SA0} < -1$. Uses of the expression $n_{SA0} < -1$ pertain for applications related to components of G-family forces, for some modeling regarding gluons, and not necessarily for other purposes. Regarding the applications related to components of G-family forces, see table 26. Regarding the gluon-related modeling, see table 39.) Here, E denotes energy, $\overrightarrow{P}$ denotes momentum, $\overrightarrow{v}$ denotes velocity, $<\_>$ denotes the expected value of _, $P^2 =< \overrightarrow{P} \cdot \overrightarrow{P} >$, and $v^2 =< \overrightarrow{v} \cdot \overrightarrow{v} >$. Here, double-entry bookkeeping pertains to models for which at least one of the TA-side set of harmonic oscillators and the SA-side set of harmonic oscillators is not necessarily isotropic.

$$n_{SA0} = -c^2P^2/E^2 \tag{54}$$

$$n_{SA0} = -v^2/c^2 \tag{55}$$

For each of the three physics-relevant cases, each of equations (54) and (55) adds a positive amount to A_{SA}^{ALG}. For each of the three cases, we posit that, for each relevant oscillator, $-1 \leq n\_ \leq 0$ pertains.

For the case of free and $n_{TA0} = 0$, for each relevant TA-side oscillator, $n_{TA\_} = 0$. One cannot satisfy double-entry bookkeeping by adding to A_{TA}^{ALG}. Satisfying double-entry bookkeeping correlates with subtracting something positive from at least one of the SA-side oscillators that correlate with $SU(2)$ kinematics symmetries. Proposed theory correlates this subtracting with aspects of refraction. Ongoing theory correlates the expression c/v (or, $(c^2/v^2)^{1/2}$) with the two-word term refractive index (or, with the three-word term index of refraction). This case correlates with refraction of light.

Table 39: 2U solutions

Solution	SA0	SAo	SAe
2Ue0	0	−1	−2
2Uoe	−1	−2	0
2U0o	−2	0	−1
2Uo0	0	−2	−1
2U0e	−2	−1	0
2Ueo	−1	0	−2

For the case of free and $n_{TA0} = -1$, for each relevant SA-side oscillator, $n_{SA\_} = -1$. One cannot satisfy double-entry bookkeeping by adding to A_{SA}^{ALG}. Satisfying double-entry bookkeeping correlates with adding something positive to at least one of the two TA-side oscillators that correlate with $SU(2)$ somewhat conservation of generation symmetry or to at least one of the TA-side oscillators that correlate with conservation of energy symmetry. This case correlates with neutrino oscillations.

For the case of unfree and $n_{TA0} = -1$, discussion is not as straightforward as is discussion for the other two physics-relevant cases. Discussion related to table 39 and table 40 pertains regarding gluons. (See discussion related to equation (56).)

Each of the three relevant cases might point to opportunities to develop new modeling. People might try to express kinematics conservation laws in terms of combinations, across modeling for each of a few interacting particles, via harmonic oscillator math. People might try to develop parallels to ongoing theory equations that, for example, sum momenta. We choose not to pursue - in this essay - such possible opportunities.

3.3.8. Gluon interactions

This unit discusses aspects regarding modeling gluons and modeling U-family interactions.

The 2U solutions correlate with gluons. Here, we provide details correlating with ALG modeling and with the $\kappa_{-1,-1,-1}$ interaction centric symmetry that correlates with the relevant ongoing theory $SU(3)$ symmetry.

We denote the three relevant oscillators by the symbols SA0, SAo, and SAe. (See table 29a.) Here, o denotes a positive odd integer and e denotes the positive even integer that is one greater than o.

Table 39 shows details regarding 2U solutions. The expression $\kappa_{-1,-1,-1}$ correlates with $A_{TA}^{ALG} = -3/2$. Each one of the six SA-side $\pi_{0,-1,-2}$ permutations pertains. Each permutation correlates with $A_{TA}^{ALG} = -3/2$. Table 39 suggests notation for gluon-related solutions. The set of three permutations for which 0, −1, and −2 appear in cyclic order correlates with interactions with one of unfree matter simple fermions and unfree antimatter simple fermions. The set of the other three permutations correlates with the other choice between unfree antimatter simple fermions and unfree matter simple fermions. Regarding unfree matter simple fermions, each of oscillators SAe, SAo, and SA0 correlates with a color charge. Relative to an ongoing theory standard representation for gluons, one of SAe and SAo correlates with the color red, the other of SAe and SAo correlates with the color blue, and SA0 correlates with the color green.

Ongoing theory correlates gluons with zero mass and with phenomena that proposed theory correlates with 2U solutions. We consider 2U phenomena regarding dynamics inside hadron-like particles. In such a frame of reference, proposed theory modeling based on equations (56) and (57) pertains. (Perhaps, compare with discussion, pertaining to refraction, regarding equations (54) and (55).) Here, the notation $a \leftarrow b$ correlates with the three-element phrase a becomes b (or, with the notion that b replaces a). Here, the symbol $\to$ denotes, in the mathematical sense of a limit, the two-word phrase goes to.

$$(n_{TA0} = -1) \leftarrow (n_{TA0} = -v^2/c^2 \to 0^-) \tag{56}$$

$$(n_{SA\_} = -2) \leftarrow (n_{SA\_} = (-1 - v^2/c^2) \to (-1)^-) \tag{57}$$

Equations (56) and (57) correlate with boson behavior for gluons. In effect, modeling of excitations and de-excitations correlates with a ground state that correlates with equation (58) and with, for the appropriate $n_{SA\_}$, equation (59). (See tables 39 and 40.) Excitation correlates with erasing a color charge (from, for example, a quark) and de-excitation correlates with painting a color charge (on, for example, a quark). (See discussion related to table 39.)

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Table 40: 2U erase or paint ground states

Ground state	SA0	SAo	SAe
2U0 = 2Ue0⊕2Uo0	0	−1	−1
2Ue = 2Uoe⊕2U0e	−1	−1	0
2Uo = 2U0o⊕2Ueo	−1	0	−1

$$n_{TA0} = 0 \tag{58}$$

$$n_{SA\_} = 0 \tag{59}$$

Table 40 shows results of applying, to items in table 39, aspects correlating with equations (58) and (59). Table 40 shows three erase or paint ground states.

A gluon correlates with a weighted sum of two or three erase-and-paint pairs. For each pair, the erase part correlates with, in effect, an ability to erase, from the unfree simple fermion that absorbs the gluon, a color. The paint part correlates with, in effect, an ability to paint, on to the unfree simple fermion that absorbs the gluon, a color. The value $n_{SA\_} = 0$ denotes an ability for a gluon to erase or paint the color charge correlating with the SA_ oscillator. Equation (60) shows an ongoing theory representation for one of the eight gluons. (Out of the eight gluons, this is the only one that involves three erase-and-paint pairs. Each of the other seven gluons involves two erase-and-paint pairs.) Regarding table 40, we make the following correlations. (Alternatively, without loss of generality or results, one might reverse the roles of SAe and SAo.) The symbol r correlates with painting the color red and with a painting application of 2Ue. The symbol $\bar{r}$ correlates with erasing the color red and with an erasing application of 2Ue. The symbol b correlates with painting the color blue and with a painting application of 2Uo. The symbol $\bar{b}$ correlates with erasing the color blue and with an erasing application of 2Uo. The symbol g correlates with painting the color green and with a painting application of 2U0. The symbol $\bar{g}$ correlates with erasing the color green and with an erasing application of 2U0.

$$(r\bar{r} + b\bar{b} - 2g\bar{g})/(6)^{1/2} \tag{60}$$

3.3.9. Channels and G-family interactions

This unit discusses aspects regarding G-family interactions and channels.

The notion of channels pertains regarding ending the series 2G2, 4G4, ... at 8G8. (See discussion related to table 26 and see discussion related to equation (67).) The notion of channels pertains to the relative strengths of electromagnetism and gravity. (See discussion related to equation (67).)

Each of equation (61) and equation (62) provides a candidate formula for the number of channels that pertain for the G-family solution ΣGΓ. Equation (61) correlates with table 22. Possible G-family forces correlating with $\Sigma \geq 10$ would not be relevant to physics. (See table 3.) Equation (62) provides another possibility, which correlates with tables 26 and 56c. Possible G-family forces correlating with $\Sigma \geq 10$ could be relevant to physics. Our discussion selects equation (61) and de-emphasizes the possibility that correlates with equation (62). (See discussion related to table 26.)

$$5 - (\Sigma/2) \tag{61}$$

$$5 - (\lambda_{max}/2), \text{ with } \lambda_{max} = \max\{\lambda | \lambda \in \Gamma\} \tag{62}$$

Proposed theory suggests that each channel can correlate with a unique blank (or, $\kappa_{0,-1}$) SA-side oscillator pair in the range from SA3-and-SA4 through SA9-and-SA10. (Perhaps note table 17 and table 22.) For this purpose, isotropic weighting pertains regarding oscillator pairs.

We discuss possible aspects of modeling for an interaction that de-excites a G-family boson. The following notions pertain.

The incoming state de-excites by transferring one unit of excitation to one of the channels. For that channel, equation (63) pertains.

$$\kappa_{0,-1} \to \kappa_{0,0} \tag{63}$$

The new SA-side $SU(2)$ symmetry adds an extra kinematics-conservation-like symmetry that cannot last. (See table 23.) The interaction includes converting the $\kappa_{0,0}$ symmetry to something, pertaining

Table 41: Rest energies for known non-zero-mass simple bosons

Φ	S	Symbol	Name	Experimental mc^2 (GeV)	Calculated N	Calculated mc^2 (GeV)	Difference (standard deviations)
W	1	2W1, 2W2	W	80.379 ± 0.012	7	80.420	≈ 3.4
W	1	2W0	Z	91.1876 ± 0.0021	9	91.1876	-
H	0	0H0	H^0	125.18 ± 0.16	17	125.33	≈ 1.0

to the outgoing state, such as $\kappa_{0,-1}$. (Discussion above de-emphasizes the notion that, for each SA-side channel, one TA-side channel exists. Double-entry bookkeeping suggests such a notion. An interaction would feature both a TA-side application of equation (63) and an SA-side application of equation (63). We think that the notion does not adversely impact results to which we allude.)

The above modeling is not incompatible with various proposed theory concepts, including the equal strengths of channels and the linear scaling, by number of channels, of interaction strengths. (See discussion regarding equation (67).)

3.4. Some properties of elementary particles

This unit discusses masses and other properties of elementary particles.

3.4.1. Masses of the weak interaction bosons, the Higgs boson, and the aye boson

This unit shows modeling that links the masses of the weak interaction bosons, the Higgs boson, and the aye boson.

We explore relationships between masses of the 2W (or, W and Z), 0H, and 0I bosons.

Table 41 shows, in the column for which the label includes the word experimental, rest energies for the known non-zero-mass simple bosons. (See reference [17].) Notation such as 2W1 and 0H0 extends the notion of Γ - as pertaining to oscillators relevant in ALG models for G-family solutions - to notions of Γ for ALG models relevant to elementary particle families other than the G family. The most accurately known of the three masses is the mass of the Z boson. The column for which the label includes the word calculated shows results based on equation (64) and on assuming that nine correlates with the square of the mass of the Z boson. Equation (65) shows the size of one unit. The related mass is $\approx 30.396\text{GeV}/c^2$. In table 41, the column for which the label includes the word difference shows the number of standard deviations (regarding the experimental results) by which the calculated mass differs from the nominal experimental mass.

$$(m_{\mathrm{H}^0})^2 : (m_{\mathrm{Z}})^2 : (m_{\mathrm{W}})^2 :: 17 : 9 : 7 \tag{64}$$

$$9.239 \times 10^2 (\text{GeV}/c^2)^2 :: 1 \tag{65}$$

We discuss approximate ratios for the squares of masses of the Higgs, Z, and W bosons. Based on the ratios (of squares of masses) that equation (64) shows, the possibly least accurately suggested mass is that of the W boson. Equation (64) correlates with a number that is within four standard deviations of the nominal mass of the W boson. (See table 41.) Proposed theory correlates the numbers in equation (64) with, respectively, the expressions $17 = 17$, $9 = 10 - 1 - 0$, and $7 = 10 - 1 - 2$. Each of zero, one, two, 10, and 17 correlates with the value of $D + 2\nu''$ for a PDE solution for which $D'' = 2$. (See table 12e.)

The following correlations might pertain regarding relative squares of masses. (See table 36 and table 12e.) For each of the W, Z, and 0H bosons, one positive term pertains. That term correlates with the value of $D + 2\nu''$ for which $\sigma'' = -1$ and $S'' = j_{\lambda \in \Gamma}$ pertain. For the W and Z bosons, a negative term pertains. That term correlates with spin-one and with the negative of the value of $D + 2\nu''$ for which $\sigma'' = -1$ and $S'' = 0$ pertain. For the W boson, another negative term also pertains. That term might correlate with the magnitude of nominal magnetic dipole moment equal to the magnitude of nominal magnetic dipole moment of the electron (or with a charge of magnitude equal to the magnitude of the charge of the electron) and with the negative of the value of $D + 2\nu''$ for which $\sigma'' = -1$ and $S'' = 2$ pertain.

To the extent that m_{W} does not exactly comport with equation (64), proposed theory suggests that an anomalous moment pertains. The W boson has non-zero charge, non-zero nominal magnetic dipole moment, and non-zero mass. We suggest that the anomalous moment might correlate mostly with the 6G24 solution. (Compare with discussion related to equation (103).) The contribution of minus two (compared to the Z boson) that equation (64) implies might correlate with each of 2G24 and nominal magnetic dipole moment.

We explore concepts regarding 0G∅.

One might assume that the 0I solution correlates with $S'' = j_{\lambda\in\Gamma} = 0$. (See table 36.) The result $S'' = 0$ correlates with a relative square of mass of one. (See table 12e.) The mass would approximately equal 30.4GeV/c^2. We know of no observations that would support the existence of such a particle. We note that, for each of the W, Z, and Higgs bosons, the 0GΓ solution has $n_{TA0} = 0$. (See table 26.) For the 0G∅ solution, $n_{TA0} = -1$.

For each $\Sigma \geq 2$ ΣGΓ solution that nature embraces, the mass is zero. We suggest that each solution correlates with $\sigma'' = +1$ and $S'' = 1$. Per table 12e, the relative mass correlates with $D + 2\nu'' = 0$.

We suggest that the 0G∅ solution correlates with $\sigma'' = +1$ and $S'' = 1$. The notion of zero mass pertains.

3.4.2. A prediction for the tauon mass

This unit suggests a relationship, which ongoing theory seems not to discuss, between the ratio of the tauon mass to the electron mass and a ratio of a strength of electromagnetism and the strength of gravity. This unit discusses the notion that adequately increasing the experimental accuracy of either one of the tauon mass and the gravitational constant leads to a prediction regarding the other quantity. This unit discusses aspects, related to G-family physics, that the ratio of force strengths suggests. This unit discusses the concept of channels.

Equation (68) possibly pertains. Here, m denotes mass, τ denotes tauon, ϵ denotes electron, q denotes charge, ε_0 denotes the vacuum permittivity, and G_N denotes the gravitational constant. Equation (68) predicts a tauon mass with a standard deviation of less than one eighth of the standard deviation correlating with the experimental result. (For relevant data, see reference [29].) Equation (71) shows an approximate value of β that we calculated, using data that reference [29] shows, via equation (67).)

$$\beta' = m_\tau/m_\epsilon \tag{66}$$

$$(4/3) \times \beta^{12} = ((q_\epsilon)^2/(4\pi\varepsilon_0))/(G_N(m_\epsilon)^2) \tag{67}$$

$$\beta' = \beta \tag{68}$$

$$m_{\tau,\text{ calculated}} \approx (1776.8400 \pm 0.0115)\ \text{MeV}/c^2 \tag{69}$$

$$m_{\tau,\text{ experimental}} \approx (1776.86 \pm 0.12)\ \text{MeV}/c^2 \tag{70}$$

$$\beta \approx 3477.1891 \pm 0.0226 \tag{71}$$

The factor of 4/3 in equation (67) correlates with notions that 2G2 correlates with four so-called channels and 4G4 correlates with three channels. For a 2G2 interaction between two electrons, the strength for each channel is $((q_\epsilon)^2/(4\pi\varepsilon_0))/4$ and four channels pertain. For a 4G4 interaction between two electrons, the strength for each channel is $G_N(m_\epsilon)^2/3$ and three channels pertain. Equation (72) characterizes a per channel ratio that pertains for interactions between two electrons.

$$(((q_\epsilon)^2/(4\pi\varepsilon_0))/4)\ /\ ((G_N(m_\epsilon)^2)/3) \approx 3.124 \times 10^{42} \tag{72}$$

The following notes pertain.

- To the extent that equation (68) correlates with nature, a more accurate experimental determination of G_N or m_τ could predict a more accurate (than experimental results) value for, respectively, m_τ or G_N.
- Equation (68) links the ratio of two simple particle masses to a ratio of the strengths of two G-family force components.
- Equation (68) links the strength of 2G2 interactions to the strength of 4G4 interactions.
- For 6G6, the number of channels is two. For 8G8, the number of channels is one.

- For $\Sigma = 10$ and $\Gamma = [\![10]\!]$, $\Sigma G \Gamma$ would correlate with zero channels and no interactions.
- Equation (73) correlates the fine-structure constant, α, with a function of the tauon mass and the electron mass. (Regarding the fine-structure constant, see equation (78).)

$$\alpha = ((q_\epsilon)^2/(4\pi\varepsilon_0\hbar c)) = (4/3) \times (m_\tau/m_\epsilon)^{12} G_N (m_\epsilon)^2/(\hbar c) \tag{73}$$

- Proposed theory does not, as yet, suggest a relationship - perhaps similar to equation (67) - regarding the ratio m_μ/m_ϵ. Here, μ denotes muon. (See discussion related to equations (88) and (89).)

3.4.3. The relative strengths of electromagnetism and gravity

This unit suggests concepts that might correlate with an ongoing theory notion that the strength of gravity is much less than the strength of electromagnetism. This unit suggests a possible relationship between the strength of electromagnetism correlating with monopole interactions with charge and the strength of electromagnetism correlating with dipole interactions with nominal magnetic dipole moment.

We use the expression in equation (74) to denote an interaction in which n_1 elementary fermions and n_2 elementary bosons interact to produce n_3 elementary fermions and n_4 elementary bosons.

$$\mathrm{n}_1\mathrm{fn}_2\mathrm{b} \rightarrow \mathrm{n}_3\mathrm{fn}_4\mathrm{b} \tag{74}$$

For this discussion, we assume that we can work within aspects of proposed theory that de-emphasize translational motion. Below, the symbol 1f correlates with a non-zero-charge non-zero-mass simple fermion that pertains throughout the discussion. We confine our attention to 1f1b→1f1b interactions such that the exiting simple fermion is the same as the entering simple fermion. Each symbol 1b denotes a boson. The outgoing boson is not necessarily the same as the incoming boson. The simple fermion correlates (as do all simple fermions) with $S = 1/2$ (or, $\Sigma = 1$). Regarding modeling, we assume that no translational motion pertains. Hence, no kinematic angular momentum pertains. We assume that conservation of angular momentum pertains. Below, in a symbol of the form 1f1b($\Sigma =$ _), the expression $\Sigma =$ _ pertains for the boson.

The expression that equation (75) shows can correlate with interactions in which effects of the incoming boson correlate with 2G2. The interaction flips the spin orientation of the simple fermion. The exiting 1b correlates with zero spin. The spin-zero boson might be a 0I boson, which has no mass and no charge. (Another possibility might be relevant. The outgoing 1b might correlate with a boson ground state. We de-emphasize further discussion of this possibility.) The expression 1f1b($\Sigma = 2$)→1f1b($\Sigma = 4$) can also pertain.

$$\mathrm{1f1b}(\Sigma = 2) \rightarrow \mathrm{1f1b}(\Sigma = 0) \tag{75}$$

We extend this thought experiment to consider 4G4. The expression 1f1b($\Sigma = 4$)→1f1b($\Sigma = 0$) does not correlate with interactions. Conservation of angular momentum cannot pertain. The expression 1f1b($\Sigma = 4$)→1f1b($\Sigma = 2$) can pertain. The expression 1f1b($\Sigma = 4$)→1f1b($\Sigma = 6$) can pertain.

The notion that 1f1b($\Sigma = 4$)→1f1b($\Sigma = 0$) does not pertain for 4G4 might correlate with ongoing theory notions that the strength of gravity is much less than the strength of electromagnetism.

For each relevant Σ_1, the dominant 1f1b(Σ_1)→1f1b(Σ_2) interaction might comport with the relationship $\Sigma_1 - 2 = \Sigma_2$. Equation (76) pertains regarding the fine-structure constant α. (Compare with equation (78).) We suggest that compatibility exists between the following concepts. One concept is the notion that, in the context of ongoing theory, some modeling might suggest $\alpha^2 m_\epsilon$ as the average neutrino mass. (See equation (93).) Regarding proposed theory, the two relevant values of Σ_1 are four and eight. One concept correlates with the ongoing theory notion that terms in anomalous magnetic dipole moment calculations seem to scale with terms proportional to $\alpha^{(\Sigma-2)/2}$. The concept that α is, in the sense of equation (76), proportional to $\hbar$ might pertain.

$$\alpha = ((q_\epsilon/\hbar)^2/(4\pi\varepsilon_0 c)) \cdot \hbar \tag{76}$$

Equation (76) might provide a link between the strength of 2G2 and the strength of 2G24. The equation includes the term $(q_\epsilon/\hbar)^2$. The Josephson constant K_J equals $2q_\epsilon/\hbar$.

The expression 1f1b($\Sigma = 2$)→1f1b($\Sigma = 0$) can pertain for each of the following cases - 1b($\Sigma = 2$) correlates with 2G, 1b($\Sigma = 2$) correlates with 2W, and 1b($\Sigma = 2$) correlates (for a case in which unfree pertains for the 1f particle) with 2U. This notion might correlate with ongoing theory notions that correlate with relationships between the strengths of the electromagnetic, weak, and strong interactions.

Table 42 notes some possibilities for relevance of the fine-structure constant regarding ratios of strengths of interactions.

Table 42: Possible relevance - regarding some interaction strengths - of the fine-structure constant (with the symbol O denoting the two-word term ongoing theory; with the symbol P denoting the two-word term proposed theory; and with the symbol * denoting the expression $(1-\delta(M',3))\cdot((3/2)\cdot(1+M'')+(j'_{M'})d'(M''))$)

P/O	Context	Aspect	Factor
O	QED calculations of anomalous magnetic dipole moments	Terms involving j virtual photons (See discussion related to equation (100).)	α^j
P	Lepton number and (ongoing theory) perceived masses for neutrinos	Ratio of strengths: 4G2468x to 8G2468x, with x equal to a or b (See discussion related to equation (92) and see table 46.)	1 to α^2
P	Possible generalization for $\Sigma \geq 4$, $2 \in \Gamma$, and $j > 0$	Ratio of strengths: ΣGΓ to $(\Sigma+2j)$GΓ	1 to α^j
P	Possible relationship between the strength of 2G2 and the strength of 2G24	(See discussion related to equation (76).)	α
P	Relationship between the masses of quarks and the masses of charged leptons	(See equation (77).)	$(\alpha^{-1/4})^*$
P	Possible (speculative) aspects regarding the mass of the W boson.	(See discussion related to table 41.)	?

3.4.4. The masses of quarks and charged leptons

This unit shows a formula that links the masses of the six quarks and three charged leptons.

We discuss a formula that approximately fits the masses of the six quarks and three charged leptons. (See equation (77).) 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_ϵ, m_μ (or, the mass of a muon), β , α, $d'(0)$, $d'(1)$, and $d'(2)$. Here, α denotes the fine-structure constant. (See equation (78).) Here, $d'(k)$ pertains regarding generation-$(k+1)$ quarks. For each generation, the number might correlate with the extent to which the two relevant quark masses do not equal the geometric mean of the two quark masses.

Table 43 shows experimental rest energies and calculated rest energies for 1C and 1Q simple fermions. Rest energy denotes rest mass times c^2. The table shows rest energies in units of MeV. (Regarding data from experiments, see reference [17].) For each particle other than the top quark, reference [17] provides one estimate. For the top quark, reference [17] provides three estimates. For each quark, table 43 shows a data range that runs from one standard deviation below the minimum nominal value that reference [17] shows to one standard deviation above the maximum nominal value that reference [17] 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. Our calculations use equation (77). In that equation, the factor 3/2 correlates with the average of $M'=2$ and $M'=1$. (Note the appearance of $M'=3/2$ in equation (82). The concepts of $M'=3/2$ and $m(M'',3/2)$ are useful mathematically, though not necessarily directly physics-relevant.) Regarding equations (83), (84), and (85), we choose values that fit data. Regarding each charged lepton, our calculations fit data to more significant figures than the numbers in the table show. Regarding the tauon, our calculation correlates with a mass that may be more accurate, and more accurately specified, than the mass that references [17] and [29] show. (See equations (69) and (70).)

$$m(M'',M') = m_\epsilon \times (\beta^{1/3})^{M''+(j''_{M''})d''} \times (\alpha^{-1/4})^{(1-\delta(M',3))\cdot((3/2)\cdot(1+M'')+(j'_{M'})d'(M''))} \tag{77}$$

$$\alpha = ((q_\epsilon)^2/(4\pi\varepsilon_0))/(\hbar c) \tag{78}$$

$$j''_{M''} = 0,+1,-1,0 \text{ for, respectively, } M''=0,1,2,3 \tag{79}$$

$$d'' = (2-(\log(m_\mu/m_\epsilon)/\log(\beta^{1/3}))) \approx 3.840679\times10^{-2} \tag{80}$$

Table 43: Approximate rest energies (in MeV) for 1C and 1Q particles

		M' Charge	3 $-1 \cdot \lvert q_\epsilon \rvert$	2 $+(2/3) \cdot \lvert q_\epsilon \rvert$	1 $-(1/3) \cdot \lvert q_\epsilon \rvert$
M''	Legend				
0	name		electron	up	down
0	data		(0.511 to 0.511)$\times 10^0$	(1.8 to 2.7)$\times 10^0$	(4.4 to 5.2)$\times 10^0$
0	calculation		$m_\epsilon c^2 \approx 0.511 \times 10^0$	$m_u c^2 \approx 2.2 \times 10^0$	$m_d c^2 \approx 4.8 \times 10^0$
1	name			charm	strange
1	data			(1.24 to 1.30)$\times 10^3$	(0.92 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 to 1.06)$\times 10^2$	(1.56 to 1.74)$\times 10^5$	(4.15 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 to 1.777)$\times 10^3$		
3	calculation		$m_\tau c^2 \approx 1.777 \times 10^3$		

Table 44: Ranges of $d'(M'')$ that fit the data ranges that table 43 shows for quark masses

Symbol	Minimum (approximate)	Nominal (table 43)	Maximum (approximate)
$d'(0)$	0.251	0.318	0.386
$d'(1)$	−1.072	−1.057	−1.042
$d'(2)$	−1.5158	−1.5091	−1.5024

$$1 - \delta(M', 3) \text{ equals } 0, \text{ for } M' = 3, \text{ and equals } 1, \text{ otherwise} \tag{81}$$

$$j'_{M'} = 0, -1, 0, +1 \text{ for, respectively, } M' = 3, 2, 3/2, 1 \tag{82}$$

$$d'(0) \sim 0.318 \tag{83}$$

$$d'(1) \sim -1.057 \tag{84}$$

$$d'(2) \sim -1.5091 \tag{85}$$

$$m(1,3) \approx 8.59341 \text{MeV}/c^2 \tag{86}$$

Table 44 shows ranges of $d'(M'')$ that fit the data ranges that table 43 shows for quark masses. (See equations (83), (84), and (85).) To the extent that people measure quark masses more accurately, people might find relationships between $d'(0)$, $d'(1)$, and $d'(2)$, and thereby reduce the number of parameters to less than seven.

Table 45 shows possible rest energies for quarks. For each row, we assume the value that the third column shows for the ratio that the second column defines. The value implies the number that the column labeled $d'(M'')$ shows. The six estimated quark rest energies might not be incompatible with experimental results that table 43 shows. To the extent that table 45 comports with nature, fitting the masses of six quarks and three charged leptons requires at most five parameters. The five parameters can be m_ϵ, m_μ, β , α, and $d'(0)$. To the extent that table 45 comports with nature, equation (87) pertains.

$$(m_s)^2 m_\mu = m_\epsilon m_\tau m_c \tag{87}$$

The charge q_ϵ correlates with β, via equation (67). The charge q_ϵ appears in α, via equation (78). Based on equations (64) and (77) and based on modeling for the G-family, proposed theory might entangle concepts related to mass and concepts related to charge more deeply than does ongoing theory.

Table 45: Possible estimates for quark rest energies

M''	Ratio	Value	$d'(M'')$	$m_{M'=2}c^2$ (MeV)	$m_{M'=1}c^2$ (MeV)
0	$m_\epsilon m_d/(m_u)^2$	1/2	≈0.31216454	m_uc^2 ≈2.203×10^0	m_dc^2 ≈4.748×10^0
1	$m(1,3)m_c/(m_s)^2$	1	−1	m_cc^2 ≈1.178×10^3	m_sc^2 ≈1.006×10^2
2	$m_\mu m_t/(m_b)^2$	1	−3/2	m_tc^2 ≈1.695×10^5	m_bc^2 ≈4.322×10^3

Equations (88) and (89) explore the possibility for a relationship - perhaps similar to equation (67) - regarding the ratio m_μ/m_ϵ or the ratio m_τ/m_μ. Equation (90) shows the result that we compute based on data from reference [17]. Equation (91) shows the result that we compute based on data from reference[29]. The main difference between the two sets of data lies in values of the gravitational constant, G_N. (The two references present the same value for the tauon mass. However, for each result, we use a tauon mass that is based on equation (67).) We do not explore possible significance for the notion that $1 + x \approx 10/9$.

$$(1 + x)\beta^{1/3} = m_\tau/m_\mu \approx m(1, 3)/m_\epsilon \tag{88}$$

$$(1 + x)^{-2}\beta^{1/3} \approx m_\mu/m(1, 3) \tag{89}$$

$$x \approx 0.110033 \tag{90}$$

$$x \approx 0.110031 \tag{91}$$

3.4.5. A prediction regarding ongoing theory estimates of the sum of neutrino masses

This unit predicts a sum of masses, for the three neutrinos, that people might determine based on observations and ongoing theory. This unit suggests alternatives to the ongoing theory notions that observations about neutrinos imply that at least one generation of neutrino has non-zero mass.

Equation (92) provides ongoing theory limits for the sum, across three generations, of neutrino masses. (See reference [17]. Reference [30] provides the lowest of the upper limits that reference [17] lists.) The integer j correlates with generation. Equation (92) comes from interpretations of astrophysics data. Equation (92) contrasts with some aspects of the ongoing theory elementary particle Standard Model that suggest that each one of the three neutrinos has zero mass.

$$0.06\text{eV}/c^2 \lesssim \sum_{j=1}^{3} m_j \lesssim 0.12\text{eV}/c^2 \tag{92}$$

Independent of results of observations and of assumptions about modeling, equation (93) pertains. The number $3\alpha^2 m_\epsilon$ might predict a bound on further tightening of the ranges that people derive from the types of observations that underlie equation (92). Here, the factor of three might correlate with the range $1 \leq j \leq 3$ in equation (92).

$$3\alpha^2 m_\epsilon \approx 0.0816eV/c^2 \tag{93}$$

Equation (93) may reflect equation (92) and a notion that some interaction strengths scale in proportion to $\alpha^{\Sigma/2}$. The exponent in the factor α^2 in equation (93) correlates with the notion that two equals four (as in half of $\Sigma = 8$) minus two (as in half of $\Sigma = 4$). (For other examples of scaling based on powers of the fine-structure constant, see discussions related to table 42.)

We explore three sets of assumptions regarding choices of modeling.

First, we assume the ongoing theory notion that neutrino oscillations correlate with interactions that we correlate with the 4G subfamily. Table 22a correlates 4G with somewhat conservation of fermion generation. Neutrino oscillations might correlate with multiple close-by interactions. However, such interactions might not account for observed magnitudes of neutrino oscillations.

Second, we explore the proposed theory notion that neutrino oscillations correlate with interactions that we correlate with the 8G subfamily.

Here, we note that 1C matter simple particles, including the electron, and 1N matter simple particles correlate with the same 3LB number - $\iota_{3LB} = 3$. We posit that the following sentence is relevant, at least conceptually. For quantum interactions with simple fermions, 4G2468a, 4G2468b, and 4G4 share, for each simple fermion, a single notion of m (or, mass).

Table 46: Interpretations regarding some aspects of G-family solutions

Aspect	Interpretation
8G	Interacts with lepton number minus baryon number
8G2468a and 8G2468b	Interact with individual neutrinos
8G2468a and 8G2468b	Catalyze neutrino oscillations
8G2468a and 8G2468b	Catalyze effects that people interpret as implying (via ongoing theory) that at least one generation of neutrino has non-zero mass

Table 46 posits modeling that reconciles discussion above, equation (92), and equation (93). Table 46 extends table 28.

We discuss possible implications regarding ongoing theory modeling. Ongoing theory astrophysics modeling does not include modeling that proposed theory correlates with 6G and 8G. We posit one or two conceptual mapping steps. First, in the context of proposed theory, modeling for 8G octupole components of force maps to modeling for octupole components of 4G forces. Perhaps that step suffices. In this context, ongoing theory modeling paralleling aspects of proposed theory 4G2468a and 4G2468b interprets 8G effects on neutrinos as correlating with non-zero mass. The following (or, second) step might pertain to the extent that relevant ongoing theory modeling does not correlate with proposed theory 4G dark energy forces. Second, in the context of proposed theory, modeling for 4G octupole components of force maps to modeling involving 4G4. In this context, ongoing theory modeling based on only proposed theory 4G4 interprets 8G effects on neutrinos as correlating with non-zero mass.

We perform a check regarding reasonableness of proposed theory regarding interactions that couple to lepton number. We consider our interpretation of aspects of ongoing theory. We consider gravitational interactions between two electrons. Equation (94) describes results based just on the component that correlates with proposed theory 4G4 effects. Equation (95) assumes that ϵ' correlates with one standard deviation regarding the mass of an electron. (Reference [17] provides the data that we use for these calculations.) The lepton number for an electron equals the lepton number for a matter neutrino. Equation (96) correlates with results based just on the component that correlates with proposed theory 8G effects. (One exponent of two correlates with the exponent of two pertaining, in essence, to equation (93). One exponent of two correlates with the notion that the interaction involves two simple fermions.) The result that equation (96) shows is less than the result that equation (95) shows. In this context of ongoing theory, the interaction, between two electrons, based on lepton number is not incompatible with measurements of electron masses.

$$G_N(m_\epsilon(1+\epsilon'))^2/r^2 \approx G_N(m_\epsilon)^2(1+2\epsilon')/r^2 \tag{94}$$

$$|\epsilon'| \approx 1.2 \times 10^{-8} \tag{95}$$

$$(\alpha^2)^2 \approx 2.8 \times 10^{-9} \tag{96}$$

Proposed theory suggests that, for Newtonian modeling, the strength of interactions with lepton number scales as r^{-5}. The strength of interactions with charge scales as r^{-2}. People might want to estimate a minimum energy for which the interaction between two charged leptons exhibits measurable effects of 8G octupole components.

Third, we note that modeling regarding neutrino oscillations might feature notions of indices of refraction. (See discussion related to equation (54).) Here, a question might remain as to mechanisms that lead to refraction. Proposed theory suggests that interactions mediated by 8G bosons might play significant roles regarding refraction of neutrinos.

3.4.6. Neutrino masses

This unit discusses the notion that all neutrinos might have zero mass, even though people interpret neutrino oscillations and other observed phenomena as suggesting that at least one flavor of neutrino correlates with non-zero mass.

Table 47 lists aspects that might correlate with the extent to which neutrinos have non-zero masses.

We discuss inferences from astrophysics data.

Discussion related to table 46 and to equation (93) suggests modeling that would be compatible with data and with elementary particle Standard Model aspects that suggest that all neutrinos have zero rest masses.

We discuss aspects related to neutrino oscillations.

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Table 47: Aspects that might correlate with the extent to which neutrinos have non-zero masses

Aspects
• Limits regarding neutrino masses, as inferred from astrophysics data.
• The existence of neutrino oscillations.
• Neutrino speeds.
• Effects of neutrino lensing (which would be based on gravity).
• Other.

Ongoing theory hypothesizes that gravity catalyzes neutrino oscillations. This hypothesis might correlate with a process of elimination. Ongoing theory suggests that each known simple particle does not catalyze neutrino oscillations. Ongoing theory suggests that photons do not catalyze neutrino oscillations. Ongoing theory suggests that the strong interaction does not catalyze neutrino oscillations. The only ongoing theory catalyst for neutrino oscillations might be gravity.

Proposed theory suggests that 4G correlates with somewhat conservation of fermion generation. Proposed theory suggests that interactions mediated by 4G bosons might be insufficient to catalyze known amounts of neutrino oscillations. Proposed theory suggests that 8G bosons catalyze observed neutrino oscillations. (See discussion related to table 46. Perhaps, note the possibility that interactions correlating with 8G lead to refraction of neutrinos.)

We know of no data about neutrino speeds that would settle the question as to the extent to which neutrinos have non-zero masses.

As far as we know, observations of impacts of possible neutrino lensing have yet to produce relevant results.

As far as we know, other possibly relevant experiments and observations do not provide additional insight about the extent to which neutrinos have non-zero masses. (See, for example, references [31] and [32].)

Proposed theory suggests that each neutrino might correlate with zero rest mass.

3.4.7. Anomalous magnetic dipole moments

This unit discusses a proposed theory approach to explaining anomalous magnetic dipole moments.

Equations (97), (98), and (99) show results of experiments regarding anomalous magnetic dipole moments. (See reference [17].) The subscripts ϵ, μ, and τ denote, respectively, electron, muon, and tauon. The symbol a correlates with anomalous magnetic dipole moment. The symbol α denotes the fine-structure constant. (See equation (78).)

$$a_\epsilon - (\alpha/(2\pi)) \approx -1.76 \times 10^{-6} \tag{97}$$

$$a_\mu - (\alpha/(2\pi)) \approx +4.51 \times 10^{-6} \tag{98}$$

$$-0.052 < a_\tau < +0.013 \tag{99}$$

Ongoing theory 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 theory 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.

Regarding the tauon, equation (100) shows a result correlating with a first-order Standard Model (or, ongoing theory) calculation. (See reference [33].)

$$a_{\tau,\mathrm{SM}} \approx +1.177 \times 10^{-3} \tag{100}$$

Proposed theory suggests that notions of anomalous electromagnetic moments correlate with $\gamma2$ solutions. Electromagnetic dipole solutions correlate with $\gamma2$ solutions for which RSDF is r^{-3}. The following remarks pertain for other than the 2G24 solution, which correlates with the ongoing theory nominal magnetic moment result of $g \approx 2$. (2G24 correlates with 2γ and not with $\gamma2$.) The relevant solutions might be 4G26, 6G24, 6G28, 8G26, and 10G28. However, 6G28 and 10G28 do not interact with individual simple fermions. 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.

Table 48: Possible approximations regarding the 6G24,1 and 6G24,t contributions to $a_{\mathrm{cl}} - (\alpha/(2\pi))$ for charged leptons

Assumption regarding t_{cl}	$a_{6\mathrm{G}24,1}$	$a_{6\mathrm{G}24,\mathrm{t}}$
m	-1.79×10^{-6}	5.96×10^{-8}
m^2	-1.76×10^{-6}	5.62×10^{-10}
M''	-1.76×10^{-6}	3.13×10^{-6}
$(M'')^2$	-1.76×10^{-6}	1.57×10^{-6}
generation	-8.03×10^{-6}	6.27×10^{-6}
(generation)^2	-3.85×10^{-6}	2.09×10^{-6}
$\log(m/m_\epsilon)$	-1.76×10^{-6}	1.18×10^{-6}
$(\log(m/m_\epsilon))^2$	-1.76×10^{-6}	2.21×10^{-7}

Table 49: Possible approximations for $a_\tau - (\alpha/(2\pi))$

Assumption regarding first order behavior for $a_{\mathrm{cl}} - (\alpha/(2\pi))$. The term is linear in a lepton's:	First order suggestion for $a_\tau - (\alpha/(2\pi))$	Prediction for a_τ	Approximate comparison $(a_\tau - a_{\tau,\mathrm{SM}})/a_{\tau,\mathrm{SM}}$	Fit
m	$+1.04 \times 10^2 \times 10^{-6}$	$+1.266 \times 10^{-3}$	$+75 \times 10^{-3}$	-
m^2	$+1.77 \times 10^3 \times 10^{-6}$	$+2.933 \times 10^{-3}$	$+1500 \times 10^{-3}$	-
M''	$+7.65 \times 10^{-6}$	$+1.169 \times 10^{-3}$	-6.9×10^{-3}	!
$(M'')^2$	$+12.35 \times 10^{-6}$	$+1.174 \times 10^{-3}$	-2.9×10^{-3}	!
generation	$+10.8 \times 10^{-6}$	$+1.172 \times 10^{-3}$	-4.3×10^{-3}	!
(generation)^2	$+15.0 \times 10^{-6}$	$+1.176 \times 10^{-3}$	-0.7×10^{-3}	!!
$\log(m/m_\epsilon)$	$+7.83 \times 10^{-6}$	$+1.169 \times 10^{-3}$	-6.8×10^{-3}	!
$(\log(m/m_\epsilon))^2$	$+12.9 \times 10^{-6}$	$+1.174 \times 10^{-3}$	-2.5×10^{-3}	!

We explore the possibility that proposed theory suggests that contributions to a scale as $\alpha^{(\Sigma-2)/2}$. (Compare with discussion regarding equation (93).) Solution 4G26 might correlate with the $\alpha/(2\pi)$ term that ongoing theory provides for charged leptons. For solution 6G24, $4 \in \Gamma$. Solution 6G24 might correlate with a result that varies with charged lepton rest mass. Solution 6G24 might correlate with a term that is proportional to $\alpha^2/(2\pi)$. (See equation (97), equation (98), and discussion regarding table 49. Note the result $\alpha^2/(2\pi) \approx 8.48 \times 10^{-6}$.) Solution 8G26 might correlate with a term proportional to $\alpha^3/(2\pi)$.

We explore an approach to estimating a_τ.

The 4G26 solution might correlate with the ongoing theory result of $\alpha/(2\pi)$. The 6G24 solution might correlate with contributions of the order α^2.

We assume that, for a charged lepton cl, equation (101) pertains. Here, t_{cl} is the construct that the first column of table 48 identifies.

$$a_{\mathrm{cl}} - (\alpha/(2\pi)) \approx a_{6\mathrm{G}24,1} + a_{6\mathrm{G}24,\mathrm{t}} t_{\mathrm{cl}} \tag{101}$$

Table 48 shows approximate possible values for $a_{6\mathrm{G}24,1}$ and $a_{6\mathrm{G}24,\mathrm{t}}$, based on fitting data that equations (97) and (98) show and using various candidates for t_{cl}. We de-emphasize the notion that 8G26 might also contribute to an actual value.

Table 49 provides, based on table 48 and equation (101), some possible suggestions for $a_\tau - (\alpha/(2\pi))$. The comparison is with respect to a Standard Model first order calculation. (See equation (100).) Per the notion that the interaction strength does not necessarily correlate linearly or quadratically with an ongoing theory property and per the quadratic behavior with respect to $|q_\epsilon|$ in the expression $\alpha^{(\Sigma-2)/2}$, we might expect that appropriate results might correlate with the square of generation or with the square of a function of $\log(m)$. (See work that includes equation (77).)

Each one of the results that table 49 shows comports with experimental results. Except for the row regarding m and the row regarding m^2, each row in table 49 might comport with the calculation based on the Standard Model. The (generation)^2-centric result that table 49 shows might comport best, of the results the table suggests, with the calculation based on the Standard Model. The (generation)^2-centric result differs from the result that equation (100) shows by about 0.7 parts in 1000.

Based on the notion that contributions to a scale as $\alpha^{(\Sigma-2)/2}$ and on results that table 48 shows, it might seem unlikely that $a_{6\text{G}24,1}$ correlates with 8G26. However, it is possible that the strength of interactions correlating with 4G26 differs from the ongoing theory result that correlates with $\alpha/(2\pi)$ and that $a_{6\text{G}24,1}$ correlates with such a difference.

Given remarks just above, we explore another approach to estimating a_τ.

We assume that the strength of each of 4G26 and 8G26 does not change with generation. We assume that, in effect, equation (102) pertains. We assume that, in effect, equation (103) pertains. Here, we have assumed a clean split between contributions that do not correlate with generation and contributions that do correlate with generation. For the left side of equation (102), $4 \notin \Gamma$. For the left side of equation (103), $4 \in \Gamma$. Regarding table 49, the leftmost column and the rightmost three columns pertain regarding this approach. (Technically, one needs to change the column heading for the leftmost column. The new heading should be the following: "Assumption regarding the behavior for $a_{6\text{G}24}$. The term is linear in a lepton's:".)

$$a_{4\text{G}26} + a_{8\text{G}26} = (\alpha/(2\pi)) + a_{6\text{G}24,1} \tag{102}$$

$$a_{6\text{G}24} = a_{6\text{G}24,\text{t}} \tag{103}$$

Discussion related to equations (102) and (103) suggests that proposed theory might pertain. Regarding lepton anomalous magnetic dipole moments, proposed theory suggests the possibility that modeling via just two terms can pertain. One term would not vary with generation. One term would vary with generation.

Generally, modeling based on ongoing theory is - as of now - better for calculating energies than is modeling based on proposed theory. Sometimes, such as for this example regarding anomalous magnetic dipole moments, proposed theory points to possible modeling that seems to be simpler than ongoing theory modeling.

3.4.8. Possible masses of tweak (or, 2T) simple particles

This unit discusses possible masses for tweak simple particles.

We explore possibilities regarding masses for T-family bosons.

The 0G∅ solution correlates with the possible 0I (or, aye) boson. The 0I boson would have zero mass. Zero mass correlates with $\sigma'' = +1$ and $S'' = 1$. (See, in table 12e, the column labeled $D + 2\nu''$.) We try to extrapolate from $\sigma'' = +1$ and $S'' = 1$ for the 0I boson, $\sigma'' = -1$ and $S'' = 3$ for W-family physics, and $\sigma'' = -1$ and $S'' = 4$ for H-family physics. The equation $S'' = 7$ provides the first possibility (beyond the limit $\lambda \leq 8$) to have G-family-like solutions for which $\Sigma = 0$. The equation $S'' = 7$ would correlate with allowed values of λ of two, four, six, eight, 10, 12, and 14. For $S'' = 7$, $D + 2\nu'' = 50$. Proposed theory suggests that equations (104) and (105) might pertain regarding the masses of T-family bosons. (Here, $\text{T}^\pm$ denotes each of $\text{T}^{\pm2}$ and $\text{T}^{\pm1}$ Here, T^0 denotes each of $\text{T}^{0''}$ and $\text{T}^{0'}$.) Here, we allow for the possibilities of adding or subtracting the integers correlating with $\sigma'' = +1$ and $S'' = 1$, $S'' = 0$, and $\sigma'' = -1$ and $S'' = 1$. Based on data from reference [17] regarding the Higgs boson, the rest energies of the T-family bosons might be between $\sim$ 208 GeV and $\sim$ 221 GeV.

$$47/17 \leq (m_{\text{T}^\pm})^2/(m_{\text{H}^0})^2 \leq 53/17 \tag{104}$$

$$49/17 \leq (m_{\text{T}^0})^2/(m_{\text{H}^0})^2 \leq 51/17 \tag{105}$$

3.4.9. Possibilities for detecting or inferring aye (or, 0I) simple particles

This unit summarizes bases for some possibilities for detecting or inferring the existence of aye simple particles.

Table 50 lists possible roles for the aye particle and for the 0I solution.

We discuss items that table 50a shows.

Discussion related to equation (129) pertains regarding inflation.

Discussion related to equation (130) pertains regarding just after inflation.

Some aspects of ongoing theory propose interactions that would produce unspecified particles that people might not have detected. For example, people propose an interaction $K_L^0 \to \pi^0 + X$ for which there is an intermediate state of two simple fermions that interact via a W boson and produce the so-designated

Table 50: Possible roles for the aye particle and for the 0I solution

(a) Possible roles in nature for the aye particle

Possible roles - the particle ...
• Plays a role during the inflationary epoch
• Functions as the inflaton and plays a role after inflation
• Helps explain some interactions
• Explains phenomena that ongoing theory correlates with a so-called quantum vacuum
• Explains phenomena that ongoing theory correlates with density of dark energy
• Might correlate with situation-specific interaction rates

(b) Possible roles in modeling for the 0I solution

Possible roles - the solution ...
• Helps explain scaling by factors of α correlating with adding vertices or with increasing spin
• Simplifies some aspects of modeling (and does not necessarily correlate with nature)

X particle. (See reference [34].) Here, the symbol K_L^0 correlates with the K-long meson. The symbol π^0 denotes a zero-charge pion. To the extent that this interaction actually occurs, proposed theory suggests the possibility that the X particle is an aye simple boson.

Ongoing theory proposes concepts such as interactions with a so-called quantum vacuum. Proposed theory can dovetail with modeling that features a quantum vacuum and can dovetail with modeling that does not embrace a notion of quantum vacuum. Interactions with 0I bosons might produce effects similar to effects that ongoing theory correlates with the notion of interactions with a quantum vacuum.

Discussion related to equation (137) pertains regarding non-zero density of dark energy.

Equation (106) shows a possibility for decay of a Higgs boson. The equation might correlate with a rate that is not very situation specific. (Here, we assume a lack of lasing.) Equation (107) shows another possibility for the decay of the Higgs boson. The equation might correlate with a rate that correlates with a density of 0I particles and might be situation specific.

$$0\mathrm{H}^0 \rightarrow ... \tag{106}$$

$$0\mathrm{I}^0 + 0\mathrm{H}^0 \rightarrow ... \tag{107}$$

We discuss items that table 50b shows.

Discussion related to the relative strengths of some components of G-family forces points to terms proportional to $\alpha^{(\Sigma-2)/2}$. (See discussion related to equation (75) and discussion related to equation (93).) Possibly, modeling based on the 0I solution correlates with aspects regarding spins and interactions. (See discussion related to equation (76).)

Table 21a shows a representation for the ground state of the 0I solution. The next two sentences provide possible interpretations. People might interpret the SA-side of the representation as implying that, in nature, the aye particle would not excite. (See table 21a.) People might interpret the SA-side representation as correlating with five channels and, therefore, with the notion that excitement can pertain. (Regarding channels, see discussion regarding equation (67) and discussion regarding equation (61).) Proposed theory suggests that the second possibility pertains.

3.4.10. Lack of magnetic monopoles and a possible lack of some electric dipole moments

This unit suggests modeling that would comport with the notion that nature does not include an elementary particle magnetic monopole. This unit suggests modeling that would comport with the notion that nature does not include a non-zero electric dipole moment for any elementary particle.

Table 56 points to no G-family solutions that would correlate with interactions with a magnetic monopole elementary particle. The lack of such G-family solutions might correlate with nature not including a magnetic monopole elementary particle. People might want to consider the notion that equation (108) expresses.

$$\text{The 2G2 solution correlates with electromagnetic (not magnetic) monopole moments.} \tag{108}$$

Table 56 points to no G-family solutions that would correlate with a non-zero electric dipole moment for a point-like elementary particle. The lack of such G-family solutions might correlate with nature not including elementary particles that have non-zero electric dipole moments.

Table 51: TSP, APM, and SSP transformations (regarding ALG models)

Swap (for each odd j' and with $j'' = j' + 1$)	Swap	Swap pertains for the transformation		
		TSP	APM	SSP
$n_{TAj'}$ and $n_{TAj''}$	-	Yes	Yes	No
-	n_{TA0} and n_{SA0}	No	No	No
$n_{SAj'}$ and $n_{SAj''}$	-	No	Yes	Yes

3.5. Other aspects regarding elementary particles

This unit discusses three related formulas that produce lengths. This unit discusses some proposed theory symmetries and some aspects of ongoing theory CPT-related symmetries. This unit suggests insight, that proposed theory might provide, regarding the strong CP problem and regarding axions.

3.5.1. A series of formulas for lengths, including the Planck length

This unit discusses three related formulas that produce lengths.

We suggest a series of formulas for lengths. Equation (109) correlates with the Schwarzschild radius for an object of mass m. Equation (110) correlates with the Planck length and does not depend on m. Equation (111) includes a factor of m^{-1}. When applied to the mass of 2W bosons, equation (111) correlates somewhat with the range of the weak interaction. When applied to the mass of a charged pion, equation (111) correlates somewhat with a range for the component, of the strong interaction, that has bases in gluons. (That component binds the two quarks that exist within the pion.) Equation (112) shows the ratio between successive formulas. Equation (113) shows, for the electron, the ratio correlating with equation (112).

$$R_4(m) = (G_N)^1 m^1 \hbar^0 c^{-2} 2^1 \tag{109}$$

$$R_2(m) = (G_N)^{1/2} m^0 \hbar^{1/2} c^{-3/2} 2^0 \tag{110}$$

$$R_0(m) = (G_N)^0 m^{-1} \hbar^1 c^{-1} 2^{-1} \tag{111}$$

$$(G_N)^{-1/2} m^{-1} \hbar^{1/2} c^{1/2} 2^{-1} \tag{112}$$

$$(G_N)^{-1/2} (m_e)^{-1} \hbar^{1/2} c^{1/2} 2^{-1} \approx 1.1945 \times 10^{22} \tag{113}$$

3.5.2. CPT-related symmetries

This unit discusses some proposed theory symmetries and some aspects of ongoing theory CPT-related symmetries.

Table 51 summarizes proposed theory concepts regarding so-called TSP, APM, and SSP transformations. The table pertains for ALG models. TSP abbreviates the three-word phrase temporal side parity (or, TA-side parity). APM abbreviates the three-element phrase antiparticle or anti-mode. SSP abbreviates the three-word phrase spatial side parity (or, SA-side parity).

Ongoing theory includes notions of C (or, charge-reversal) transformation and approximate symmetry, P (or, parity-reversal) transformation and approximate symmetry, and T (or, time-reversal) transformation and approximate symmetry. In ongoing theory, invariance under CPT transformation pertains.

Table 52 might correlate with ongoing theory notions of T, C, and P approximate symmetries. Similarities exist between TSP transformation and T transformation, between APM transformation and C transformation, and between SSP transformation and P transformation. A significant difference between APM symmetry and C symmetry might pertain and might correlate with gluons and with color charge. A significant difference between SSP symmetry and P symmetry might pertain and might correlate with gluons and with color charge.

People might want to consider implications of the possibility that conservation of each of TSP, ASP, and SSP pertains more exactly than does conservation of (respectively) T, C, and P. This possibility might explain aspects of the strong CP problem. (Regarding CP violations, see, for example, reference [35].)

Table 52: Ongoing theory T, C, and P transformations, in a context of proposed theory ALG models

Swap (for each odd j' and with $j''=j'+1$)	Swap	Swap pertains for the transformation			Transformation and swap pertain for gluons and color charge		
		T	C	P	T	C	P
$n_{TAj'}$ and $n_{TAj''}$	-	Yes	Yes	No	No	No	No
-	n_{TA0} and n_{SA0}	No	No	No	No	No	No
$n_{SAj'}$ and $n_{SAj''}$	-	No	Yes	Yes	No	No	No

3.5.3. The strong CP problem and possible axion elementary particles

This unit suggests insight, that proposed theory might provide, regarding the strong CP problem and regarding axions.

Ongoing theory explores the possibility that the strong interaction contributes to violation of CP symmetry (or, charge conjugation parity symmetry). People might have yet to detect strong interaction contributions to the violation of CP symmetry. People use the three-element term strong CP problem. Theoretically, such violation might correlate with the existence of axions.

Each of the following statements might point to insight regarding the strong CP problem or regarding attempting to detect axions. Proposed theory suggests possible insight regarding CPT-related symmetries. (See table 52.) Proposed theory suggests insight regarding the electric dipole moment of the neutron. (See discussion related to equation (165).) Proposed theory suggests possible insight regarding the possible existence of magnetic monopoles. (See discussion related to equation (108).) Proposed theory suggests the possibility that people might mistake observations of phenomena related to the difference between 2(6)G248 and 2(1)G248 for observations related to axions. (See discussion related to equation (138).) Proposed theory suggests the possibility that people might mistake observations of phenomena related to the aye (or, 0I) boson for observations related to axions. (For example, equation (130) shows an interaction that might create effects that people might interpret as correlating with producing a magnetic field.)

To the extent that nature exhibits the relevant ongoing theory suggestion for non-zero CP violation, proposed theory suggests that some of the following statements might pertain. Table 52 points to aspects that correlate with the non-conservation of CP symmetry. That non-conservation might correlate with breaking a possible $\pi_{r,b,g}$ symmetry correlating with red, blue, and green color charges. (Perhaps, see discussion related to equation (60) and discussion related to table 52.) That non-conservation might correlate with breaking an $SU(5)$ symmetry that correlates with conservation of energy. (See discussion related to equation (167).) Conservation of energy might pertain only to the extent that one includes consideration for at least two isomers of the universe that correlates with the relevant PRnISe modeling. (See table 55.)

To the extent that nature includes axions, proposed theory offers the possibility that axions correlate with existence of 4U, 6U, or 8U forces. (Consider discussion related to table 30 and consider the possibility that the relevant ΣU forces might correlate with an identity operator.) The masses of axions might correlate with an interaction range. (See discussion related to table 30 and discussion related to equation (111).) For an assumed interaction range of the size of a galaxy, a mass for axions might be roughly $10^{-31}eV/c^2$. (Here, we used the following assumptions. The range of the residual strong interaction is about 10^{-15} meters. A size for galaxies correlates with 10^5 light years. The number of meters per light year is 10^{16}. The mass of a pion is about $10^5 eV/c^2$. Equation (114) pertains.) For an assumed range of the size of a neutron star, a mass for axions might be roughly $10^{-14}eV/c^2$. (Here, we used a size of 10^4 meters.)

$$-31 = -15 - 5 - 16 + 5 \tag{114}$$

4. Results: dark matter, dark energy, astrophysics, and cosmology

This unit discusses dark matter models that might explain observed ratios of dark matter aspects such as density to ordinary matter aspects such as density. This unit discusses a model that might explain eras regarding the rate of expansion of the universe. This unit discusses models that might explain aspects regarding galaxy formation. This unit discusses other astrophysics phenomena and other cosmology phenomena. This unit lists topics, regarding aspects of the cosmology timeline, for which proposed theory suggests insights.

Table 53: Aspects of nature - that ongoing theory discusses or suggests - for which proposed theory seems to provide insight that might augment insight that ongoing theory suggests

Aspect
• Eras during which the rate of expansion of the universe increases or decreases.
• Ratios of dark matter amounts or effects to ordinary matter amounts or effects.
• Details regarding the inflationary epoch.
• Details regarding just after the inflationary epoch.
• Details regarding mechanisms leading to baryon asymmetry.
• Details regarding fundamental components of dark matter.
• A possible additional source of acoustic oscillations that influenced the formation of filaments.
• Details regarding some aspects of galaxy formation.
• Details regarding dark matter objects that would be smaller than galaxies.

Table 54: Approximate ratios of dark matter effects to ordinary matter effects (with DM denoting dark matter; with OM denoting ordinary matter; with _MA denoting _M amount; with CMB denoting cosmic microwave background radiation; and with * denoting that proposed theory also suggests an explanation that does not correlate with dark matter)

Apprx. DMA/OMA	Amounts
5	Density of the universe
5	Amount of stuff in galaxy clusters
1	Amount of absorption of OM CMB via interactions with DM* or OM atoms.
0	Amount of stuff in some early galaxies
4	Amount of stuff in some early galaxies
0	Amount of stuff in some later galaxies
4	Amount of stuff in some later galaxies

4.1. Summary of results: dark matter, dark energy, astrophysics, and cosmology

This unit discusses aspects of nature - correlating with the terms dark matter, dark energy, astrophysics, and cosmology - for which proposed theory might provide more details or better-defined explanations than does ongoing theory.

Table 53 lists some topics for which proposed theory seems to provide insight that might augment insight that ongoing theory suggests.

We discuss immediately below some, but not all, of the items that table 53 lists.

Ongoing theory suggests notions regarding three known eras in the rate of expansion of the universe. One era features an accelerating (or, increasing) rate and correlates with the so-called inflationary epoch. A later multibillion-year era features a decelerating (or, decreasing but still positive) rate. The current multibillion-year era features an accelerating rate. Proposed theory suggests an explanation that has bases in components of 4G forces. The explanation does not necessarily depend on ongoing theory notions of dark energy pressure or on ongoing theory modeling based on general relativity. The proposed theory explanation might be generally compatible with ongoing theory models. The proposed theory explanation points to some subtleties that ongoing theory modeling might miss.

Table 54 lists some observed approximate ratios of dark matter effects to ordinary matter effects. Proposed theory suggests explanations for each of these ratios. The explanations have bases in proposed theory specifications for dark matter and for effects correlating with components of 4G forces. Ongoing theory seems not to offer explanations that would have bases in fundamental physics. As far as we know, ongoing theory does not point to a description of dark matter that would explain the ratios. Proposed theory does not seem to point to possible directly observable, widely applicable, easily explained approximate ratios of, for example, three or six. We do not know of observations that would point to directly observable, adequately widely applicable approximate ratios of, for example, three or six. (Regarding the possible explanation that does not correlate with dark matter, see table 58.)

Ongoing theory suggests that the early universe includes a so-called inflationary epoch. Ongoing theory proposes a role, during that epoch, for a so-called inflaton particle. Proposed theory suggests that the aye (or, 0I) simple particle correlates with the notion of an inflaton. Proposed theory suggests that octupole components of 4G forces provided for rapid expansion.

Ongoing theory suggests that the achievement of baryon asymmetry occurred after the formation of the universe. Ongoing theory proposes mechanisms that might have catalyzed baryon asymmetry. Ongoing theory does not necessarily point to the tweak simple bosons that proposed theory suggests exist. Proposed theory suggests that tweak bosons catalyzed the achievement of baryon asymmetry.

Ongoing theory provides various hypotheses regarding descriptions for dark matter and regarding the possibilities for substantial objects that might be significantly smaller than galaxies and contain mostly dark matter. Proposed theory suggests specific descriptions for fundamental components of dark matter. Proposed theory suggests some specifics regarding some objects that would be significantly smaller than galaxies and would contain mostly dark matter.

4.2. Summary of methods: models that have bases in isomers of charge

This unit posits that most dark matter correlates with isomers of the charged simple particles. This unit shows models that have bases in one, six, and 36 isomers of charged simple particles. This unit compares features of ongoing theory, PR1ISe modeling, PR6ISe modeling, and PR36ISe modeling.

We introduce the symbols that equations (115) and (116) 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 such particles include protons, neutrons, and pions. 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.

$$1\text{Q} \otimes 2\text{U} \tag{115}$$

$$1\text{R} \otimes 2\text{U} \tag{116}$$

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.

Work above does not explain observed ratios of dark matter effects to ordinary matter effects. Some of the ratios correlate with amounts that correlate with gravitational effects. People correlate those effects with the term mass. One of the ratios might correlate with depletion of CMB (or, cosmic microwave background radiation). Ongoing theory seems not to explain these ratios.

Work above correlates with so-called PR1ISe modeling.

The first-known one of the ratios comes from interpretations of measurements of CMB. People infer that the universe includes somewhat more than five times as much dark matter as ordinary matter. People use, regarding the amount for each of dark matter and ordinary matter, the four-word term density of the universe. As far as we know, inferred ratios of density of the universe of dark matter to density of the universe of ordinary matter do not vary much for times that are at least somewhat more than 380 thousand years after the Big Bang. (Communication 71e indicates a five-plus to one inferred ratio regarding 380 thousand years after the Big Bang.)

We explore the notion that a five to one ratio reflects something fundamental in nature. We posit that the universe embraces six isomers of charged simple particles. One isomer of the monopole component of gravity (or, 4G4) interacts with all of the six isomers of charged simple particles. We say that one isomer of 4G4 spans six isomers of charged simple particles. Each isomer of charged simple particles correlates with its own isomer of at least two components of 2G forces. Each isomer of charged particles correlates with its own isomer of 2G2. Each isomer of charged particles correlates with its own isomer of 2G24. The span for each of 2G2 and 2G24 is one.

We use the two-element term PR6ISe modeling to refer to models that embrace the notion that the universe embraces exactly six isomers of charged simple particles. The two letters PR abbreviate the two-word term physics relevant. The three letters ISe abbreviate the four-word term isomers of the electron.

PR6ISe modeling can explain the five-plus to one ratio of dark matter density of the universe to ordinary matter density of the universe. Five isomers of charged simple particles correlate with dark matter. One isomer of charged simple particles correlates with ordinary matter. The plus in five-plus to one can correlate with 1R⊗2U hadron-like particles.

Mathematical modeling correlating with spans suggests that 2G248 has a span of six isomers of charged simple particles.

PR6ISe modeling dovetails with the notion that the span of six for 2G248 embraces the same six isomers of charged simple particles as does the span of six for 4G4.

PR36ISe modeling embraces the possibility that the span of six for 2G248 is, in effect, orthogonal (or, perpendicular) to the span of six for 4G4. Here, six isomers of 4G4 pertain. Each of those six isomers of 4G4 spans six isomers of charged simple particles. The term doubly-dark matter pertains to the 30 isomers of charged simple particles that do not interact with the ordinary matter isomer of charged particles via 4G4. Doubly dark matter does not interact with ordinary matter via 2G2, 2G24, 4G4, or

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Table 55: Cumulative features of various types of modeling

(a) Featured modeling

Modeling	ι_I	New descriptions and new explanations	New subtleties
Ongoing theory	NR	• (Baseline)	-
PR1ISe	1	• New simple particles and root forces • Baryon asymmetry • Some dark matter	• Dark energy forces • Ratios of dark energy density of the universe to density of the universe of ordinary matter plus dark matter
PR6ISe	6	• More dark matter • Ratios of dark matter effects to ordinary matter effects • Objects, smaller than galaxies, that feature dark matter.	• Spans • Dark energy forces

(b) Possibly useful modeling

Modeling	ι_I	New descriptions and new explanations	New subtleties
PR36ISe	36	-	• Ratios of dark energy density of the universe to density of the universe of ordinary matter plus dark matter

other components of 4G. Five doubly dark matter isomers of charged simple particles interact with the ordinary matter isomer of charged simple particles via 2G248.

From the perspective of one of the 36 isomers of charged simple particles, the following statements pertain. The isomer correlates with its own isomers of 2G2, 2G24, 4G246, 4G2468a, and 4G2468b. The isomer of charged simple particles interacts via 2G248 with five other isomers of charged simple particles. The isomer of charged simple particles interacts via 4G4 with five other isomers of charged simple particles. None of the first five other isomers is one of the second five other isomers. The first five other isomers are - from the perspective of the one isomer - doubly dark matter isomers. The second five other isomers are - from the perspective of the one isomer - dark matter isomers.

We preview features of each of PR1ISe, PR6ISe and PR36ISe modeling.

Table 55 discusses cumulative features of various types of modeling. Generally, each row augments the rows above that row. Regarding ongoing theory, the symbol NR denotes the concept that the notion of isomers is not relevant. We think that PR6ISe provides useful insight about nature. Regarding ratios of dark energy density of the universe to density of the universe of ordinary matter plus dark matter, PR36ISe offers an alternative (to PR6ISe) explanation of dark energy density. (See discussion related to equation (137).) Otherwise, regarding bases for aspects that table 55 lists, PR36ISe is similar to PR6ISe. Discussion related to equation (137) suggests that PR6ISe modeling might suffice to explain known phenomena and that it might not be necessary to consider PR36ISe modeling. (Table 7c discusses the symbol ι_I.) From a standpoint of observations, distinguishing between the case of PR6ISe and the case of PR36ISe might prove difficult.

4.3. Spans for simple particles, components of root forces, and some objects

This unit discusses the notion that nature embraces more than one isomer for each of some simple particles, some components of root forces, and some hadron-like particles.

We consider the context of PR6ISe modeling.

We start from the span of six that we posit for 4G4. We consider TA-side symmetries for G-family solutions. (See table 26.) We aim to develop numbers that belong in the table 26 column that has the label span (for n≥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 $6 = g_7/g_3$ is relevant. (Regarding notation, see equation (34).) We generalize. We assert that, for each

G-family solution for which a TA-side symmetry of $SU(j)$ pertains, equation (117) provides the span. We assume that we can generalize from the assumption that the span of 2G2 is one. For each G-family solution with no TA-side symmetry, the span is one. The W boson has non-zero charge. We assume that the span of the W boson is one. A span of one comports with information that tables 26 and 36 show. The following sentences pertain. A span of six pertains for the Z boson. A span of one pertains for the Higgs boson.

$$g_7/g_j \tag{117}$$

We discuss spans for simple particles and other objects that we do not correlate directly with G-family solutions.

Each charged simple fermion has a span of one. We assume that the span for 2U parallels the span for the Z boson. The span for 2U is six. We assume that the spans for 0K and 0P parallel the span for 2U. The span for 1Q⊗2U is one, based on the non-zero charges of 1Q particles. We assume that a span of six pertains for each zero-charge simple fermion. We assume that the span of 1R⊗2U is six.

Equation (118) shows notation for denoting the span, s, for a simple particle or a component of a root force.

$$\Sigma(\mathrm{s})\Phi \quad \text{or} \quad \Sigma(\mathrm{s})\Phi\Gamma \tag{118}$$

Ongoing theory does not consider the notion of a span of more than one. Equation (119) characterizes an ongoing theory photon. The notation $\oplus\cdots$ alludes to the remaining components, such as 2G68. Equation (120) characterizes a proposed theory PR6ISe photon.

$$2(1)\mathrm{G} = 2(1)\mathrm{G}2 \oplus 2(1)\mathrm{G}24 \oplus 2(1)\mathrm{G}248 \oplus \cdots \tag{119}$$

$$2\mathrm{G} = 2(1)\mathrm{G}2 \oplus 2(1)\mathrm{G}24 \oplus 2(6)\mathrm{G}248 \oplus \cdots \tag{120}$$

For each of each simple particle, each hadron-like particle, and each component of G-family forces, the one-word term span denotes the number of isomers of a set of, at least, non-zero-charge simple particles with which an isomer of the particle or force component interacts. The set includes all non-zero-charge simple particles and the ongoing theory photon 2(1)G.

Table 56 shows the span for each component of G-family forces. The table pertains for each of PR6ISe modeling and PR36ISe modeling. Rows in table 56a list all $\Sigma\gamma$ components of root forces. Rows in table 56b list G-family force components that do not correlate with $\Sigma\gamma$. Table 56 lists 2(6)G248 and does not list 2(1)G248. (See table 56a.) Table 56c lists some solutions that proposed theory does not correlate with G-family forces. (Here, we assume that the limit of $\lambda \leq 8$ extends to a limit of $\Sigma \leq 8$. See discussion regarding table 26.)

We consider all three of PR1ISe modeling, PR6ISe modeling, and PR36ISe modeling.

Table 57 summarizes information regarding spans for simple particles, for hadron-like particles, and for some components of root forces. The table summarizes information regarding types of objects with which boson simple particles and some root force components interact. The table separates, based on a proposed theory view, elementary particle Standard Model aspects from aspects that the elementary particle Standard Model does not embrace. The magnitude of charge for the $\mathrm{T}^{\pm1}$ boson is one-third the magnitude of the charge for each of the $\mathrm{W}^{\pm3}$ boson and the electron. The magnitude of charge for the $\mathrm{T}^{\pm2}$ boson is two-thirds the magnitude of the charge for each of the $\mathrm{W}^{\pm3}$ boson and the electron. The symbol 1Q⊗2U correlates with known and possible hadrons. The symbol 1R⊗2U correlates with possible hadron-like particles. Regarding the PR36ISe case, the notation (‖2G) denotes a span that couples ordinary matter and doubly dark matter. The symbol ‖2G correlates with the 3-element phrase parallel to 2G248. Regarding the PR36ISe case, the notation (‖4G) denotes a span that couples ordinary matter and dark matter. The symbol ‖4G correlates with the 3-element phrase parallel to 4G4. Regarding the G-family, table 57a includes just the $\Sigma\gamma$ solutions. Regarding the PR6ISe case, the span for 2G68 is two. (See table 57b.) Regarding the PR36ISe case, the span for 2G68 is two and the notion of ‖2G pertains. Table 57 shows the extent to which each of the simple bosons and some of the root force components interacts directly with each of at least some simple fermions and with each of at least some multicomponent objects. The symbol Y denotes that interactions occur. The symbol † denotes that somewhat conservation of fermion generation pertains for 1f1b→1f1b interaction vertices. The symbol N denotes that interactions do not occur. Proposed theory suggests the possibility that neither the 0H boson nor the 0I boson interacts directly with multicomponent objects. Proposed theory suggests that G-family

Table 56: A catalog of components of G-family forces

(a) G-family force components for which $\Sigma \in \Gamma$

$\Sigma\Gamma$ ($\Sigma \in \Gamma$)	S	Monopole (RSDF $= r^{-2}$)	Dipole (RSDF $= r^{-3}$)	Quadrupole (RSDF $= r^{-4}$)	Octupole (RSDF $= r^{-5}$)
Yes	1	2(1)G2	2(1)G24	2(6)G248	
Yes	2	4(6)G4	4(2)G48	4(1)G246	4(1)G2468a
Yes	2				4(1)G2468b
Yes	3	6(2)G6		6(6)G468	
Yes	4	8(1)G8			8(1)G2468a
Yes	4				8(1)G2468b

(b) G-family force components for which $\Sigma \notin \Gamma$

$\Sigma\Gamma$ ($\Sigma \in \Gamma$)	S	Monopole (RSDF $= r^{-2}$)	Dipole (RSDF $= r^{-3}$)	Quadrupole (RSDF $= r^{-4}$)	Octupole (RSDF $= r^{-5}$)
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	

(c) Some G-family solutions for which $\Sigma \geq 10$

$\Sigma\Gamma$ ($\Sigma \in \Gamma$)	S	Monopole (RSDF $= r^{-2}$)	Dipole (RSDF $= r^{-3}$)	Quadrupole (RSDF $= r^{-4}$)	Octupole (RSDF $= r^{-5}$)
No	5		10(2)G28	10(6)G248	
No	5		10(6)G46	10(6)G468	
No	6		12(2)G48	12(1)G246	12(1)G2468
No	6			12(6)G268	
No	7		14(2)G68	14(6)G248	
No	8			16(6)G268	16(1)G2468
No	9			18(6)G468	
No	10				20(1)G2468

solutions for which the TA-side symmetry is $SU(5)$ or $SU(7)$ do not correlate with direct interactions with simple fermions. (See discussion related to table 23 and discussion related to table 26.) For each unfree simple boson for which table 57 shows a non-one span, the non-one span numbers result from mathematics underlying assumed modeling. The effective span depends on the span correlating with the object (such as a hadron-like object) in which the simple boson exists. Tables 57c and 57d summarize some concepts relevant to tables 57a and 57b.

In table 57, the items for which free pertains and the PR36ISe span might be 36 are 1N, 1R⊗2U, and 0I. The 1N simple particles (or, neutrinos) have zerolike mass and zero charge. For 1R⊗2U, the component simple particles have zerolike or zero mass and zero charge. The 0I simple particle (or, aye) would have zerolike mass and zero charge.

We discuss concepts regarding the 2(2)G68 solution.

The 2(2)G68 solution does not belong to the set of 2γ solutions and does not belong to the set of $\gamma 2$ solutions. The 2(2)G68 solution does not correlate with interactions with individual simple fermions. Table 46 correlates $\lambda = 8$ with leptons and baryons. Table 38 correlates $\lambda = 6$ with changes of internal states for multicomponent objects. We posit that 2(2)G68 correlates with some electromagnetic (or, $\Sigma = 2$) interactions with atoms and other objects.

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 dark matter objects (for the case in which PR6ISe pertains to nature) or doubly dark matter objects (for the case in which PR36ISe pertains to nature) via 2(2)G68. Unlike for the cases of electromagnetic interactions that correlate with 2(1)G2 and 2(1)G24, 2G produced by some dark matter objects (for the case in which PR06ISe pertains to nature) or by some doubly dark matter objects (for the case in which PR36ISe pertains to nature) interacts with ordinary matter via 2(2)G68.

We discuss ratios that PR6ISe or PR36ISe might predict or explain.

Table 58 lists some approximate ratios of dark matter effects to ordinary matter effects that PR6ISe modeling might explain. Proposed theory designed PR6ISe modeling to explain the five-plus to one ratios that people observe regarding densities of the universe. Here, the five correlates with dark matter isomers and the plus correlates with hadron-like particles that do not interact with 2γ force components. Galaxy clusters seem to be sufficiently large to comport with similar ratios. Discussion just above regarding 2(2)G68 correlates with the one to one ratio. (See, also, discussion related to equation (128).) Ratios of zero to one and four to one comport with roles of dark energy forces in scenarios regarding galaxy formation. (See discussion related to table 62.) Ratios of zero to one and four to one comport with scenarios regarding some galaxies for which observations correlate with times well after galaxy formation. (See other discussion related to table 62.) Generally, we do not expect directly observable, widely applicable, easily explained approximate ratios of, for example, three or six.

We note that discussion above de-emphasizes some aspects that might correlate with PR6ISe modeling and PR36ISe modeling.

For the case of PR6ISe, one can label the isomers of charged particles by using the numbers zero through five. We choose the number zero to pertain to the ordinary matter isomer. (See discussion related to table 60.) Based on discussion related to equation (128) and on numbering and discussion related to table 60, we suggest correlating the number three with the isomer that interacts, via 2(2)G68, with ordinary matter. The issue of the isomers that 4(2)G48 connects remains open. For example, 4(2)G48 connections might match the pairings that table 60 suggests. This essay de-emphasizes the issue of which 4(2)G48 pairings pertain.

Other G-family force components have spans of two. (See table 56.) Similar PR6ISe modeling choices regarding alignment regarding spans pertain regarding these components. This essay de-emphasizes the issue of which pairings (relative at least to the 2(2)G68 pairs and maybe also to other pairings, such as 4(2)G48 pairings) pertain.

For the case of PR36ISe, various alignment choices pertain. This essay assumes that each 2(6)GΓ connection is orthogonal to each 4(6)GΓ′ connection. (Here, regarding notation, the Γ in 2(6)GΓ does not match the Γ′ in 4(6)GΓ′.) Possibly, such an assumption need not pertain. Issues, similar to PR6ISe issues for components with span two, might pertain regarding components with span two. This essay de-emphasizes such issues.

Table 57: 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 root force components interact with simple fermions and with multicomponent objects (with the symbol MCO denoting multicomponent object; and with the symbol † denoting that somewhat conservation of fermion generation pertains)

(a) Particles and solutions, other than G-family components that are not $\Sigma\gamma$ components

Standard Model entities	Possible entities	PR1ISe span	PR6ISe span	PR36ISe span	1b interact w/ 1f	1b interact w/ MCO
1C	-	1	1	1	-	-
1N	-	1	6	6 (‖2G) or 36	-	-
1Q	-	1	1	1	-	-
-	1R	1	6	6 (‖2G)	-	-
2U	-	1	6	6 (‖2U)	Y†	N
2W: Z		1	6	6 (‖2G)	Y†	N
	2T: $2T^{0''}$, $2T^{0'}$	1	6	6 (‖2G)	Y†	N
2W: $W^{\pm 3}$	2T: $2T^{\pm 2}$, $2T^{\pm 1}$	1	1	1	Y†	N
1Q⊗2U	-	1	1	1	-	-
-	1R⊗2U	1	6	6 (‖2G) or 36	-	-
0H	-	1	1	1	Y	N
-	0I	1	1, or 6	1, 6 (‖?), or 36	Y	N
-	0K	1	6	6 (‖2G)	N	Y
-	0P	1	6	6 (‖2G)	N	Y
2G2	-	1	1	1	Y	Y
2G24	-	1	1	1	Y	Y
2G248	-	1	6	6 (‖2G)	Y†	Y
-	4G4	1	6	6 (‖4G)	Y†	Y
-	4G48	1	2	2 (‖4G)	N	Y
-	4G246	1	1	1	Y†	Y
-	4G2468a	1	1	1	Y†	Y
-	4G2468b	1	1	1	Y†	Y
-	6G6	1	1	1	N	Y
-	6G468	1	1	1	Y	Y
-	8G8	1	1	1	N	Y
-	8G2468a	1	1	1	Y	Y
-	8G2468b	1	1	1	Y	Y

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

Standard Model entities	Possible entities	PR1ISe span	PR6ISe span	PR36ISe span	1b interact w/ 1f	1b interact w/ MCO
-	2G68	1	2	2 (‖2G)	N	Y

(c) Notes regarding the case PR6ISe

Notes
• For any $\Sigma\Phi$ and non-zero charge, the span is one. • For 1Φ and 2Φ; $\Phi \neq$ G; and zero charge, the span of six correlates with somewhat conservation of generation. • For 0K and 0P, the spans equal the span for 2U. • For 0H, we assume that the span is one. (See table 36 and note that, elsewhere, ΣG2468 correlates with a span of one.) • For 0I, we assume that the span is one of one or six.

(d) Notes regarding the case PR36ISe

Notes
• For each $\Sigma\Phi$ with $\Phi \neq$ G or I and with a PR6ISe span of six or two, we assume that ‖2G pertains. • For each $4G\Gamma$ with a PR6ISe span of six or two, we assume that ‖4G pertains. • For 0I, we assume that the span is one of one, six, or 36.

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Table 58: Approximate ratios of dark matter effects to ordinary matter effects (with DM denoting dark matter; with OM denoting ordinary matter; with _MA denoting _M amount; with CMB denoting cosmic microwave background radiation; and with * denoting that proposed theory also suggests an explanation that does not correlate with dark matter)

Approx. DMA/OMA	Amounts
5	Density of the universe
5	Amount of stuff in galaxy clusters
1	Amount of absorption of OM CMB via interactions with DM* or OM atoms.
0	Amount of stuff in some early galaxies
4	Amount of stuff in some early galaxies
0	Amount of stuff in some later galaxies
4	Amount of stuff in some later galaxies

4.4. Densities of the universe

This unit discusses various densities of the universe. This unit explores numerical relationships that interpretations of data suggest.

Ongoing theory discusses five partial densities of the universe. The symbol Ω_ν denotes neutrino density 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_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 (121) pertains regarding the total density of the universe, Ω.

$$\Omega = \Omega_\nu + \Omega_c + \Omega_b + \Omega_\gamma + \Omega_\Lambda \tag{121}$$

Proposed theory suggests equation (122). The symbol Ω_{1R2U} denotes 1R⊗2U density of the universe. The symbol Ω_{ib} denotes dark matter baryonic density of the universe. (The letter i symbolizes the word isomer.) The symbol $\Omega_{i\gamma}$ denotes dark matter photon density of the universe.

$$\Omega_c = \Omega_{1R2U} + \Omega_{ib} + \Omega_{i\gamma} \tag{122}$$

We interpret data regarding recent states of CMB (or, cosmic microwave background radiation) as correlating with equation (123). The symbol Ω_{1R2U} correlates with the plus in the ratio five-plus to one. The relationship $\Omega_b \gg \Omega_\gamma$ pertains regarding data. (Reference [17] provides data regarding $\Omega_b \gg \Omega_\gamma$.)

$$\Omega_{ib} \approx \Omega_{ib} + \Omega_{i\gamma} \approx 5(\Omega_b + \Omega_\gamma) \approx 5\Omega_b \tag{123}$$

Equation (127) estimates Ω_{1R2U} for the current state of the universe. (Reference [17] provides the data that equations (124), (125), and (126) show.)

$$\Omega_b \approx 0.0484 \pm 0.001 \tag{124}$$

$$\Omega_c \approx 0.258 \pm 0.011 \tag{125}$$

$$\Omega_\gamma \approx 0.0000538 \pm 0.0000150 \tag{126}$$

$$\Omega_{1R2U} \approx \Omega_c - 5\Omega_b \approx 0.016 \tag{127}$$

Reasons exist for not taking the results that equation (127) shows to be exact. For example, we note the size of the standard deviation in equation (125).

4.5. Dark matter ratios inferred from data regarding cosmic microwave background radiation

This unit discusses dark matter ratios that people infer from data about cosmic microwave background radiation.

We know of up to two types of CMB (or, cosmic microwave background radiation) observations that might measure ratios of dark matter effects to ordinary matter effects.

One type of observation measures ratios of dark matter density of the universe to ordinary matter density of the universe. (See discussion that leads to table 55 and includes equation (117).) A ratio of five-plus to one seems to pertain for billions of years. (See discussion related to equation (123) and

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discussion related to equation (147).) We use that ratio to posit the basis for PR6ISe modeling. The basis features the notion of six isomers of non-zero-charge simple particles.

The other type of observation might also measure ratios of dark matter effects to ordinary matter effects related to CMB. People measure absorption of CMB via hyperfine interactions with hydrogen-like atoms. (See reference [24].) The amount of absorption 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 [36].)

Proposed theory suggests the following explanation. Solution 2(2)G68 has a span of two. 2(2)G68 interactions are 2(2)GΓ interactions. Equation (128) pertains. Solution 2(2)G68 does not correlate with interactions with individual simple fermions. (The TA-side symmetry is $SU(5)$. See table 26 and table 57b.) Solution 2(2)G68 might correlate with hyperfine interactions. (Note, for example, that the six in Γ might correlate with aspects of multicomponent objects. The eight in Γ might correlate with at least one of lepton number and spin.) Half or somewhat less than half of the observed absorption correlates with the ordinary matter isomer of hydrogen atoms. An equal amount of the observed effect correlates with hydrogen-atom isomers that correlate with one dark matter isomer of PR6ISe-span-one phenomena or with one doubly dark matter isomer of PR6ISe-span-one phenomena. The dark matter case correlates with PR6ISe modeling. The doubly dark matter case correlates with PR36ISe modeling. To the extent that the ordinary matter absorption is less than half of the total absorption, other 2GΓ solutions with spans of at least two might correlate with relevant effects. Each one of solutions 2(6)G46 and 2(6)G468 might pertain. 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 dipole effect. Solution 2(6)G468 correlates with a quadrupole effect.

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

4.6. The rate of expansion of the universe

This unit discusses dark energy forces and suggests an explanation for eras regarding the rate of expansion of the universe.

Two thought experiments set the stage for discussing aspects regarding the rate of expansion of the universe.

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.

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.

Table 59 summarizes, regarding the rate of expansion of the universe, eras and 4G force components. In this context, the eras pertain to the largest objects that people can directly infer. Early acceleration pertains for some time after the Big Bang. Then, deceleration pertains for some billions of years. (Regarding observations that correlate with the eras that correlate with deceleration and recent acceleration, see references [8], [9], [10], and [11].) Acceleration pertains for the most recent few billion years. Regarding smaller objects, dominant forces within objects and between neighboring objects have, at least conceptually, generally transited parallels to the above-mentioned eras and now generally exhibit behavior correlating with RSDF of r^{-2}. (Discussion regarding table 64 notes that high-outflow phenomena related to black holes or neutron stars might provide exceptions regarding the notion of complete dominance correlating with an RSDF of r^{-2}. For some aspects of these cases, r^{-3} net repulsion might pertain.) The column labeled A/R notes net effects, across force components dominating for each era. The column labeled components of 4γ lists solutions that might correlate with significant forces. (See table 27. Proposed theory suggests that, for the purposes of this discussion, neither 4(1)G268 nor 4(2)G26 correlates with significant effects.) Proposed theory suggests that, for the components of 4γ that table 59 lists, the two-word term net repulsive correlates with a notion of essentially always repulsive (though perhaps sometimes not significantly repulsive). Proposed theory suggests that, for the components of 4γ that

Table 59: Eras and 4G forces, regarding expansion of the universe

Era	A/R	RSDF	Components of 4γ	Other components of 4G	Span (PR6ISe or PR36ISe)
early acceleration	net repulsive	r^{-5}	4(1)G2468a, 4(1)G2468b		1
deceleration	net attractive	r^{-4}	4(1)G246	4(1)G268	1
recent acceleration	net repulsive	r^{-3}	4(2)G48	4(2)G26	2
(recent, for smaller objects)	attractive	r^{-2}	4(6)G4		6

table 59 lists, the two-word term net attractive correlates with a notion of essentially always attractive (though perhaps sometimes not significantly attractive).

Proposed theory suggests that the ongoing theory notion of dark energy forces (or, dark energy pressure) correlates with the components, other than 4(6)G4, of 4γ.

A better characterization than the six-word term rate of expansion of the universe might feature a notion of the rates of moving apart of observed very large astrophysical objects.

4.7. Phenomena during and just after inflation

This unit discusses phenomena that might correlate with times during and just after the inflationary epoch.

Ongoing theory suggests that an inflationary epoch might have occurred. Ongoing theory 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 that data confirms the occurrence of an inflationary epoch.

Ongoing theory 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 theory. (Reference [37] summarizes aspects related to inflation, points to references regarding ongoing theory, and discusses some ongoing theory work.)

Reference [12] 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 theory suggests the possibility that, during the inflationary epoch, aye particles (or, 0I particles) provided a major non-root-force component of the universe. The aye particle matches ongoing theory notions of a boson with zero spin. (See reference [37].) Ongoing theory uses the word inflaton to name that boson. Proposed theory suggests the possibility that the octupole components of 4γ provided the repulsive aspect of gravity. (See, for example, table 64.) Those components interact with individual simple particles and are repulsive. Equation (129) shows such an interaction. Here, x and y might be either of a and b. The end of the inflationary epoch would correlate with a change, regarding effects of 4γ, from dominance of octupole repulsion to dominance by quadrupole attraction. 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.

$$0\mathrm{I} + 4(1)\mathrm{G2468x} \rightarrow 0\mathrm{I} + 4(1)\mathrm{G2468y} \quad (129)$$

References [12] and [37] suggest that inflaton particles dominated (what proposed theory would characterize as) the non-root-force composition of the universe for some time after the inflationary epoch. Inflatons produced a cascade of interactions that led to a preponderance of protons, neutrons, and electrons. Clumping of the resulting hydrogen atoms led to the formation of stars.

Proposed theory suggests the possibility that, for some time just after the inflationary epoch, the aye particle might have been a dominant non-root-force component of the universe. The dominant G-family force component would have been the quadrupole component of 4γ. That component interacts with individual simple particles and is attractive. Interactions between aye particles would produce components of 2G forces. (See equation (130).) Each of proposed theory and ongoing theory includes interactions by which 2G components produce matter-and-antimatter pairs of simple fermions. Interactions between elementary particles would produce non-aye simple bosons. From there, the above-mentioned cascade

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could occur. Proposed theory suggests the possibility that attraction based on the quadrupole component of 4γ contributed to clumping.

$$0\text{I} + 0\text{I} \rightarrow 2\text{G} + 2\text{G} \tag{130}$$

Discussion above de-emphasizes the question of the extent to which, for clumps or objects that involve multiple simple particles, 4γ octupole repulsion might dominate 4γ quadruple attraction for at least some time after the end of the inflationary epoch.

Discussion above de-emphasizes the notions of isomers and spans. Discussion above de-emphasizes the notion of phenomena that might have preceded the inflationary epoch.

We discuss isomers and spans.

Our work considers three PRnISe cases - n is one, n is six, and n is 36. Table 57 suggests that the span for each of the quadrupole component of 4γ and the two octupole components of 4γ is one. For each one of the PR6ISe case and the PR36ISe case, the span of 0I might be one or might be more than one. For each one of the PR6ISe case and the PR36ISe case, the proposed theory possibility that the span of 0I is one might point to the notion that each of the n isomers originally develops similarly to and originally somewhat essentially independently from the other (n minus one) isomers. More substantial coupling between isomers might start with the production of simple particles that have spans that exceed one. Coupling might also involve, for example, contributions correlating with the 4G48 component of 4γ, the 4G4 component of 4γ, and the 2G248 component of 2G. For each one of the PR6ISe case and the PR36ISe case, the proposed theory possibility that the span of 0I is more than one would point to yet more robust coupling - early on - between isomers.

4.8. Baryon asymmetry

This unit discusses proposed theory explanations for baryon asymmetry.

To the extent that the early universe featured essentially the same number of antimatter quarks as matter quarks, something happened to create baryon asymmetry. The two-word term baryon asymmetry correlates with the present lack, compared to matter quarks, of antimatter quarks.

Aspects of ongoing theory consider that early in the universe baryon symmetry pertained. Ongoing theory 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 [38].)

Proposed theory suggests scenarios that might have led to baryon asymmetry.

In one scenario, equations (131) and (132) pertain. This scenario converts three antimatter fermions into one matter fermion. Equation (133) shows an overall result. (Regarding equation (131) and to the extent that one wants to try to impose notions of conservation of lepton number and conservation of baryon number, the notion of $2\text{T}^{-1}_{+2;0,-2}$ would pertain. Regarding equation (132) and to the extent that one wants to try to impose notions of conservation of lepton number and conservation of baryon number, the notion of $2\text{T}^{-1}_{+2;+3,+1}$ would pertain.) Baryon asymmetry would arise because reactions such as equations (131) and (132) show dominated compared to similar reactions that involve antiparticles to the particles that equations (131) and (132) show. Domination might correlate with an occurrence of more $2\text{T}^{-1}_{+2;}$ lasing than $2\text{T}^{+1}_{-2;}$ lasing. Here, baryon asymmetry arises because of an imbalance - regarding lasing - that occurred, in effect, statistically.

$$1\text{Q}^{+1}_{+1;0,-1} + 1\text{Q}^{-2}_{+1;0,-1} \rightarrow 2\text{T}^{-1}_{+2;} \tag{131}$$

$$1\text{C}^{+3}_{-3;-3,0} + 2\text{T}^{-1}_{+2;} \rightarrow 1\text{Q}^{+2}_{-1;0,+1} \tag{132}$$

$$1\text{C}^{+3}_{-3;-3,0} + 1\text{Q}^{+1}_{+1;0,-1} + 1\text{Q}^{-2}_{+1;0,-1} \rightarrow 1\text{Q}^{+2}_{-1;0,+1} \tag{133}$$

A threshold energy might be in or above the range of 208 GeV to 221 GeV. (See equation (104).) A corresponding temperature is about 2×10^{15} degrees Kelvin. As far as we know, this result is not inconsistent with established ongoing theory.

4.9. Galaxy clusters, ratios of dark matter amounts to ordinary matter amounts, and filaments

This unit discusses, for galaxy clusters, observed ratios of dark matter amounts to ordinary matter amounts. This unit notes possible implications, regarding filaments, of dark matter baryon acoustic oscillations.

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

References [39] and [40] report ratios of five-plus to one. The observations have bases in gravitational lensing. Reference [41] reports, for so-called massive galaxy clusters, a ratio of roughly 5.7 to one. (Perhaps note reference [42].) The observations have bases in X-ray emissions.

Proposed theory is not incompatible with these galaxy cluster centric ratios.

Reference [43] 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. Proposed theory might suggest a correlation, based on proposed similarities between most dark matter and ordinary matter. We are uncertain as to the extent to which people might consider that the formula supports this aspect of proposed theory.

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

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

4.10. Evolution of dark matter isomers, plus an explanation for aspects of the Bullet Cluster

This unit discusses the notion that various ones of the one ordinary matter isomer and the five dark matter isomers evolve differently from some of the other isomers. This unit explains aspects of observations regarding the Bullet Cluster.

We consider either PR6ISe modeling or PR36ISe modeling. For each case, there are five dark matter isomers and one ordinary matter isomer.

Possibly, the evolution of each one of the six isomers paralleled the evolution of each of the other five isomers.

Such parallel evolution might lead to difficulties regarding explaining observations regarding the so-called Bullet Cluster.

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 physics 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. For each of the two clusters, stars move along trajectories generally consistent with just gravitational interactions. For each of the two clusters, 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 term intergalactic medium. Ongoing theory 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 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, there would not be enough 1R⊗2U dark matter to significantly help regarding explaining the amount of dark matter that is not lagging.

We discuss the notion that four isomers evolved somewhat similarly to each other, the other two isomers evolved similarly to each other, and the somewhat similar four isomers evolved differently from the similar two isomers.

We explore possible implications of equations (66), (67), (68), and (77). We focus on charged leptons. Thus, $M' = 3$ pertains. We imagine that there is a particle for which $M'' = 18$. For interactions between two such particles, the strength per channel for the 2G2 component of electromagnetism equals

Table 60: Modeling pertaining to the one ordinary matter isomer and the five dark matter isomers

n	Formula	Interpretation
0, 1, 2, 3, 4, or 5	$M'' = 3n + 1$	No particle
0 or 3	$M'' = 3n$	Generation 1
1 or 4	$M'' = 3n$	Generation 3
2 or 5	$M'' = 3n$	Generation 2

Table 61: Relationships between baryon generation and lepton generation

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

the strength per channel for the 4G4 component of gravity. Equation (134) shows the equality. (Compare with equations (67) and (77).)

$$1 = (((q_\epsilon)^2/(4\pi\varepsilon_0))/4) \,/\, ((G_N(\times\beta^6 m_\epsilon)^2)/3) \tag{134}$$

We explore mathematics that correlates each of the six relevant isomers with a range of M''. In equation (135), the integer n numbers the isomers.

$$\text{isomer } n \;\leftrightarrow\; 3n \le M'' \le 3n+3, \text{ for } 0 \le n \le 5 \tag{135}$$

Table 60 shows interpretations regarding modeling for the six isomers. (Compare with table 43.) Here, for $n \geq 1$, the $M'' = 3n$ generation relevant to isomer n equals the $M'' = 3(n-1)+3$ generation relevant to isomer $n-1$. Within an isomer, an overall result correlates with the same cyclic ordering, for generations, that table 43 shows.

Table 61 shows, for each value of n, relationships between baryon generation and lepton generation. Table 61 extends table 60 and includes baryons. For each n, the order for baryons is generation one, generation two, and then generation three.

We discuss the time, in the evolution of the universe, before and around which each of the six isomers forms its own isomer of protons and other hadrons. Without loss of generality, we correlate ordinary matter with $n = 0$. Isomer three proceeds on a path that parallels the evolution of ordinary matter.

We discuss isomers one and four. For each of isomers one and four, there are more tauon analogs than there are tauons for isomer zero. Possibly, before isomers form hadron-like particles, the evolution of each of isomers one and four diverges from paralleling the evolution for isomer zero. This essay de-emphasizes that possibility. This essay discusses the possibility that the analogs to tauons catalyze nuclear fusion reactions at rates that exceed rates for ordinary matter.

We discuss isomers two and five. For each of isomers two and five, there are more muon analogs than there are muons for isomer zero. For each of isomers two and five, there are more tauon analogs than there are tauons for isomer zero. Possibly, before isomers form hadron-like particles, the evolution of each of isomers two and five diverges from paralleling the evolution for isomer zero. This essay de-emphasizes that possibility. This essay discusses the possibility that the analogs to muons and the analogs to tauons catalyze nuclear fusion reactions at rates that exceed rates for ordinary matter.

Regarding isomers one, two, four, and five, we are uncertain as to how far fusion proceeds and as to the extent of then near-term consequences. At a minimum, the four isomers that exhibit enhanced fusion produce abundances of heavy analogs to atomic nuclei. We de-emphasize discussing the extent to which analogs to white dwarf stars, analogs to neutron stars, or black holes might form.

Presumably, each one of the four isomers that exhibit enhanced fusion somewhat rapidly features mainly just non-zero mass objects and a somewhat analog to CMB (or, ordinary matter centric cosmic microwave background radiation). From that time forward, the dominant effects are cooling and 4G interactions.

We return to discussion of the Bullet Cluster.

Based on discussion related to tables 60 and 61, proposed theory suggests that, for each of the two galaxy clusters, at least 80 percent of the incoming isomeric dark matter would pass through the collision with just gravitational interactions having significance. The 80 percent correlates with values of n of one, two, four, and five. Proposed theory suggests that essentially all of the incoming 1R⊗2U dark matter would also pass through the collision with just gravitational interactions having significance.

We think that these proposed theory notions can 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 clusters and the fractions of IGM that, in effect, detach from outgoing clusters.

We discuss possible aspects regarding an outgoing cluster.

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

We discuss possible aspects regarding detached IGM.

To the extent that IGM detaches from galaxy clusters after the 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 a value of three for n.

4.11. Galaxies, including formation and including ratios of dark matter to ordinary matter

This unit suggests scenarios for the formation and evolution of galaxies. This unit discusses, for galaxies, observed ratios of dark matter amounts to ordinary matter amounts.

We discuss galaxy formation and evolution scenarios and aspects pertaining to the amounts of ordinary matter and dark matter in galaxies. We assume that nature comports with at least one of PR6ISe modeling and PR36ISe modeling. (Neither ongoing theory nor PR1ISe modeling includes the notion of dark matter isomers. We think that it would be, at best, difficult to explain - based on for example 1R⊗2U dark matter - ratios, that observations suggest, of dark matter amounts to ordinary matter amounts.) For now, we de-emphasize some phenomena such as 1R⊗2U hadron-like particles and collisions between galaxies.

We anticipate that such galaxy formation and evolution scenarios will explain galaxy centric data that tables 53 and 58 show.

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), filaments (which correlate with effects of early universe baryon acoustic oscillations), 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 formation and evolution. For purposes of this discussion, we assume that we can de-emphasize collisions. 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. (Communication 71c and communication 71b discuss data that pertains regarding a time range of 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 regarding the early evolutions of various isomers do not lead, for the present discussion, to adequately significant differences - regarding galaxy formation and 4G interactions - between isomers. (Perhaps, see discussion regarding table 60.)

We organize this discussion based on the isomer or isomers that originally clump based on, respectively, 4G246 attraction or 4G246 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.

We discuss 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 PR6ISe modeling pertains. 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.

- 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 (or, featured) 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.

We explore the extent to which the galaxy formation scenario comports with observations.

Observations of 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.

Reference [19] 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 theory suggests the above galaxy evolution scenario comports with this data. Presumably, other galaxies have one-isomer clumps that do not feature the ordinary matter isomer. Early on, those galaxies would not emit much 2G radiation that people could detect. People would not see such galaxies.

Reference [20] provides data about early stage galaxies. (See, for example, figure 7 in reference [20]. 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 [44] suggests that redshifts of at least seven pertain to times ending about 770 million years after the Big Bang. We suggest that our galaxy evolution scenario comports with this data.

We discuss observations correlating with later times.

Reference [21] discusses some MED09 spiral - or, disk - galaxies. A redshift of approximately $z = 1.57$ pertains. (See reference [45].) The redshift correlates with a time of 4.12 billion years after the Big Bang. (We used reference [44] to calculate the time.) Reference [21] reports ratios of amount of dark matter to amount of ordinary matter of approximately four to one. The observations have bases in gravitational lensing.

To the extent that such an MED09 galaxy models as being nearly untouched, proposed theory 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.

To the extent that such an MED09 galaxy models as not being untouched, proposed theory 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

Table 62: A method for cataloging not-significantly-collided galaxies that formed during the first few billion years after the Big Bang (with DM:OM denoting a ratio of amount of dark matter to amount of ordinary matter)

Original clump	Eventual DM:OM	Relative abundance	Spiral-like	Note
1IS: OM	∼4	1	Many (?)	Visible early
1IS: DM1	large	1	Many (?)	Dark matter galaxy
1IS: DMn	∼4	4	Many (?)	Visible later
2IS including OM	?	x	Some (?)	Possibly visible early
2IS including DM1	large	x	Some (?)	Possibly, a dark matter galaxy
2IS: DMn, DMn′	?	x	Some (?)	Visible later
3IS including OM	?	y	Few (?)	Possibly visible early
3IS including DM1	large	y	Few (?)	Possibly, a dark matter galaxy

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 [18] 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 [44] 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 [46].) The observations have bases in light emitted by visible stars. This case correlates with the three-word term dark matter galaxy. Proposed theory suggests that this galaxy might have formed based on a core that included the isomer that repels the ordinary matter isomer.

Table 62 suggests a method for cataloging not-significantly-collided galaxies that formed during the first few billion years after the Big Bang. We use the one-element term not-significantly-collided to include possible collisions during the formation of original clumps and to exclude subsequent collisions. We use the one-element term spiral-like to include spiral dark matter galaxies. We use the two-element term possibly spiral-like to include the possibility that multi-isomer original clumps might produce other than spiral-like galaxies. (Each isomer might correlate with essentially just one axis of rotation but the axes might not align with each other. The three-element term other than spiral-like might correlate with the one-word term elliptical.) Some aspects of table 62 are conceptual or not necessarily completely rigorously expressed. The leftmost column describes the original clump. We do not specify mathematically boundaries between 1IS (or, one original isomer), 2IS (or, two original isomers), and 3IS (or, three original isomers). OM denotes the ordinary matter isomer. DM1 denotes the dark matter isomer that the ordinary matter isomer repels via the 4(2)G48 component of the 4G force. (Regarding table 60, $n = 0$ correlates with OM. We do not specify a value of n that correlates with DM1.) Each of DMn and DMn′ can denote any one of the other four isomers that are relevant for the case of PR6ISe. Here, each of n and n′ is one of two, three, four, or five. Here, choices of DMn and DMn′ comport with the notion that DMn does not interact with DMn′ via 4(2)G48. The next column estimates, based on assumptions such as a lack of collisions, ratios of dark matter density to ordinary matter density. (Collisions might tend to produce elliptical galaxies.) The estimates do not necessarily take into account phenomena related to 1R⊗2U dark matter. The relative abundances pertain billions of years ago. Each of x and y depends on natural phenomena and on the boundaries that one assumes between 1IS, 2IS, and 3IS. The column with the one-element label spiral-like has bases in some assumptions about the extent to which stuff correlating with a single isomer rotates around a single axis and about the extent to which, for multi-isomer original clumps, axes correlating with different isomers align with each other. Each one of the three words many, some, and few pertains regarding the galaxies that pertain for the relevant row in the table. Regarding the rightmost column, the following notions pertain. The word early might correlate with redshifts that exceed roughly seven (and, possibly, with some smaller redshifts). The word later might correlate with redshifts that do not exceed roughly seven (or, a number less than seven). We embrace an ongoing theory use of the three-word term dark matter galaxy.

The following notions pertain regarding other data of which we know. Here, the ratios are ratios of dark matter amounts to ordinary matter amounts.

- Reference [47] discusses six baryon-dominated ultra-diffuse galaxies that seem to lack dark matter, at least to the radius studied by gas kinematics via observations of light with a wavelength of 21 centimeters. These observations seem not to be incompatible with a scenario correlating with an original clump that features the ordinary matter isomer.

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- Reference [48] discusses 19 dwarf galaxies that lack having much dark matter, from their centers to beyond radii for which ongoing theory suggests that dark matter should dominate. These observations measure r-band light that the galaxies emitted. These observations seem not to be incompatible with a scenario correlating with an original clump that features the ordinary matter isomer.

- The galaxy NGC1052-DF2 might correlate with a ratio of much less than one to one. (See reference [49].) The observation has bases in the velocities of stars - or, galaxy rotation curves. This observation seems not to be incompatible with the scenario correlating with an original clump that features ordinary matter. A different observation suggests results that differ from the previous observation. Reference [50] suggests, for NGC1052-DF2, that at least 75 percent of the stuff within the half mass radius is dark matter. To the extent this suggestion comports with nature, phenomena related to NGC1052-DF2 might correlate with results that reference [21] discusses regarding some MED09 galaxies. (See discussion above regarding MED09 galaxies.) Proposed theory seems to be not incompatible with either ratio. Proposed theory might not, based on known data, be able to refute either ratio.

- The galaxy NGC1052-DF4 might correlate with a ratio of much less than one to one. (See reference [51].) The observation has bases in the velocities of stars - or, galaxy rotation curves. This observation seems not to be incompatible with the scenario correlating with an original clump that features ordinary matter.

- 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 [22].) Observations feature the X-ray brightness and temperature of hot gas. This galaxy might correlate with the case correlating with the three-element term 3IS including OM and 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 [52].) People speculate regarding a so-called quenching mechanism. Proposed theory might suggest that phenomena similar to phenomena that might pertain regarding Markarian 1216 might pertain regarding XMM-2599.

- People report other data. We are uncertain as to the extents to which proposed theory provides insight that ongoing theory 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 [53].) People deduce that the galaxy originally featured dark matter and that the galaxy attracted ordinary matter. In terms that table 62 uses, this galaxy might correlate with 1IS: DMn or with 2IS: DMn, DMn′.
  - One example features so-called massive early-type strong gravitation lens galaxies. (See reference [54].) 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 [55].) Observations feature sub-millimeter wavelength light. We might assume that proposed theory galaxy formation scenarios comport with such galaxies. We are not certain about the extent to which proposed theory 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 theory 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 theories. (For a discussion of some possible inconsistencies, see reference [56].)
  - We are uncertain as to the extent to which proposed theory might provide insight regarding the existence of two types - born and tidal - of ultra-diffuse galaxies. (See reference [57].)

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

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

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 [58] suggests that 65 percent of the ultra-diffuse galaxies are more massive than people might expect based on ongoing theory relationships, for so-called normal galaxies, between stellar mass and halo mass. We are uncertain as to the extent to which proposed theory might explain this result. For example, proposed theory might suggest that phenomena related to isomers might play a role. (See, for example, table 62.) 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.

4.12. Aspects regarding some components of galaxies - stars and black holes

This unit discusses some aspects regarding ordinary matter, dark matter, stars, and black holes.

Discussion related to table 62 is not incompatible with the notion that visible stars do not include much dark matter.

Discussion related to table 62 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 [59] and [60].)

We suggest that proposed theory 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 [61].) Proposed theory 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 theory 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 of a pair of colliding black holes features.

4.13. Dark matter effects within the Milky Way galaxy

This unit discusses some observations that might pertain regarding dark matter in the Milky Way galaxy.

People look for possible local 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 [23].) 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 [62].) Proposed theory 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 [62] and [63].) 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 theory notions of the existence of dark matter stars that would be similar to ordinary matter stars.

4.14. High-mass neutron stars

This unit suggests proposed theory 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 [64].) 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 [65] and [66].)

Some ongoing theory models suggest a maximum neutron star mass of about $1.5M_\odot$. (See reference [66].)

Observations correlate with most known neutron star pairs having masses in the range that equation (136) shows and one neutron star pair having a mass of about 3.4 solar masses. (See references [67] and [68].) Here, M denotes the mass of a pair. The 3.4 number results from the second detection

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via gravitational waves of a merger of two neutron stars. People assign the name GW190425 to that detection.

$$2.5M_{\odot} \lesssim M \lesssim 2.9M_{\odot} \tag{136}$$

People speculate - based on, at least, the GW190425 result - about needs for new theory regarding neutron stars. (See references [67] and [66].)

To the extent that people need new theory regarding high-mass neutron stars, proposed theory might suggest useful new theory. Some high-mass neutron stars might, in effect, result from mergers of neutron stars, with each merging neutron star correlating with an isomer of charge (or, of charged simple particles) that differs from the isomer pertaining to each other neutron star that forms part of the merger. The notion that the span of 4G4 exceeds one (and is six) underlies this possibility. The notion that the PR6ISe span of gluons (or, 2U simple particles) is six might underlie this possibility. The span of each isomer of quarks (or, 1Q simple particles) is one.

4.15. Dark energy density

This unit discusses possible explanations for non-zero dark energy density. This unit notes that proposed theory can embrace ongoing theory aspects that correlate with non-zero dark energy density. This unit notes that the existence of the aye (or, 0I) boson might correlate with some of those ongoing theory aspects. This unit discusses the notion that dark energy densities might correlate with dark matter or doubly dark matter.

Equation (137) shows an inferred ratio of present density of the universe of dark energy to present density of the universe of dark matter plus ordinary matter plus (ordinary matter) photons. (Reference [17] provides the four items of data.) From a standpoint of each of ongoing theory and proposed theory, equation (137) does not include neutrino density of the universe. From a standpoint of proposed theory, Ω_c includes effects correlating with 1R⊗2U hadron-like particles. (See equation (122).) From a standpoint of proposed theory, for models for which n (as in PRnISe) exceeds one, Ω_c includes effects correlating with dark matter isomers that are similar to the ordinary matter isomer. We know of no inferences that would not comport with a steady increase, regarding the inferred ratio correlating with equation (137), from approximately zero, with time since somewhat after the Big Bang. (Communication 71e implies a ratio of approximately zero correlating with 380 thousand years after the Big Bang.)

$$\Omega_\Lambda / (\Omega_c + \Omega_b + \Omega_\gamma) \approx 2.3 \tag{137}$$

Some aspects of ongoing theory correlate inferred dark energy densities of the universe with phenomena correlating with terms such as vacuum energy, vacuum fluctuations, or quintessence. Proposed theory is not necessarily incompatible with notions such as vacuum energy. However, double-entry aspects of proposed theory point to possibilities for modeling that does not embrace notions such as vacuum energy.

Aspects related to aye (or, 0I) bosons might lead to phenomena similar to effects that ongoing theory correlates with vacuum energy, vacuum fluctuations, or quintessence. (See discussion related to equation (75).) Ongoing theory correlates some of those effects with data about dark energy densities. To the extent that phenomena correlating with aye bosons suffice to explain dark energy densities, there might not be a need to consider PR36ISe modeling. Assuming that such phenomena might not adequately explain non-zero dark energy density, we discuss possibilities for other proposed theory aspects that might explain non-zero dark energy density.

For PR6ISe modeling, proposed theory includes the notion of 2(6)G248, whereas ongoing theory correlates with the notion of 2(1)G248. We suggest that the difference, in proposed theory, between 2(6)G248 and 2(1)G248 might correlate with nature's indirectly producing effects, regarding CMB, that people correlate, via ongoing theory, with some non-zero dark energy density. The difference correlates with interactions between ordinary matter and dark matter.

For PR36ISe modeling, differences between 2(>1)GΓ and 2(1)GΓ correlate with interactions between ordinary matter plus dark matter and doubly dark matter. For example, half or somewhat less than half of the effect that reference [24] reports correlates with 2G68 interactions correlating with one doubly dark matter isomer of hydrogen atoms. Also, any span-36 phenomena would correlate with interactions between ordinary matter plus dark matter and doubly dark matter. Neutrinos, 1R⊗2U hadron-like particles, and aye simple bosons might provide for such interactions. (See table 57.) In effect, dark energy density correlates with a notion of dark energy stuff. Much of the dark energy stuff would correlate with doubly dark matter. Modeling suggests an upper bound of approximately five regarding, in effect, a possible future value for the ratio that correlates with equation (137).

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Proposed theory comports with the notion that ratios of inferred density of dark energy to inferred density of ordinary matter plus dark matter grow with respect to the time, since the Big Bang, correlating with observed phenomena upon which people base the inferences. Data that communication 71e shows supports the notion of such growth. Inferences that reference [69] discusses might comport with this aspect of proposed theory.

4.16. Directly detecting dark matter

This unit discusses aspects of extant approaches for directly detecting dark matter. This unit discusses possible new approaches for directly detecting dark matter or doubly dark matter.

We discuss possibilities for observing dark matter effects without creating dark matter.

People attempt to directly detect dark matter. (See, for example, reference [70].) Some efforts look for WIMPs. We are uncertain as to the extent to which these efforts might be able to detect 1R⊗2U hadron-like particles. Some efforts look for axions. We are uncertain as to the extent to which these efforts might attribute axion sightings to effects that correlate with the difference that equation (138) shows.

$$2(6)\mathrm{G}248 \neq 2(1)\mathrm{G}248 \tag{138}$$

Proposed theory suggests new possibilities for directly detecting dark matter or doubly dark matter. To the extent that PR6ISe pertains to nature and PR36ISe does not pertain to nature, the following discussion pertains to detecting dark matter. To the extent that PR36ISe pertains to nature, the following discussion pertains to detecting doubly dark matter. The basis for one possibility is the difference between 2(6)G248 and 2(1)G248. Here, a detector might feature a rotating magnetic dipole moment, with the axis of rotation not matching (and perhaps being orthogonal to) the axis correlating with the magnetic dipole. Independent of that possible means for detection, people might try to infer 2(6)G248 phenomena correlating with dark matter magnetic fields (or - for the PR36ISe case - 2(6)G248 phenomena correlating with doubly dark matter magnetic fields). A basis for another possibility is the difference between 2(2)G68 and 2(1)G68. Proposed theory suggests that 2G68 correlates with, at least, some atomic transitions.

We discuss three possibilities for making and detecting dark matter.

Equations (139), (140), and (141) show interactions that convert a neutron into a dark matter 1R⊗2U hadron-like particle that features three arc (or, 1R) simple fermions. (A neutron includes two Q^{-1} quarks and one Q^{+2} quark.) The minimum energy to trigger this set of interactions correlates with the sum of the rest energies of one neutron and two charged tweaks. A range for that minimum energy is 417 GeV to 443 GeV. (Here, we assume results that equation (104) shows.) For an experiment, the number of conversions might be small. The following notions might correlate with such smallness. The range of the $2\mathrm{T}^{\pm}$ boson might be small compared to the size of a neutron. (See discussion related to equation (111).) Effects that ongoing physics correlates with the two-word term Pauli exclusion might imply that the probability for the original three quarks to be adequately close to each other is low.

$$2(\mathrm{Q}^{-1} \rightarrow \mathrm{R}^0 + \mathrm{T}^{-1}) \tag{139}$$

$$\mathrm{Q}^{+2} + \mathrm{T}^{-1} \rightarrow \mathrm{Q}^{+1} \tag{140}$$

$$\mathrm{Q}^{+1} + \mathrm{T}^{-1} \rightarrow \mathrm{R}^0 \tag{141}$$

We speculate about means for detecting such a conversion of a neutron into a three-arc hadron-like particle. We assume that the neutron resides in an atomic nucleus in a target material. Given the relevant energies, we assume that the three-arc particle exits the target. We speculate that people would not detect the three-arc particle. With one target and enough conversions that do not produce escapes of atomic nuclei, people might detect a change in the isotopic composition of the target. Possibly, an easiest detection would correlate with effects other than those we just mentioned. Such effects might correlate with byproducts of the interaction.

Equations (142), (143), and (144) show interactions that convert a proton into a dark matter 1R⊗2U hadron-like particle that features three arc (or, 1R) simple fermions. (A proton includes two Q^{+2} quarks and one Q^{-1} quark.) The minimum energy to trigger this set of interactions correlates with the sum of the rest energies of one proton and three charged tweaks. A range for that minimum energy is 625 GeV to 664 GeV. (Here, we assume results that equation (104) shows.)

$$2(\mathrm{Q}^{+2} \rightarrow \mathrm{R}^0 + \mathrm{T}^{+2}) \tag{142}$$

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$$Q^{-1} \rightarrow R^0 + T^{-1} \tag{143}$$

$$2(T^{+2}) + T^{-1} \rightarrow W^{+3} + I^0 \tag{144}$$

Compared with trying to detect the conversion of a neutron into dark matter, the possibility for converting a proton offers advantages and disadvantages. One advantage might be the possibility for detecting the weak interaction that the W^{+3} boson would catalyze. Another advantage might correlate with an ability to use colliding beams instead of an approach that might feature one beam and a fixed target. One disadvantage might be the need to use higher energy for the incoming particles.

Equations (145) and (146) show interactions that convert a positron and an electron into the fermion components for a 1R⊗2U hadron-like particle that would have some similarity to a neutral pion. A threshold energy could be about 81 GeV. Detecting the 1R⊗2U particle might prove difficult. To the extent that the preferred decay of the particle features a matter neutrino and an antimatter neutrino, detecting decay products might prove difficult.

$$C^{+3} \rightarrow R^0 + W^{+3} \tag{145}$$

$$C^{-3} + W^{+3} \rightarrow R^0 \tag{146}$$

4.17. Constancy of the density of the universe ratio regarding dark matter and ordinary matter

This unit discusses the notion that relative densities of the universe pertaining to dark matter and ordinary matter likely have not changed much for billions of years.

Proposed theory points to types of stuff that measures as dark matter. Regarding each of PR1ISe modeling, PR6ISe modeling, and PR36ISe modeling, one type of stuff is 1R⊗2U hadron-like particles. Regarding PR6ISe modeling and PR36ISe modeling, dark matter also includes five dark matter isomers, each of which is similar to ordinary matter 1Q⊗2U plus ordinary matter 2(1)G.

Elsewhere, we discuss possible threshold energies pertaining to reactions that might produce 1R⊗2U hadron-like particles. (See, for example, discussion regarding equations (145) and (146).) The relative densities of the universe of 1R⊗2U hadron-like particles and ordinary matter 1Q⊗2U hadron particles might be essentially constant after the universe cools to a temperature correlating with an energy of 81 GeV. (See discussion regarding equations (145) and (146).) Regarding PR6ISe modeling and PR36ISe modeling, proposed theory does not necessarily include interactions that would directly convert ordinary matter 1Q⊗2U to dark matter 1Q⊗2U or interactions that would directly convert dark matter 1Q⊗2U to ordinary matter 1Q⊗2U.

The actual ratio of dark matter density of the universe to ordinary matter density of the universe might not much change after the cooling to the temperature correlating with the energy 81 GeV. That energy correlates with a temperature of about 10^{15} degrees Kelvin. That temperature correlates with a time that is less than 10^{-4} seconds after the Big Bang. (Reference [71] notes that a temperature of 10^{13} degrees Kelvin correlates with a time of 10^{-4} seconds after the Big Bang.)

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 (147) pertains. (Perhaps, see equations (124) and (126).) That time range starts somewhat after 380,000 years after the Big Bang and continues through now.

$$\Omega_{\gamma} \ll \Omega_{\mathrm{b}} \tag{147}$$

4.18. Aspects regarding the cosmology timeline

This unit suggests some phenomena that people might want to add to the cosmology timeline or for which people might want to add details to the cosmology timeline.

We note aspects that discussion elsewhere in this essay de-emphasizes.

- Early in the evolution of the universe, quarks, arcs, and gluons formed hadron-like seas. The seas might have undergone phase changes, with the last changes featuring at least one transition from seas to hadron-like particles.

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Table 63: Some phenomena that people might want to add to the cosmology timeline or for which people might want to add details to the cosmology timeline

Phenomena
• Possible transition to dominance by left-handed simple fermions. (See discussion related to equation (167).)
• Production of 1R⊗2U hadron-like particles. (Possibly, the vanishing of seas composed of gluons and quarks or arcs.)
• Transition in dominance, regarding various sizes of objects, from repulsion based on 4(1)G2468a and 4(1)G2468b to attraction based on 4(1)G246. (See discussion related to table 59.)
• Earliest visible galaxies of various types that table 62 suggests.
• Achievement, by some galaxies, of approximately four to one ratios of dark matter density to ordinary matter density. (See table 62.)
• Transition in dominance, regarding various sizes of objects, from attraction based on 4(1)G246 to repulsion based on 4(2)G48. (See discussion related to table 59.)
• Transition in dominance, regarding various sizes of objects, from repulsion based on 4(2)G48 to attraction based on 4(6)G4. (See discussion related to table 59.)

- Scenarios regarding clumping suggest that a significant fraction of early black holes contained stuff correlating with essentially just one isomer. Regarding PR6ISe modeling, approximately one-sixth of such one-isomer black holes feature ordinary matter and approximately five-sixths of such one-isomer black holes feature dark matter.
- Proposed theory is not incompatible with an ongoing theory notion of possible large-scale flatness for the universe.

Table 63 suggests some phenomena that people might want to add to the cosmology timeline or for which people might want to add details to the cosmology timeline.

5. Discussion: theories and models for motion

This unit discusses aspects of kinematics modeling and aspects of dynamics modeling. This unit suggests limits on the applicability of general relativity. This unit catalogs interaction vertices, for interactions that involve simple particles and root forces, that correlate with a possible proposed theory parallel to some aspects of ongoing theory quantum field theory. This unit suggests possibilities for developing dynamics modeling based on proposed theory. This unit discusses possible dynamics modeling for hadron-like particles, nuclear physics, and quantum transitions.

5.1. Perspective regarding quantum modeling and kinematics modeling

This unit discusses relationships between quantum modeling and kinematics modeling.

Proposed theory might seem to include a problem regarding possible dissonance between modeling pertaining to quantum interactions and modeling pertaining to kinematics.

For example, proposed theory suggests that 4G interactions do not necessarily directly significantly lead to neutrino oscillations. Yet, kinematics modeling needs to allow for gravity to alter the trajectories of neutrinos. Symbolically, equations (148) and (149) might pertain.

$$\text{1N} + \text{4G} \nrightarrow \text{1N} + \text{4G} \text{ pertains regarding quantum mechanical transitions} \tag{148}$$

$$\text{1N} + \text{4G} \rightarrow \text{1N} + \text{4G} \text{ pertains regarding translational motion} \tag{149}$$

Similar concerns might pertain regarding photons. Similar concerns might pertain regarding the aye (or, 0I) boson. For the aye boson, proposed theory suggests that interactions with 4G2468a and 4G2468b lead to effects during and just after inflation. (See discussion related to equation (129).) However, aye bosons have no mass (and presumably have no mass-centric moment of inertia) and might not interact quantum mechanically with 4G.

We think that resolution lies in the notion that motion of a simple particle or of a photon can occur without the simple particle or photon undergoing a quantum transition. Proposed theory modeling regarding quantum transitions and ongoing theory modeling regarding motion have some independence from each other. Discussion regarding equations (40) and (41) provides an example regarding phenomena related to ΣG (or, the G-family).

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5.2. Perspective regarding models that feature gravitation

This unit discusses models for non-quantum interactions between objects and gravity. This unit suggests limits regarding the applicability of modeling based on general relativity. This unit suggests possible opportunities for research regarding modeling various aspects of large-scale physics.

5.2.1. Models for interactions with gravity

This unit discusses models for non-quantum interactions between objects and gravity.

Equation (150) shows Newtonian modeling regarding gravity. Each $m\_$ denotes the mass of an object. The symbol $\overrightarrow{r}$ denotes a vector pointing from object one to object two. The symbol r denotes the distance between the two objects and the length of the vector. The symbol $\overrightarrow{F}$ denotes the force that object one exerts on object two. The symbol $\overrightarrow{a}$ denotes the acceleration that pertains regarding the motion of object two.

$$(G_N m_1 m_2/r^2)(-\overrightarrow{r}/r) = \overrightarrow{F} = m_2 \overrightarrow{a} \tag{150}$$

The factor m_2 appears in each of the leftmost and rightmost parts of equation (150). Observations show that gravity bends the paths of light. Equation (151) pertains, including for photons. Equations (152) and (153) might pertain and might point toward aspects of general relativity. The symbol E denotes energy. The symbol $\overrightarrow{P}$ denotes momentum.

$$(G_N m_1/r^2)(-\overrightarrow{r}/r) = \overrightarrow{a} \tag{151}$$

$$-(G_N E_1 E_2/r^2)\overrightarrow{r} = \overrightarrow{F} = E_2 \overrightarrow{a} \tag{152}$$

$$(E\_)^2 = (m\_ c^2)^2 + (\overrightarrow{P\_} \cdot \overrightarrow{P\_})c^2 \tag{153}$$

We consider the motion of a free simple boson or of a quantum that correlates with a G-family force. ALG modeling pertains. Quantum excitation or de-excitation need not necessarily pertain regarding effects of gravity. (See discussion regarding equations (40) and (41).) Modeling regarding energy and momentum might pertain. (See, for example table 23. Discussion related to equation (54) notes notions that might underlie such modeling.)

5.2.2. General relativity and large-scale physics

This unit suggests limits regarding the applicability of modeling based on general relativity. This unit suggests possible opportunities for research regarding modeling various aspects of large-scale physics.

While general relativity comports with various phenomena, people discuss possible problems regarding the applicability of general relativity to large-scale physics. (See, for example, reference [72].) Also, people express other concerns regarding modeling pertaining to large-scale physics. For example, reference [7] alludes to possible concerns correlating with the Hubble constant (or, a Hubble parameter).

Proposed theory offers possible insight and resolution regarding such concerns.

Table 64 lists aspects related to 4GΓ solutions. In the context of PR1ISe modeling, each row (possibly except for the last row) in the table points to a possible correlation with general relativity. For each row, the extent to which the possible correlation pertains might be an open question. People associate the two-element term Lense-Thirring effect with the two-element term rotational frame-dragging. The Einstein field equations allow solutions that correlate with repulsion. (See reference [12].) This essay does not explore the extent to which modeling based on the notion of an RSDF (or, radial spatial dependence of force) of r^{-6} and on the notion of $\rho \neq 0$ might correlate with general relativity modeling for which a non-zero cosmological constant pertains. (See discussion related to table 26.)

We consider modeling that might pertain to large-scale phenomena for other than the very early universe.

We assume that general relativity pertains regarding PR1ISe modeling, including 4γ aspects of PR1ISe modeling.

We consider the case of PR6ISe modeling.

We assume that galaxy clusters tend to have equal amounts of stuff correlating with each of the six isomers.

We consider modeling related to the current multibillion-year era of accelerating rate of expansion of the universe. (See table 59.) We consider two similar objects that have equal amounts of stuff correlating with each of the six isomers and that are at least as large as galaxy clusters. We assume that proposed

Table 64: Possible correlations, regarding PR1ISe modeling, with general relativity

Aspect regarding proposed theory	Aspect regarding general relativity
4G48	rotational frame-dragging
4G48 repulsion	Einstein field equations
4G246 attraction	Einstein field equations
4G2468a and 4G2468b repulsion	Einstein field equations
4G components other than 4γ components	Einstein field equations
RSDF (or, radial spatial dependence of force) of r^{-6}	Cosmological constant

theory pertains. We assume that ongoing theory general relativity pertains. If the objects are adequately far apart, the dominant 4γ force component is 4G4. The 4G4 component has a span of six. By assumption, modeling based on general relativity suffices. If the objects are adequately close to each other, 4G48 can be the dominant 4γ force. The 4G48 component has a span of two. The ratio of two to six is one-third. Each span-one simple particle within one object experiences a force that is one-third the force that might correlate with modeling based on general relativity. General relativity might over-estimate the interaction between the two objects, unless one adjusts something like the cosmological constant or a relationship between density and pressure. Absent such an adjustment, modeling would overestimate rates of expansion. (We use the word rates - and not the word rate - because the rate changes with time.)

Regarding a possible model that includes both the multibillion-year era of decelerating rate of expansion and the current multibillion-year era of accelerating expansion, similar problems might arise. The 4G246 attractive component of 4γ has a span of one isomer. Tuning a model to the era of deceleration might produce a model that underestimates effects that lead to the (accelerating) rates that correlate with the current era.

We consider modeling regarding black holes and neutron stars. To the extent that a black hole or neutron star includes significant amounts of material correlating with each of at least two isomers, modeling - based on general relativity - for gravitational effects regarding high-outflow phenomena might be less than adequately accurate. Inaccuracy might occur, for example, to the extent that the outflow material does not interact via 4G48 with an isomer for which the black hole or neutron star has a significant amount. People observe high-outflow phenomena related to - for example - quasars, blazars, and pulsars.

We consider the case of PR36ISe modeling. Six isomers of 4(6)G4 pertain. General relativity might pertain somewhat for each of the six PR6ISe-like isomers. General relativity would not pertain across PR6ISe-like isomers.

Concepts such as those we just mentioned might point to opportunities for observational and theoretical research regarding each of the following topics and regarding relationships between the following topics - the domain of applicability of general relativity; equations relating pressures to densities; the notion and applicability of the concept of a Hubble parameter; notions regarding geodesic motion; and the spans and the strengths of forces correlating with the 4G48, 4G246, 4G2468a, and 4G2468b solutions.

We de-emphasize in this essay possible problems with trying to, in effect, extend modeling, based on general relativity, to very early times after the Big Bang.

5.3. Modeling that proposed theory suggests regarding dynamics

This unit contrasts possible dynamics modeling, based on proposed theory, with ongoing theory dynamics modeling.

Discussion above in this essay features proposed theory suggestions regarding elementary particles and dark matter, plus ongoing theory notions regarding motion. We generally assume that the QPT particle set and ongoing theory models for motion dovetail adequately well with each other.

Aspects - discussed above in this essay - of proposed theory verge on suggesting modeling regarding motion. Equation (52) provides an example. Table 11 alludes to possible applications, based on mathematics that underlies PDE modeling, to aspects of nature beyond the application correlating with matching known and suggesting new elementary particles.

We do not necessarily expect that proposed theory models for motion duplicate ongoing theory models for motion. Ongoing theory models tend to be linear in energy. Ongoing theory quantum models for motion tend to be linear in $\hbar$. Proposed theory models for motion tend to be quadratic in energy. (See for example, equation (52).) Proposed theory quantum models tend to be quadratic in $\hbar$. (Note, for example, that Ω_{SA} in equation (4) correlates with the expression $S(S+1)\hbar^2$.)

Table 65: Comparative features of proposed theory dynamics modeling and ongoing theory dynamics modeling

Compared to ongoing theory modeling regarding motion, use of proposed theory modeling might be ...
• As or more successful regarding describing allowed states.
• As or less successful regarding estimating - based on limited use of observed data - energies for allowed states.
• Easier or simpler - when applicable - to use.
• Based on more rigorous use of mathematics.

Table 66: Interaction vertices for interactions involving only simple particles and root forces (with ν denoting the effective ν)

Interaction	ν	Example
0f1b↔2f0b	-1	A Z boson creates a matter-and-antimatter pair of fermions.
1f1b↔1f1b	$-3/2$	An electron and a W^{+3} boson produce a neutrino.
1f1b↔3f0b	$-3/2$	Three antimatter fermions produce a matter fermion and a boson.
0fnb↔0fnb, for n≥2	$-n$	A Higgs boson creates two photons.

We do not necessarily expect that proposed theory aspects that seem to have parallels to ongoing theory QFT (or, quantum field theory) need to comply with special relativity. Regarding ongoing theory, reference [73] discusses a definition of QFT that does not necessarily imply a correlation with special relativity.

Table 65 compares aspects of proposed theory dynamics modeling and aspects of ongoing theory dynamics modeling.

5.3.1. Interaction vertices that involve simple particles and root forces

This unit catalogs interaction vertices, for interactions that involve simple particles and root forces, that correlate with a possible proposed theory parallel to some aspects of ongoing theory quantum field theory.

We explore notions correlating with the second row in table 11.

This work generalizes from work above that, nominally, pertains for free simple particles. Equations (11) and (12) pertain regarding all simple particles and all root forces. We posit that results - regarding some roles for ν_{SA}, ν_{TA}, and ν'' - from that work extend to all simple particles and all root forces. (See, for example, table 12b.)

Table 66 lists types of interaction vertices that proposed theory includes. Here, in the symbol nf, n denotes a number of simple fermions. In the symbol nb, n denotes a number of simple bosons and root forces. A symbol of the form a↔b denotes two cases, namely a→b and b→a. A symbol of the form a→b denotes the notion that the interaction de-excites each component of a by one unit and excites each component of b by one unit. (Note, for example, that de-excitation of a photon mode does not necessarily produce a ground state.) For each type of interaction vertex, the effective ν is the sum, over incoming field solutions, of the relevant $\nu\_$ and is also the sum, over outgoing field solutions, of the relevant $\nu\_$. In effect, the value of effective ν can correlate with aspects of a product of solutions of the form that equation (6) shows. Ongoing theory includes (and table 66 mentions examples of) 1f0b↔1f1b and 0f1b↔0f2b interactions. Proposed theory can embrace 1f0b↔1f1b interactions via the case of 1f1b↔1f1b and the notion that the other boson correlates with 0I phenomena. (The symbol 0I denotes a zero-spin, zero-mass, zero-charge, free simple boson that proposed theory suggests that nature might embrace. See table 3.) Proposed theory can embrace 0f1b↔0f2b interactions via the case of 0f2b↔0f2b and the notion that the other boson correlates with 0I phenomena. Proposed theory modeling can embrace, at least regarding 0f1b↔0fnb cases in which the 1b in 0f1b correlates with a non-zero-mass zero-charge simple boson, the notion of an effective ν of $-n$. Ongoing theory includes limits based on fermion statistics and does not necessarily include 1f1b↔3f0b interactions. Equation (133) provides - assuming that one adds a 0I boson to the outgoing side of the expression - an example of a 1f1b↔3f0b interaction. The interaction might contribute to the formation of baryon asymmetry. Each of the three incoming 3f fermions differs from the other two incoming 3f fermions. Ongoing theory limitations based on fermion statistics do not necessarily pertain. (Also, ongoing theory might be able to model some proposed theory 1f1b→3f0b interactions via the sequence 1f1b→1f1b followed by 0f1b→2f0b. Here, the outgoing 1b in the first interaction becomes the incoming 1b in the second interaction.)

Ongoing theory includes the following sequence of vertices. A fermion enters a 1f0b→1f1b vertex. The exiting fermion enters a 1f0b→1f1b vertex. The fermion exiting the second vertex enters a 1f1b→1f0b vertex that de-excites the boson that the first vertex excited. Modeling based on such a sequence can pertain for ongoing theory calculations of anomalous magnetic dipole moments. The boson is a photon. Proposed theory can dovetail with such sequences. Proposed theory also dovetails with modeling - for anomalous magnetic dipole moments and for other aspects of nature - that does not include the notion of virtual particles and does not include such a sequence. (See discussion related to equation (103).) We think that such theory is not without precedent. Statistical mechanics includes modeling that parallels ongoing theory quantum field theory modeling that uses interaction vertices. People use analogs to Feynman diagrams. Reference [74] shows techniques that sum statistical mechanics analogs to Feynman diagrams. (Perhaps, see instead communication 71d.)

Proposed theory can accommodate, for the weak interaction, modeling that does not require the notion of virtual particles. Equation (154) shows an ongoing theory 1f1b↔1f1b vertex. A muon transforms into a matter neutrino and a W boson. Equation (155) shows an ongoing theory 1f1b↔1f1b vertex. The W boson transforms into an electron and an antimatter neutrino. Proposed theory can accommodate that modeling. Also, proposed theory can accommodate the 1f1b↔3f0b vertex that equation (156) shows. Equation (156) does not show a virtual particle such as a W boson. Modeling based on equation (156) can be useful. However, modeling based just on equation (156) would not estimate properties of the W boson and would not necessarily estimate the strength of the interaction that equation (156) shows.

$$\mu^{-3} \to \nu^0 + \mathrm{W}^{-3} \tag{154}$$

$$\mathrm{W}^{-3} \to \mathrm{e}^{-3} + \bar{\nu}^0 \tag{155}$$

$$\mu^{-3} + 0\mathrm{I}^0 \to \nu^0 + \mathrm{e}^{-3} + \bar{\nu}^0 \tag{156}$$

For proposed theory modeling of interactions that involve simple particles and root forces in free environments, the PDE notion of the mathematical limit expression $(\eta_{SA})^2 \to 0$ pertains. (See discussion related to equation (10).) Here, $(\eta_{TA})^2 \to 0$ pertains. We say that the vertex models as being point-like with respect to coordinates. Here, point-like refers to the temporal coordinate and refers to either a radial spatial coordinate or three spatial coordinates.

An example of modeling of interactions that involve simple particles in so-called confined environments might feature modeling regarding interactions with a quark that exists within a proton.

For proposed theory modeling of interactions that involve simple particles and root forces in confined environments, the PDE notion of $(\eta_{SA})^2 > 0$ can pertain. (See discussion related to equation (160).) The expression that equation (157) shows might correlate with the size of the multicomponent object that correlates with the term confined environment. We say that the vertex models as being volume-like with respect to coordinates. Here, volume-like refers to, at least, either a radial spatial coordinate or three spatial coordinates. Volume-like correlates also with a non-point-like domain for the temporal coordinate.

$$|\eta_{SA}| \tag{157}$$

5.3.2. Dynamics models for some objects

This unit discusses possibilities for developing, based on mathematics that quantum particle physics uses, models for some multicomponent objects and for temporal aspects of quantum transitions.

We explore notions correlating with the third and fourth rows in table 11.

This work generalizes from work above that, nominally, can correlate with squares of energies and with potentials that have spatial dependences of at least one of r^{-1} and r^1. (See equations (3), (4), and (11).) We think that such theory is not without precedent. Ongoing theory modeling can feature potentials. Ongoing theory modeling can correlate with the Klein-Gordon equation, which is quadratic in energy. Aspects of modeling might have parallels to aspects of reference [75].

Discussion regarding table 67 mentions possibilities for applications regarding quarks in hadrons. In such applications, modeling based on potentials could obviate needs to include modeling based on gluons. Discussion related to equation (160) mentions possibilities for applications regarding nuclear physics. Another possibility for applications pertains regarding temporal aspects of quantum transitions. Another possibility for applications pertains regarding atomic physics. Regarding atomic physics, people might to want use modeling that correlates with equations (158) and (159). Equation (158) can correlate

Table 67: Sources, within some models, for SA-side symmetries related to kinematics conservation laws related to free hadron particles

Symmetry	Aspect	Source
$SU(2)$	Conservation laws component one	Modeling for fermions
$SU(2)$	Conservation laws component two	Modeling for bosons
$SU(2)$ or no symmetry	Boost related	Modeling for bosons

with de-emphasizing non-residual aspects of the strong force. The strong force is not relevant to the relevant aspects of atomic physics. We de-emphasize further discussing atomic physics.

$$(\xi'_{SA}/2)(\eta_{SA})^{-2} \to 0^+ \tag{158}$$

$$(\xi'_{SA}/2)(\eta_{SA})^2 \text{ is a positive constant} \tag{159}$$

5.3.3. Dynamics models for hadron-like particles

This unit discusses an approach, compatible with proposed theory, for modeling aspects, in hadrons, correlating with quarks and gluons. This unit illustrates the notion that modeling for components of a multicomponent object does not necessarily need to correlate, for each component, with conservation of angular momentum and conservation of linear momentum. This unit calls attention to possible differences between modeling for the dynamics of hadron-like particles that contain no more than three quarks and modeling for the dynamics of hadron-like particles that contain more than three quarks.

We discuss the notion that each hadron-like particle that includes no more than three quarks (or, 1Q particles) and arcs (or, 1R particles) does not include both quarks and arcs. Discussion related to table 33 suggests that a hadron-like particle has a charge for which the magnitude is either zero or a non-zero integer multiple of $|q_\epsilon|$ and has a baryon number that is either zero or a non-zero integer multiple of one. For a hadron-like particle that includes no more than three quarks and arcs, the restrictions to integer charge and integer baryon number preclude the simultaneous presence of more than zero quarks and more than zero arcs. A tetraquark might contain a matter-and-antimatter pair of quarks and a matter-and-antimatter pair of arcs.

We discuss modeling for dynamics in hadrons that contain no more than three quarks.

Ongoing theory QCD (or, quantum chromodynamics) modeling correlates with symmetries, for each of quarks and gluons, that correlate with special relativity.

We explore the notion that proposed theory suggests possibilities for modeling that correlates one subset of those symmetries with motion for quarks and another subset of those symmetries with motion for gluons.

Modeling for a free hadron requires two TA-side $SU(5)$ symmetries and four SA-side $SU(2)$ symmetries. (See discussion regarding equation (24).) Proposed theory suggests that each one of bosons (within the hadron) and simple fermions (within the hadron) can contribute one TA-side one $SU(5)$ symmetry and two SA-side $SU(2)$ symmetries. Such modeling would not use - for each of bosons and simple fermions - one TA-side $SU(5)$ symmetry and two SA-side $SU(2)$ symmetries. Dynamics modeling - for each of bosons and simple fermions - can correlate with just the previously unused one TA-side $SU(5)$ symmetry and two SA-side $SU(2)$ symmetries. Here, the bosons are gluons and the simple fermions are quarks.

Table 67 pertains.

This proposed theory dynamics modeling correlates with the notion that neither one of quarks and gluons behaves like a free simple particle. Proposed theory suggests that a hadron-like particle must include at least two (non-virtual) unfree fermions. (The notion of virtual correlates with ongoing theory. Proposed theory dovetails with modeling that includes the notion of virtual fermions and with modeling that does not include the notion of virtual fermions.)

We discuss notions that might correlate with modeling that might output masses for hadrons.

References [76] and [77] suggest opportunities to improve understanding regarding modeling that might explain the masses of hadrons such as protons. Proposed theory suggests concepts that might help regarding such opportunities. One concept correlates with avoiding relying on modeling that correlates with special relativity. (See discussion nearby above.) One concept correlates with equations (3) and (4) and with $D = 3$. Here, the term that is proportional to r^2 might correlate with the square of a potential. For a two-quark hadron, the potential associated with one quark affects the other quark. For a three-quark hadron, the potential associated with two quarks affects the third quark.

We discuss modeling for dynamics in hadrons that contain more than three quarks.

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Reference [78] suggests that some of the dynamics within at least some pentaquarks correlates with the dynamics for a system composed of a meson-like particle and a baryon-like particle. The meson-like particle features a matter quark and an antimatter quark. The baryon-like particle features three matter quarks. Aspects that proposed theory correlates with the pie simple particle and with the cake simple particle might play roles in such dynamics.

Modeling might consider that, if hexaquarks exist, some hexaquarks have parallels to atomic nuclei.

5.3.4. Dynamics models for nuclear physics

This unit suggests possibilities for developing proposed theory models for atomic nuclei.

We discuss nuclear physics.

Ongoing theory bases some aspects of modeling on notions of a Pauli exclusion force and on notions of a Yukawa potential. Ongoing theory correlates these effects with notions of a residual strong force. The Pauli exclusion force keeps hadrons apart from each other. The Yukawa potential attracts hadrons to each other. Modeling suggests virtual pions as a source for the Yukawa potential.

Reference [79] expresses concerns regarding modeling some aspects of nuclear physics based on the notion of virtual pions.

Proposed theory dovetails with modeling that includes a Pauli exclusion force and a notion of virtual pions and dovetails with modeling that does not correlate with a Pauli exclusion force or with notions of virtual pions.

From a standpoint of modeling, pie (or, 0P) bosons might correlate with attraction between hadrons. (See discussion related to table 30.) The attraction might correlate with a PDE-centric expression proportional to the term that equation (160) shows. (See discussions related to equations (21) and (157).)

$$\exp(-tr/(|\eta_{TA}|\cdot|\eta_{SA}|)) \rightarrow \exp(-r/|\eta_{SA}|) \tag{160}$$

Cake (or, 0K) bosons might correlate with repulsion between hadrons. (See discussion related to table 30.) A potential correlating with equation (161) might pertain. For this case, the scale length $|\eta_{SA}|$ would be less than the scale length pertaining to the 0P centric Yukawa potential.

$$\exp(-tr/(|\eta_{TA}|\cdot|\eta_{SA}|)) \rightarrow \exp(-r/|\eta_{SA}|) \tag{161}$$

People might develop models, for atomic nuclei, based on potentials that correlate with spatial aspects of equations (160) and (161).

Some ongoing theory modeling for atomic nuclei correlates with potentials similar to harmonic oscillator potentials. People might develop models based on notions of a possible 4U subfamily.

We are uncertain as to the extent to which such models for atomic nuclei would improve on ongoing theory techniques.

5.3.5. Dynamics models for quantum transitions

This unit discusses the possibility that aspects of proposed theory pertain to temporal aspects of quantum transitions.

People may have observed quantum transitions that take non-zero time. (See reference [80].)

Proposed theory suggests that people can model such aspects of transitions via volume-like vertices. Modeling that features volume-like vertices might parallel temporal aspects of equation (160). (See discussions regarding equations (21) and (160).)

6. Discussion: theories and models for objects

This unit discusses relationships between various theories and models that pertain regarding objects. This unit discusses possible synergies between proposed theory and the elementary particle Standard Model. This unit notes that proposed theory is not necessarily compatible with supersymmetry. This unit notes that aspects of proposed theory might help people explore the relevance of string theory to elementary particle physics. This unit suggests modeling that would comport with the notion that nature does not include a non-zero neutron electric dipole moment. This unit explores concepts related to the masses of hadron-like particles that include arc simple fermions. This unit discusses phenomena that might correlate with times before the inflationary epoch. This unit shows a possible link between dynamics modeling that we suggest and a notion of entropy.

6.1. The elementary particle Standard Model

This unit discusses possible synergies between proposed theory and the elementary particle Standard Model.

People might try to add to the Standard Model some of the symmetries that proposed theory suggests. Examples include conservation of charge, somewhat conservation of fermion generation, and somewhat conservation of lepton number.

We discuss adding to the Standard Model some of the simple particles and root forces that proposed theory suggests.

To the extent that satisfying symmetries such as $SU(3) \times SU(2) \times U(1)$ boson symmetries suffices, people might be able to add, to the Standard Model, simple particles and root forces that proposed theory suggests.

Proposed theory might provide a basis for extending the Standard Model to include concepts related to mass and to forces that correlate with bosons that have spins of at least two.

People might explore synergies between Standard Model approaches and proposed theory approaches to various topics. One such topic is anomalous magnetic dipole moments.

We do not speculate regarding the extent to which people might find synergies between Lagrangian aspects of the Standard Model, models such as discussion related to refraction suggests, and kinematics conservation laws. (Regarding refraction, see discussion related to equation (55).)

6.2. Supersymmetry

This unit notes that proposed theory is not necessarily compatible with supersymmetry.

Table 3 might suggest possibilities for some notion of symmetry based on equation (162). Here, the symbol $\leftrightarrow$ correlates with notions of exchanging roles. Table 3 might suggest possibilities for some notion of symmetry based on equation (163). For some relevant nonnegative values of Σ, table 3 might not suggest possibilities for a relevant notion of symmetry based on equation (164).

$$\text{free} \leftrightarrow \text{unfree} \tag{162}$$

$$m \dot{>} 0 \leftrightarrow m \doteq 0 \tag{163}$$

$$\Sigma \leftrightarrow \Sigma + 1 \tag{164}$$

Tables 3 and 56 seem, in themselves, to be incompatible with supersymmetry. People might explore the notion of layering supersymmetry over results that tables 3 and 56 show. However, given aspects of proposed theory, supersymmetry might not be necessary to explain known phenomena.

6.3. String theory

This unit notes that aspects of proposed theory might help people explore the relevance of string theory to elementary particle physics.

String theory correlates with notions of space-time frothiness on the scale of the Planck length (or, $R_2(m)$). (See equation (110).) Proposed theory suggests that there might be no need to appeal to such frothiness in order to limit sums of boson ground state energies. Leaving aside some mathematical aspects of proposed theory, proposed theory might not necessarily require that elementary particles have zero size. The Planck length might correlate with a size for elementary particles that have non-zero spin. (See equation (110).) The Schwarzschild radius might correlate with a size for elementary particles that have zero spin. (See equation (109).) Speculatively, the disparity between these two sizes might lead to means to explore making string theory more relevant to elementary particle physics that it seems to have proven to be.

We suggest perspective about string theory and about proposed theory. (Reference [81] provides perspective about string theory.) Regarding simple particles and root forces, proposed theory correlates with the three-word term theory of what. Proposed theory outputs a list of what elementary particles nature embraces or might embrace. We contrast notions of a theory of what with notions correlating with the three-word term theory of how. Proposed theory might not yet suggest a theory of how nature selects or forms elementary particles. Attempts to apply string theory might correlate with trying to develop a theory of how and trying to use the theory of how to produce a theory of what.

Table 68: Possible rest energies for 1R⊗2U hadron-like particles

Possible rest energies (in GeV) for 1R⊗2U
1. ~ 0.009.
2. ~ 0.06.
3. ~ 0.6.
4. ~ 1.
5. ~ 1.5.
6. ~ 4.4.
7. ~ 6.6.
8. Other.

6.4. Possible lack of a neutron electric dipole moment

This unit suggests modeling that would comport with the notion that nature does not include a non-zero neutron electric dipole moment.

For each hadron for which dynamics modeling based on PDE techniques pertains and for which all the quarks occupy one state with respect to spatial characteristics, the electric dipole moment might be zero. (See discussion, related to table 10, regarding PDE-based modeling that correlates with some aspects of the strong, electromagnetic, and weak interactions.) Equation (165) shows an upper bound on the electric dipole moment for the neutron. (See reference [17]. Here, the one-letter symbol m denotes meters.) Proposed theory suggests that the neutron and proton might be such hadrons. Some research suggests that some pentaquarks might not be such hadrons. (See interpretation, in reference [78], of reference [82].)

$$0.30 \times 10^{-27} \, |q_\epsilon| \, \mathrm{m} \tag{165}$$

6.5. Other discussion regarding the masses of hadron-like particles

This unit explores concepts related to the masses of hadron-like particles that include arc simple fermions.

We discuss rest energies for 1R⊗2U hadron-like particles.

The rest energy of a proton does not differ much from the rest energy of a neutron. For hadrons composed of generation-one quarks, the masses of hadrons do not vary much based on the masses of the quarks or on the charges of the quarks. The rest energies of 1R⊗2U hadron-like particles that contain exactly three arcs might approximate the rest energy of the proton, which is about 938 MeV. (Reference [17] provides data regarding hadron masses.) The rest energies of 1R⊗2U hadron-like particles that contain exactly two arcs might approximate the rest energy of the zero-charge pion, which is about 135 MeV.

We explore another concept for estimating masses for 1R⊗2U hadron-like particles. The concept has bases in the relative densities of the universe of 1Q⊗2U hadrons and 1R⊗2U hadron-like particles.

Nature might have created concurrently, essentially, the current populations of 1Q⊗2U hadrons and 1R⊗2U hadron-like particles. We assume that each of 1Q⊗2U hadrons and 1R⊗2U hadron-like particles consists mainly of three-fermion particles. We explore three cases, in which, respectively, the span, s, of 1R⊗2U is one, six, and 36. (See table 57a.) A span of one correlates with PR1ISe modeling. A span of six correlates with PR6ISe modeling and might correlate with PR36ISe modeling. A span of 36 might correlate with PR36ISe modeling. Equation (166) might estimate the current relevant ratio of density of 1R⊗2U hadron-like particles to density of ordinary matter. The symbol $m\_$ denotes the rest mass of a typical hadron-like particle. The leftmost use of the ratio $m_{1\mathrm{R}\otimes 2\mathrm{U}}/m_{1\mathrm{Q}\otimes 2\mathrm{U}}$ correlates with rest energy (or rest mass) per particle. The rightmost use of the ratio $m_{1\mathrm{R}\otimes 2\mathrm{U}}/m_{1\mathrm{Q}\otimes 2\mathrm{U}}$ occurs as the input to a calculation of an exponential and correlates with a hypothesis regarding the relative number of particles that nature created.

$$\Omega_{\mathrm{ib}}/(\mathrm{s} \cdot \Omega_{\mathrm{b}}) \sim (m_{1\mathrm{R}\otimes 2\mathrm{U}}/m_{1\mathrm{Q}\otimes 2\mathrm{U}}) \exp(-m_{1\mathrm{R}\otimes 2\mathrm{U}}/m_{1\mathrm{Q}\otimes 2\mathrm{U}}) \tag{166}$$

The respective values of $\Omega_{\mathrm{ib}}/(\mathrm{s} \cdot \Omega_{\mathrm{b}})$ are ~ 0.33, ~ 0.054, and ~ 0.0090. For each value of s, two mathematical solutions exist. The respective solutions, expressed in terms of m_c^2 and in units of GeV are ~ 0.6 and ~ 1.5, ~ 0.06 and ~ 4.4, and ~ 0.009 and ~ 6.6.

Table 68 summarizes some possible rest energies for 1R⊗2U hadron-like particles.

6.6. Speculation regarding phenomena before inflation

This unit discusses phenomena that might correlate with times before the inflationary epoch.

We speculate about phenomena that might have preceded the inflationary epoch.

Proposed theory correlates an $SU(5)$ symmetry with conservation of energy. The number of generators of $SU(5)$ is 24. Equation (167) might pertain. Here, $g_{U(1)}$ denotes the number of generators for $U(1)$ and equals two. The number 24 equals six times two times two. One factor of two might correlate with the possibility for two values of handedness for leptons. One factor of two might correlate with the possibility for two values for handedness for baryons. The factor of six might correlate with the relevance of six isomers regarding color charge. Specifically, the factor of six might correlate with a $\pi_{r,b,g}$ symmetry correlating with red, blue, and green color charges and with oscillators SA0, SAo, and SAe. (See table 40.) Here, six equals three times two. There are three possibilities regarding the color associated with SA0. For each of the three possibilities, there are two possibilities for the color associated with SAo.

$$(g_7/g_3) \times g_{U(1)} \times g_{U(1)} \tag{167}$$

To the extent that such aspects correlating with the $SU(5)$ symmetry comport with nature, one might consider models that suggest 24 somewhat similar entities. People might apply the two-word term our universe to one of the 24 somewhat similar entities.

We note, but do not pursue further, the possibility that theory might correlate, with the Big Bang, a transition that involves, in effect, a decoupling of the possible 24 somewhat similar entities.

6.7. Entropy

This unit shows a possible link between dynamics modeling that we suggest and a notion of entropy.

We consider cases of multicomponent objects that involve $k+1$ peer component objects. Here, k is a nonnegative integer.

We consider the case of $k = 1$. The multicomponent object includes two peer component objects. Compared with dynamics symmetries for the multicomponent object, the two peer components collectively contribute one too many instance of each of conservation of energy symmetry, conservation of angular momentum symmetry, and conservation of momentum symmetry. Modeling can re-assign the extra three symmetries to a combination of the two peer components and a field - such as a gravitational field - that correlates with interactions between the peer components.

We consider the case of $k > 1$. Here, we de-emphasize the possibility of non-peer subdivision. An example of non-peer subdivision involves the sun, earth, and moon. For this example of non-peer subdivision, one might use two steps, each correlating with $k = 1$. The first step considers each of the sun and the earth plus moon to be objects. The second step considers the earth plus moon to be a multicomponent object consisting of the earth and the moon. Without adequately significant additions to modeling, this example might correlate with modeling for which - regarding ocean tides - effects of lunar gravity pertain and effects of solar gravity do not pertain.

For $k > 1$, ongoing theory modeling becomes more complex than ongoing theory modeling for two-body (or, $k = 1$) systems. Many applications might pertain - for example, to astrophysical systems, to ideal gasses, and so forth. For some applications, keeping the number of fields at one might correlate with a notion of entropy and, at least within that notion, with the ongoing theory expression for entropy that equation (168) shows. Here, people might want to consider at least one of the two cases $j = k + 1$ and $j = k$. Here, people might want to consider each of a notion of entropy for physical systems and a notion that might correlate, regarding mathematics-based modeling, with a term correlating with the word entropy.

$$j \log(j) \tag{168}$$

7. Discussion: possible opportunities to develop deeper insight

This unit discusses modeling that people might use to develop new aspects of physics theory.

7.1. Numbers of dimensions

This unit speculates regarding some aspects of the topic of numbers of dimensions.

Proposed theory suggests that, at least in some sense, a number - three - of spatial dimensions correlates with $D^*_{SA} = 3$ and a number - one - of temporal dimensions correlates with $D^*_{TA} = 1$. (See equations (11) and (12).)

Proposed theory includes modeling that features other than three spatial dimensions. (See, for example, the SA-side aspects of representations that table 22 shows or the column labeled D in table 12b.) Ongoing theory includes modeling that features other than three spatial dimensions.

Some proposed theory uses of notions of $D^*_{SA} = 3$ and $D^*_{TA} = 1$ include modeling that correlates with $\nu_{SA} < 0$ and that outputs a list of known and possible elementary particles. (See table 11.) As far as we know, ongoing theory does not include parallels to such proposed theory modeling. Ongoing theory aspects that correlate with three spatial dimensions and one temporal dimension tend to correlate with proposed theory aspects for which $\nu_{SA} \geq 0$ pertains. (See table 11.)

Equations (11) and (12) might provide a characterization that can be useful, for much physics modeling, of the notions of three spatial dimensions and one temporal dimension.

7.2. Arrow of time

This unit notes that proposed theory may provide perspective regarding the topic of arrow of time.

Equation (21) and discussion related to equation (18) suggest a notion of a $\Psi(t, r)$ that correlates with the TA0-and-SA0 oscillator pair. (See equation (6).) We suggest that equation (169) might pertain. The domains $t > 0$ and $r > 0$ pertain for $\Psi(t, r)$. Without loss of generality, we posit that $\eta_{TA} > 0$ pertains regarding after an interaction, $\eta_{TA} > 0$ does not pertain regarding before an interaction, $\eta_{TA} < 0$ pertains regarding before an interaction, and $\eta_{TA} < 0$ does not pertain regarding after an interaction. We posit that $\eta_{SA} > 0$ pertains regarding elementary particles that exit an interaction, $\eta_{SA} > 0$ does not pertain regarding elementary particles that enter an interaction, $\eta_{SA} < 0$ pertains regarding elementary particles that enter an interaction, and $\eta_{SA} < 0$ does not pertain regarding elementary particles that exit an interaction. Of the four possibilities $\eta_{TA} > 0$ and $\eta_{SA} > 0$, $\eta_{TA} < 0$ and $\eta_{SA} < 0$, $\eta_{TA} > 0$ and $\eta_{SA} < 0$, and $\eta_{TA} < 0$ and $\eta_{SA} > 0$, mathematically, Ψ normalizes for only the first two possibilities. To the extent that this modeling correlates with the topic of arrow of time, the lack of dual normalization regarding each of the case of incoming and the case of outgoing might provide insight.

$$\Psi(t, r) \propto \exp(-tr/(\eta_{TA}\eta_{SA})) \tag{169}$$

The proposed theory notion that aspects of modeling of conservation of energy correlate with an $SU(5)$ symmetry (and not necessarily with an ongoing theory notion of $S1G$ symmetry) might provide insight regarding the topic of arrow of time. Proposed theory tends to correlate $SU(\_)$ symmetries with origins (with respect to coordinates) and with radial coordinates.

7.3. The Higgs mechanism, entanglement, and tachyon-like behavior

This unit provides possible proposed theory perspective regarding the ongoing theory notions of a Higgs mechanism, entanglement, and tachyon-like behavior.

At least to the extent that one models the universe as being a confined environment, the following statements might pertain.

- The aye (or, 0I) boson correlates with the Higgs mechanism or Higgs field.
- Theory does not completely disentangle any object from a notion of the universe minus that object.
- These notions correlate with a large-scale notion of tachyon-like behavior.

7.4. Notions that might link physics constants and modeling

This unit speculates regarding relationships between some minimal non-zero values that people observe and some aspects of proposed theory. This unit notes that proposed theory might point to opportunities to further explore relationships between charge and mass. This unit suggests a possible opportunity to explore relationships between handedness, chirality, helicity, lepton number or baryon number, rotation, and spin.

Table 69 shows speculation about possible conflations regarding two notions. One notion is the Σ in G-family mathematical solutions $\Sigma G \Gamma$. One notion is quantities (or, properties) with which some $\Sigma\gamma$ components of G-family forces interact. Each quantity (or, property) might pertain for each of some

Table 69: Possible conflations regarding G-family solutions and properties with which G-family forces interact (with (_) denoting a suggested smallest non-zero property magnitude, _, regarding modeling free objects; and with ((_)) denoting a different type of non-zero physics constant)

Σ	Scalar	Vector	2-tensor	3-tensor
0				
2	Charge ($\lvert q_\epsilon \rvert$)	Magnetic flux (K_J)	Precessing flux	
4	Mass	Rotating mass	Moments of inertia	Rotating moments
6	Freeable energy			
8	N_{L-B} (1)	Spin ($\hbar/2$)		?
...				
16	Speed ((c))			

aspects of classical physics modeling and some aspects of quantum physics modeling. (Compare with table 28 and table 46.) In table 69, an item in parentheses shows a non-zero magnitude that pertains for modeling that correlates with the notion of free. Except for regarding speed, the number is a minimal non-zero magnitude. (For charge, for unfree, $|q_\epsilon|/3$ pertains. For lepton number minus baryon number, for unfree, 1/3 pertains. Except for regarding speed, the numbers are minimal non-zero magnitudes.) Some modeling regarding refraction and effective mass might correlate (via, aspects correlating with longitudinal polarization) with a lack of a minimal non-zero quantity. (See discussion related to equations (54) and (55).) Regarding the case of $\Sigma = 16$, there might be a correlation with the notion that modeling might correlate boost symmetry with the oscillator pair SA15-and-SA16. (See discussion that includes discussion of table 24.) Such a correlation might dovetail with solutions that allow $\lambda = [\![16]\!] \in \Gamma$.

Some items in table 69 might correlate, in essence, with other physics constants. Charge might correlate with $1/(4\pi\varepsilon_0)$ and the vacuum electric permittivity ε_0. Magnetic flux correlates with $|q_\epsilon|$ and $\hbar$ and might correlate with μ_0, the vacuum magnetic permeability. Mass might correlate with G_N, the gravitational constant.

Proposed theory might suggest opportunities to further explore relationships between charge and mass and relationships between strengths of components of G-family forces. For example, table 42 points to possible relationships between charge and mass.

Proposed theory might offer an opportunity for new looks, regarding models, at relationships between handedness, chirality, helicity, lepton number or baryon number, rotation, and spin. (Note the row, in table 69, for which $\Sigma = 8$ pertains.)

Proposed theory might suggest another opportunity to explore modeling related to masses. We discuss a possibly useful notion regarding masses of non-zero-mass simple particles. Equations (170) and (171) pertain. The symbol m denotes mass. Boson simple particle masses tend to feature relationships regarding squares of masses. Equation (170) points to results that feature squares of masses. For each free simple boson, the equation evaluates approximately to an integer. The equation might correlate with the 2U-related potential that scales like r^1 and that pertains regarding unfree simple fermions in hadron-like particles. Equation (171) points to results that feature logarithms of masses. For each simple fermion other than the neutrinos, the equation evaluates somewhat approximately to an integer. The equation might correlate with ΣG-related potentials that scale like r^{-1} and that pertains regarding simple fermions that have quantum interactions with 2G2 and 4G4 root forces. Equation (172) follows from equation (171) and produces results pertaining to squares of simple fermion masses other than neutrino masses.

$$\int_0^{m/(m_Z/3)} 2r^1 dr \tag{170}$$

$$\int_1^{m/m_\epsilon} r^{-1} dr \tag{171}$$

$$\int_1^{m/m_\epsilon} 2r^{-1} dr \tag{172}$$

We are uncertain regarding the usefulness of further pursuing notions that we discuss immediately above.

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Table 70: Possible themes for experiments or observations

Theme
• Find or rule out elementary particles that we (or other people) suggest.
• Measure properties of new particles.
• Hone some measurements regarding some known particles.
• Verify or rule out the notion that gravity does not produce the main contributions to neutrino oscillations.
• Verify or rule out the relationship that we suggest regarding the tauon mass and the gravitational constant.
• Verify, hone, or refute relationships, that we suggest, between particle properties and other constants.
• Verify or rule out the description of dark matter that we propose.
• Determine properties of dark matter.
• Hone, extend, or rule out aspects that we suggest regarding galaxies.
• Add details - or rule out aspects that we suggest - regarding the cosmological timeline.
• Determine ranges of usefulness regarding - and test synergies between - various theories and models.
• Predict and try to verify other phenomena that might correlate with proposed theory.

8. Discussion: possible opportunities for experimental or observational research

This unit suggests themes for experiments and observations that people might want to conduct.

Table 70 suggest themes for experiments and observations that people might want to conduct. This essay de-emphasizes the topic of when techniques and technology will suffice to enable specific experiments or observations. We de-emphasize the topic of when - for each of various predictions we or other people make based on proposed theory - falsifiability becomes feasible.

9. Concluding remarks

This unit discusses possible opportunities based on proposed theory.

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

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

Proposed theory 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, nuclear physics, atomic physics, astrophysics, and cosmology.

Proposed theory might suggest applied mathematics techniques that have uses other than uses that we make.

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Table 71: Communications that this essay cites but that do not necessarily qualify for inclusion in the bibliography

(a)

Communication	Note
Wong, K. C.; Suyu, S. H.; Chen, G. C.-F. & others. H0LiCOW XIII. A 2.4% measurement of H_0 from lensed quasars: 5.3σ tension between early and late-Universe probes. Mon. Not. R. Astron. Soc., in press 2020. Link(2020): https://arxiv.org/abs/1907.04869.	We were unable to verify a claim of a status of "in press."

(b)

Communication	Note
LeFevre, O.; Bethermin, M.; Faisst, A. & others. The ALPINE-ALMA [CII] survey: Survey strategy, observations and sample properties of 118 star-forming galaxies at 4<z<6. 2019. Link(2020): https://arxiv.org/abs/1910.09517	We found a claim of a status of "working paper."

(c)

Communication	Note
Clavin, W. Rotating Galaxies Galore 2020. Posted by the California Institute of Technology. Link(2020): https://www.caltech.edu/about/news/rotating-galaxies-galore	We did not find a name for a series of articles that pertains to this article.

(d)

Communication	Note
Thomas J. Buckholtz. Statistical Mechanics of Two-Species Plasmas, with Applications to White Dwarf Stars and Metallic Hydrogen. Ph.D. thesis, University of California, Berkeley, reprinted, UCRL 51055, Lawrence Radiation Laboratory, Livermore, 1971(?)	We are uncertain regarding the accessibility of this reprint.

(e)

Communication	Note
Anonymous. Content of the universe - pie chart. National Aeronautics and Aerospace Administration, April 2013. Link(2020): https://map.gsfc.nasa.gov/media/080998/index.html	We did not find a source for the data that the chart presents.

this work: Helen Buckholtz, Joel Buckholtz, Sylvia Buckholtz, Hugh E. DeWitt, George Michael, and various teachers.

Table 71 lists communications for which the following two sentences pertain. This essay cites the communication. We did not necessarily find information sufficient to qualify the communication for inclusion in the bibliography.

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