Models for elementary particles, dark matter, dark energy, and galaxies

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December 15, 2019

Abstract

We show theory that spans tiny and vast aspects of physics. We suggest descriptions for new elementary particles, dark matter, and dark energy. We use those descriptions to explain data regarding dark matter effects, dark energy effects, and galaxy formation. Our mathematics-based modeling, descriptions, and explanations embrace and augment standard physics theory and modeling. One basis for our modeling is an extension to mathematics for harmonic oscillators.

Contents

1 Introduction

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

1.1 Overview

This unit discusses highlights about proposed theory.

We develop a framework for physics theories. The framework seems to embrace ongoing theories. The framework suggests new physics theory. We use the two-word term proposed theory to denote the new theory.

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

- Extensions to harmonic-oscillator mathematics. Minor changes in assumptions lead to 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 dark energy forces. The description of dark energy forces explains three eras regarding the rate of expansion of the universe. The list of elementary particles provides a candidate explanation for baryon asymmetry.

- Astrophysics (galaxy formation). A combination of dark matter aspects and dark energy forces 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 may 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 another example, describe dark energy pressure or forces. 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 approach features, from its beginning, quantized concepts. The approach does not originally address translational motion.

The approach matches, explains, or predicts phenomena that ongoing theory approaches do not. For example, we suggest - with some specificity - descriptions of new elementary particles, dark matter, and dark energy forces. The approach suggests formalism that can complement and integrate with ongoing theory.

1.3 Similarities and differences between proposed theory and ongoing theory

This unit notes some similarities and some differences between proposed theory and ongoing theory.

Physics theories entwine concepts. One concept is that of an object. One concept features internal properties of objects. One concept features motions of objects. One concept features interactions between objects. One concept features changes over time regarding objects, their internal properties, their motions, and their interactions.

The Newtonian physics equation $\vec{F} = m\vec{a}$ embraces each one of those five concepts. The equation applies to one object. The term m refers to an internal property, mass, of the object. The term $\vec{a}$ refers to acceleration and dovetails with motion. The term $\vec{F}$ denotes force and refers to interactions between the object and other objects. At least one term, $\vec{a}$, pertains regarding changes over time. One change over time pertains to velocity. Velocity is an aspect of motion.

Each one of ongoing theory and proposed theory addresses all of the five concepts.

Roots for ongoing theory include models for motion, models for interactions, and mathematics that features continuous functions. People use the four-word term principle of stationary action to name one guiding tenet.

Roots for proposed theory include models for objects, models for internal properties, models for interactions, and mathematics that features discrete solutions. We use the two-element term double-entry bookkeeping to name one guiding tenet.

Proposed theory tries to address topics that ongoing theory tries to address. (For example, reference [7] provides an ongoing theory attempt to address topics that proposed theory tries to address.)

1.4 Nature, data, a framework for theories, theories and models, and mathematics

This unit interrelates concepts regarding nature, data, theories and modeling, and mathematics.

Physics entwines concepts. One concept is that of nature. One concept is data about nature. One concept is models that explain or predict data. One concept is theories that underlie models. One concept is mathematics that underlies theories or models. The concepts do not necessarily separate completely. Interpretations of data depend on models.

We show and use a framework that encompasses some physics theories. The framework encompasses some ongoing theory. The framework encompasses the proposed theory that we suggest.

We extend traditional mathematics for harmonic oscillators. The extended math provides a basis for the framework. The extended math provides a basis for theories and models that we suggest.

We use the framework to spot choices regarding theories and models. We discuss possible synergies between some theories. We discuss possible discord between some theories. We discuss possible synergies between some models. We discuss possible discord between some models.

We explore the range of applicability for each of some theories and for each of some models. We prefer to correlate a range with data. We sometimes correlate a range with theories or models. We de-emphasize some notions such as the notion that nature, in effect, understands or follows mathematics correlating with specific theories or models.

1.5 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 and for dark energy forces. 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. Some proposed theory offers complements to or suggests limits regarding some aspects of ongoing theory kinematics and dynamics modeling.

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.

1.5.1   Elementary particles

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

People try two approaches to 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 [34].) 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 aspects except long-range forces. We use the two-element phrase long-range forces to include bases for phenomena such as electromagnetic fields, gravity, and dark energy forces. We do not separate the notion of boson particles from a broader (than just long-range) 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 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 outputs from the modeling technique as candidates for simple particles and long-range forces. Some or all of the candidates might represent opportunities for research to detect or infer phenomena. The candidates might not necessarily conflict with verified aspects of ongoing theory.

1.5.2   Dark energy forces and cosmology

This unit summarizes - regarding dark energy forces and cosmology - 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 [55].) People suggest phenomenological remedies regarding the modeling. (See, for example, reference [41].) People sometimes use the three-word term dark energy forces in discussions that include notions of dark energy pressure.

Proposed theory regarding spin-two long-range forces points to a candidate unified treatment of gravitational forces and dark energy forces. Proposed theory provides a candidate explanation for three observed eras in the rate of expansion of the universe. The first era correlates with a rate that increases with time. We characterize the dominant force components for this era by the word octupole. 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 [13], [39], [43], and [44] provide, that ends

some billions of years later. We characterize the dominant force component for this era by the word quadrupole. 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. We characterize the dominant force component for this era by the word dipole. 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 a monopole force, namely ongoing theory gravity.

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

We think that proposed theory provides a candidate means to close gaps between observations and ongoing theory. Opportunities exist to characterize (in terms of the rest energies and a few other characteristics, such as rates of rotation, of objects) the strengths of the non-monopole force components of our suggested notion of gravity plus dark energy forces.

1.5.3 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 necessarily well-specified. For example, searches for axions span several orders of magnitude of possible axion mass. People suggest that nature might include dark matter photons. (See, for example, reference [19].) People suggest that dark matter might include components that include quarks or that might experience Yukawa-like potentials. (See, for example, references [59] and [14].)

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 [50] provides.) People also infer ratios, for some galaxies and for some galaxy clusters, of dark matter effects to ordinary matter effects.

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 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. 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 gravity interacts with all six isomers of charged simple particles. We say that the span of gravity is six, as in six isomers of charged simple particles. One isomer of charged simple particles correlates with ordinary matter. The other five isomers of charged simple particles correlate with dark matter. For n

equal to 36, nature embraces six isomers of gravity, with each isomer of gravity correlating with its own PR6ISe-like set of phenomena. One PR6ISe-like set correlates with ordinary matter plus dark matter. We use the three-word term doubly dark matter to refer to the 30 isomers of charged simple particles that are neither ordinary matter nor dark matter.

PR1ISe does not provide bases for explaining, from fundamental principles, the observed ratios.

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.

PR36ISe provides the same bases (that PR6ISe provides) for explaining the above-mentioned observed ratios. PR36ISe differs from PR6ISe regarding explaining a possibly observed ratio that correlates with depletion of cosmic microwave background radiation.

Each of the cases PR6ISe and PR36ISe suggests the following scenario for the formation and evolution of galaxies. For purposes of discussion, we de-emphasize PR36ISe.

The scenario features, for each galaxy, the notion of an original clump. Clumping takes placed based on the quadrupole long-range force, which 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 long-range force, more than one isomer of PR6ISe-span-one phenomena. With respect to each isomer in the clump, the repulsive dipole long-range force 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. One-sixth of one-isomer original clump galaxies feature an ordinary matter original clump. Two-thirds of one-isomer original clump galaxies feature a dark matter original clump that does not repel ordinary matter. One-sixth of one-isomer original clump galaxies feature a dark matter original clump that repels ordinary matter. We suggest that the ongoing theory notion of dark matter galaxy correlates 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 [52] discusses a dark matter galaxy. Reference [21] 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 [9] seems to support (especially via data pertaining to redshifts of at least seven) the notion of ordinary matter intensive original clumps. Observations that reference [29] reports might support the notion of an approximately four to one ratio that might correlate with the approximately five-sixths of one-isomer clump galaxies that are not dark matter galaxies. The observation that reference [12] reports might correlate with a three-isomer original clump galaxy.

The galaxy formation and evolution scenario seems to comport with data. The scenario does not necessarily comport, for ordinary matter intense galaxies, with some ongoing theory assumptions about roles, in galaxy formation, of dark matter halos.

We think that each of PR6ISe and PR36ISe is not incompatible with inferred galaxy cluster related ratios of dark matter effects to ordinary matter effects.

Each of PR6ISe and PR36ISe 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 [10], regarding data regarding the stellar stream GD-1.

1.5.4 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 [11] reports about depletion of CMB (or, cosmic microwave background radiation) by absorption by hydrogen atoms might dovetail with the existence of dark matter isomers of hydrogen atoms or with the existence of doubly dark matter isomers of hydrogen atoms. For the PR6ISe case, dark matter pertains. For the case PR36ISe, doubly dark matter pertains. 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 [38].)

1.5.5 Motion, kinematics conservation laws, QFT, QED, and QCD

This unit summarizes - regarding motion, kinematics conservation laws, QFT (or, quantum field theory), QED (or, quantum electrodynamics), and QCD (or, quantum chromodynamics) - aspects of and relationships between proposed theory, physics data, and ongoing theory.

Ongoing theory has roots in theories of motion. Aspects, to which we allude above, of proposed theory generally do not depend on choosing a specific model regarding translational motion.

Ongoing theory correlates an $SU(2)$ symmetry with conservation of angular momentum and correlates an $SU(2)$ symmetry with conservation of (linear) momentum.

Proposed theory permits adding, to work to which we allude above, ongoing theory symmetries correlating with conservation of angular momentum and conservation of linear momentum. We can add symmetry correlating with conservation of energy. Regarding models that correlate with special relativity, we can add symmetry correlating with boost.

Regarding conservation of angular momentum and conservation of linear momentum, proposed theory permits either of two choices. For one choice, one can add, for each of simple fermions and elementary bosons, two $SU(2)$ symmetries. This choice provides a path toward much ongoing theory QFT, QED, and QCD. For the other choice, one can add one $SU(2)$ symmetry for simple fermions and one $SU(2)$ symmetry for elementary bosons. This proposed theory choice provides an alternative, to ongoing theory means, way for modeling aspects of dynamics within multiparticle systems such as protons. Here, kinematics conservation laws pertain for the proton but do not necessarily pertain for individual components of the proton. Modeling correlating with special relativity can pertain for the proton without pertaining to individual components of the proton. Modeling based on potentials can pertain. Modeling does not necessarily feature elementary bosons or virtual particles.

Mathematics-modeling bases for proposed theory QFT, QED, and QCD are inherent in the mathematics-modeling bases that underlie aspects of proposed theory that emphasize objects and (up to now in this discussion) de-emphasize motion. The bases include aspects that correlate with ongoing theory concepts of fields and particles. The bases include aspects that correlate with interaction vertices that are volume-like with respect to coordinates. The volume-like aspects correlate, for example, with the concept that one can model, for a proton, one quark existing within a potential correlating with the other two quarks. Modeling for a proton suggests that boost symmetry (and some alternatives, including no symmetry) - which might pertain for the proton - correlates with modeling that would (had modeling via potentials not, in effect, replaced modeling via virtual elementary bosons) be related to gluons.

Proposed theory QFT, QED, and QCD offer some advantages and exhibit some possible disadvantages compared to ongoing theory QFT, QED, and QCD. Aspects of proposed QED and QCD may be less complex conceptually and more sound mathematically than similar aspects of ongoing QED and QCD. Proposed QED modeling and proposed QCD modeling do not necessarily involve the concept of virtual particles. Aspects of proposed QED and QCD may be less developed and less capable of producing - without results from observations or from ongoing theory - numerical results than are similar to aspects of ongoing QED and QCD.

We think that proposed QED and QCD and ongoing QED and QCD do not conflict significantly with each other and might provide synergies between each other.

1.5.6 Kinematics and dynamics models

This unit summarizes - regarding kinematics and dynamics models - aspects of and relationships between proposed theory, physics data, and ongoing theory.

Ongoing theory provides choices regarding bases for kinematics and dynamics models. One choice features quantum physics modeling and classical physics modeling. Another choice features Newtonian physics, special relativity, general relativity, and other possible bases.

We think that the set of simple particles and long-range forces that proposed theory suggests is compatible with ongoing theory choices regarding kinematics and dynamics models that we list above, except possibly regarding some modeling that would be based on general relativity. Ongoing theory seems open to the concept that general relativity might not pertain well for some large-scale aspects of nature. (See, for example, reference [28].)

Modeling based on general relativity might not be adequately accurate to the extent that some adequately significant phenomena correlate with one span and other adequately significant phenomena correlate with another span. For example, regarding PR6ISe modeling under circumstances in which the quadrupole attractive component of dark energy forces dominates, a dark matter clump that starts on a trajectory similar to the trajectory of a similar ordinary matter clump would not necessarily follow the trajectory that the ordinary matter clump follows. The isomer of the quadrupole attractive component of dark energy forces that correlates with the ordinary matter clump does not equal the isomer of the quadrupole attractive component of dark energy forces that correlates with the dark matter clump. While all six isomers of PR6ISe-span-one phenomena interact via monopole gravity, each one of the six isomers of PR6ISe-span-one phenomena interacts with itself, but not with other isomers of PR6ISe-span-one phenomena, via the quadrupole and octupole components of dark energy forces. Reference [41] points to a possible difficulty regarding modeling based on general relativity. We suggest that this possible difficulty might correlate with aspects of dark energy forces.

We think that proposed theory is not incompatible with known observations that people correlate with validating general relativity. Opportunities might exist to determine the extent to which proposed theory extends applications of general relativity to some realms for which people have not verified the applicability of general relativity. For example, our dipole component of dark energy forces might correlate with the ongoing theory general relativity concept of rotational frame-dragging.

1.5.7 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 parallel 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 long-range forces. The elementary particles are the tauon and the electron. The forces are electrostatic repulsion between two electrons and 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 2018 data, four 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 via dark energy force dipole repulsion and the coalescing of two black holes that do not interact with each other via dark energy force dipole repulsion.

- Proposed theory suggests resolution regarding the possible mismatch between the elementary particle Standard Model notion that all neutrinos 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. We suggest that spin-four components of long-range 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. We suggest that all neutrinos might have zero rest mass. While this work may prove controversial, we offer the possibility that it resolves an underlying tension regarding ongoing theory.

- Proposed theory QED points to a possibility for modeling lepton anomalous magnetic dipole moments via a sum of just three terms. Each term correlates with a component, for which the spin exceeds one, of long-range forces. This work exemplifies remarks above about relative advantages

of, relative disadvantages of, and possible synergies between proposed theory QED and ongoing theory QED.

- 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 two new non-zero-mass spin-one simple bosons, which would correlate with an $SU(2) \times U(1)$ symmetry similar to the symmetry correlating 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.

- Proposed theory suggests possibilities for a new look at aspects of nuclear physics. Proposed theory that suggests new elementary particles suggests one elementary particle that might correlate with repulsive aspects of the residual strong force and one elementary particle that might correlate with the Yukawa potential (or, attractive component of the residual strong force). Modeling that features these two forces could parallel proposed theory modeling, based on potentials and not based on virtual gluons, for quarks in a hadron. We are uncertain as to the extent to which such modeling might provide a basis for new insight about nuclear physics. We are aware of some concern regarding modeling some aspects of nuclear physics based on the notion of virtual pions. (See reference [3].)

1.6 Evolution of proposed theory

This unit discusses the notion that, as of the year 2018, proposed theory seemed to achieve a stable basis of theory centric assumptions and proposed theory began to offer explanations for an increasing scope of observed natural phenomena that people have, starting in 2017 and continuing thereafter, reported.

In 2011, we decided to try to explain eras pertaining to the rate of expansion of the universe.

For years thereafter, we felt that the scope of major assumptions on which we based proposed theory grew somewhat in parallel to the scope of natural phenomena that the work seemed to explain. During this period, we did not consider the evolution of galaxies.

In 2018, the trajectories of the two scopes seemed to decouple. The scope of major assumptions seemed to stop growing. The scope of seemingly explained natural phenomena continued to grow. Newly explained natural phenomena tend to correlate with astrophysics observations that people reported during and after 2017. The astrophysical observations tend to pertain to galaxies and dark matter.

1.7 Perspective about this essay

This unit discusses some aspects of this essay.

We try to provide perspective regarding theories and models. Aspects of perspective include correlations with data, limits of applicability, opportunities to make improvements, and alternatives. Reference [20] suggests standards regarding such perspective.

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.

2 Elementary particles, field theories, and interaction vertices

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. This unit discusses proposed theory alternatives to ongoing theory quantum field theories.

2.1 A table of elementary particles (or, simple particles and long-range forces)

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

Table 1 catalogs elementary particles that 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 correlates with one value of spin S. Here, S denotes spin, in units of $\hbar$. 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

Table 1: Elementary particles (or, simple particles and long-range forces)

Spin	Σ	$\sigma = +1$ $m > 0$	$\sigma = +1$ $m \doteq 0$	$\sigma = -1$ $m > 0$	$\sigma = -1$ $m \doteq 0$
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 (2)	2U (8)
2	4		4G ((2))		
3	6		6G ((2))		
4	8		8G ((2))		
…	…		…		
10	20		20G ((2))		

$\Sigma\Phi$. 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. For $\sigma = -1$, the particles model as if they occur in confined environments. Examples of confined environments include hadrons and atomic nuclei. For $\sigma = +1$, the particles model as if they can occur in confined environments and can occur outside of confined environments. We use the two-word term free environment to contrast with the two-word term confined environment. The expression $m \doteq 0$ denotes a notion of zerolike mass. Some ongoing theory models do or might correlate $m \doteq 0$ elementary fermions with small positive masses. Some ongoing theory models do or might correlate $m \doteq 0$ elementary fermions with zero masses. The expression $m > 0$ correlates with positive mass. A number (n) denotes a number of elementary particles. A number ((n)) denotes a number of modes. The items 10G, 12G, …, and 20G might provide for only negligible effects or might have no relevance to physics. (See discussion related to equations (109) and (110).) The 0I entry in table 1 correlates with useful aspects of mathematics-based modeling. Nature might include 0I elementary particles.

We use the two-word term simple particle to pertain to each entry in table 1 other than G-family entries. We correlate the two-element term long-range force with each G-family entry in table 1. Modeling for each one of some long-range forces points to components for that force. Particle counts in table 1 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 continue to use the two-word term simple particle. We continue to use the two-element term long-range force. We use the four-word phrase elementary particle Standard Model. Otherwise, we tend to de-emphasize the two-word term elementary particle.

We discuss the simple particles for which $\sigma = +1$ and $m > 0$. 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.

We discuss the simple particles for which $\sigma = +1$ and $m \doteq 0$. The 0I, or so-called aye, particle is a possible zerolike-mass relative of the Higgs boson. 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 the Standard Model, suggest the neutrino masses are zero. Proposed theory suggests the possibility that neutrinos have zero mass. Proposed theory suggests that effects of 8G long-range forces might explain neutrino oscillations and the relevant astrophysics data.

We discuss the long-range forces. The expressions $\sigma = +1$ and $m \doteq 0$ 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. For 4G, ongoing theory suggests classical physics models. The word gravitation can pertain. 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 dark energy forces. In proposed theory, quantum interactions, involving simple fermions, mediated by gravitational aspects of 4G can correlate with fermion generation. In proposed theory, classical interactions with multicomponent 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 6G may interact with baryon number and that 8G may interact with lepton number. Regarding long-range forces, a lack of use of the two-word term simple particles dovetails

Table 2: 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, $@_0$						

with modeling that suggests, in some sense, more than one component for each one of some ΣG.

We discuss the simple particles for which $\sigma = -1$ and $m > 0$. The 0P, or so-called pie, possible particle might correlate with an attractive component of the residual strong force. (See discussion related to equation (96).) The 0P particle might provide an aspect for alternative modeling regarding interactions between hadrons in atomic nuclei. The six 1Q particles are the six quarks. The two 2T, or so-called tweak, possible particles are analogs to the weak interaction bosons. The charge of the one non-zero-charge 2T particle is one-third the charge of the W boson. The non-zero-charge tweak particle may have played a role in the creation of baryon asymmetry.

We discuss the simple particles for which $\sigma = -1$ and $m \doteq 0$. The 0K, or so-called cake, possible particle might correlate with a repulsive component of the residual strong force. (See discussion related to equation (96).) The 0K particle might provide an aspect for alternative modeling regarding interactions between hadrons in atomic nuclei. 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. The eight 2U particles are the eight gluons.

2.2 Theory that develops aspects of the table of simple particles and long-range forces

This unit shows aspects of the framework we develop for physics theories. This unit develops aspects of the table of simple particles and long-range forces.

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 might be that using four oscillators adds no insight. However, using four oscillators leads to a framework for physics theories and, eventually, even 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. 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 (3).) 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 2 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 2 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. Later we discuss PDE modeling. PDE abbreviates the three-word term partial differential equation.

- For ALG modeling, equation (1) pertains. Each of A_{TA}^{ALG} and A_{SA}^{ALG} 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.

$$0 = A^{ALG} = A_{TA}^{ALG} - A_{SA}^{ALG} \tag{1}$$

- The above discussion extends the domain correlating with equation (2) from $n \geq 0$ to $n \geq -1$. Here, a^+ denotes a harmonic oscillator raising operator. Proposed theory includes equation (3). Equations (4) and (5) pertain regarding a lowering operator.

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

$$a^+|-1> = 0|0> \tag{3}$$

$$a^-|n> = n^{1/2}|n-1> \tag{4}$$

$$a^-|0> = 0|-1> \tag{5}$$

- We posit that equations (6) and (7) extend equation (1). Here, the applicable number, n, of excitations satisfies $n \geq 0$.

$$a^+ A_{TA}^{ALG} = a^+ A_{SA}^{ALG} \tag{6}$$

$$a^- A_{TA}^{ALG} = a^- A_{SA}^{ALG} \tag{7}$$

- 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 avoiding 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 $3 \cdot (0 + 1/2)$.

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

Table 3 shows groups to which proposed theory refers and shows representations that correlate with those groups. Aside from the appearance of items using the aspect $n\_ = -1$, 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 except the last 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. 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 $\chi_{(0,0),(-1,-1)}$ denotes two choices. For one choice $n_{TA0} = n_{SA0} = 0$. For the other choice $n_{TA0} = n_{SA0} = -1$. 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 (8) and (9) describe the continuum of possibilities correlating with $\kappa_{0,-1}$. 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 (10) pertains regarding the symbol $\kappa'_{0,0}$. The symbol A0− denotes $\pi_{@_{-1},@_{-1}}$. The symbol A0+ denotes $\pi_{@_0,@_0}$. The symbol $\widehat{A}_{XA}^{ALG}$ denotes the contribution that the relevant oscillators make toward a total A_{XA}^{ALG}. The symbol $\widehat{A}_{(TA0,SA0)}^{ALG}$ denotes the contribution that the TA0-and-SA0 oscillator pair makes toward a total A^{ALG}. The symbol [blank] - in the first row of table 3 - denotes the concept that, in tables such as table 2, one can interpret a blank cell as correlating with $\kappa_{0,-1}$.

Table 3: Groups and representations

O	Groups	$\widehat{A}_{XA}^{ALG} < 0$		$A^{ALG} = 0$		$\widehat{A}_{XA}^{ALG} > 0$	
		Symbol	$\widehat{A}_{XA}^{ALG}$	Symbols	A^{ALG}	Symbol	$\widehat{A}_{XA}^{ALG}$
2	-	A0−	−1	[blank], $\kappa_{0,-1}$	$\widehat{A}_{XA}^{ALG} = 0$	A0+	1
1	$S1G$	χ_{-1}	−1/2	-	-	χ_0	1/2
2	$U(1)$	-	-	$\pi_{0,-1}$	$\widehat{A}_{XA}^{ALG} = 0$	$\pi_{0,@_0}$	1
2	$U(1)$	-	-	$\pi_{@_0,@_{-1}}$	$\widehat{A}_{XA}^{ALG} = 0$	-	-
j	$SU(j), j \geq 2$	$\kappa_{-1,\cdots,-1}$	$-j/2$	-	-	$\kappa_{0,\cdots,0}$	$j/2$
2	$SU(2) \times U(1)$	-	-	-	-	$\kappa'_{0,0}$	1
2	$U(1)$	-	-	$\chi_{(0,0),(-1,-1)}$	$\widehat{A}_{(TA0,SA0)}^{ALG} = 0$	-	-

Table 4: Excitations for a photon

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

$$d|n_{XA1} = 0, \, n_{XA2} = -1 > \; + \; e|n_{XA1} = -1, \, n_{XA2} = 0 > \tag{8}$$

$$|d|^2 + |e|^2 = 1 \tag{9}$$

$$\kappa'_{0,0} = \kappa_{0,0} \times \pi_{0,-1} \tag{10}$$

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

In equation (11), 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 ∦ denotes the four-word phrase does not divide evenly. For some aspects of physics modeling, equation (11) 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.

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

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 2.

Table 4 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 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 modeling associates with the SA0 oscillator? To what extent does $n_{SA0} = -1$ represent modeling correlating with circumstances that nature does not exhibit? One such circumstance might be zero entanglement between an elementary particle and the rest of the universe.

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

Table 5: 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	$n_Z = 0$	$n_{W^-} = 0$, $n_{W^+} = 0$						

Table 6: Ground states for photons and weak interaction bosons

(a) Ground states for photons

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

(b) Ground states 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	$\pi_{@_0,@_{-1}}$	$\kappa_{@_0,@_0}$					
SA	*	*						

Table 5 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. There might be no link between this assignment regarding charge and the assignment of photon circular polarization modes.) Below, we discuss a reason, within the bounds of $A^{ALG} = 0$, for placing $\kappa_{0,0}$ with the SA3-and-SA4 oscillator pair.

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^+ 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^- and the other W boson being a W^+. Ongoing theory results suggest that conservation of fermion generation need not pertain for the relevant quarks. (A transition from the state that table 5 shows to the state characterized by $n_{TA0} = 2$, $n_{SA0} = 0$, $n_{SA1} = 1$, and $n_{SA2} = 1$ would violate equation (6).) Equations (6) and (7) imply that at least one of oscillators TA3 and TA4 participates. Generation correlates with mass. It seems correct to associate the topic of conservation of fermion generation with oscillators TA3 and TA4. 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 3.) We use the four-word term somewhat conservation of generation (or, the five-word term somewhat conservation of fermion generation). We note the possibility that, in appropriate settings, one might be able to detect non-conservation, induced by W-family effects, of lepton generation. Such a setting might need to be adequately conducive to multiple nearby interactions involving W bosons. Here, the word nearby pertains regarding both temporal aspects and spatial aspects.

We discuss an ongoing theory W-family symmetry. Ongoing theory associates $SU(2) \times U(1)$ symmetry with the weak interaction. We associate $SU(2)$ symmetry with the combination $n_{W^-} = 0$, $n_{W^+} = 0$. We associate $U(1)$ symmetry with either or both of two aspects. One aspect features the restrictions that equations (6) and (7) imply. The other aspect features the notion that, for a specific simple fermion, interactions can occur with one but not both of W^- and W^+. Both aspects show parallels to the $U(1)$ symmetry that pertains for photons. For the W-family, the $SU(2)$ and $U(1)$ symmetries combine to form $\kappa'_{0,0}$ (or, $SU(2) \times U(1)$).

All known interactions conserve charge. The expression $\pi_{@_0,@_{-1}}$ pertains and contributes $\widehat{A}^{ALG}_{XA} = 0$. (See table 3.)

Table 6 retrofits conservation of charge into representations for 2G ground states and 2W ground states.

We extend proposed theory to include the Higgs boson.

Table 7 shows excitations for the Higgs (or, 0H) boson. The ground state value $n_{SA0} = 0$ correlates

Table 7: Excitations for the Higgs boson

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

Table 8: States for 0I, 1C, and 1N simple particles

(a) Ground state for 0I bosons

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

(b) States for charged leptons

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

(c) States for neutrinos

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

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.

We note that a number of SA-side oscillators seems to correlate with each of spin and numbers of particles.

For each of 0H, 2W, and 2G, equation (12) 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.

$$N_{SA} = 2S + 1 \tag{12}$$

We extend work above to include all known and suggested simple particles and long-range forces for which $\sigma = +1$. (See table 1.)

Table 8 shows states 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 (12). For fermions (or, for particles for which $2S = 1$), equation (12) pertains, given two assumptions. One assumption is that we do not count the SA3-and-SA4 oscillator pair, which correlates with three generations. One assumption is that each of $n_{SA1} = -1$ and $n_{SA2} = -1$ disables one oscillator and, in effect, leads to the result $N_{SA} = 2$. The simple particle 0I seems not capable of excitation. Under circumstances that we have not discussed, 0I might play roles in some models. For each of charged leptons and neutrinos, the states are either populated or not populated. Each of charged leptons and neutrinos exhibits a TA3-and-TA4 approximate $SU(2)$ symmetry. That symmetry suggests approximate conservation of fermion generation. Each state that table 8 shows comports, via a TA1-and-TA2 entry, with conservation of charge.

We note an aspect regarding W bosons and leptons. (See tables 6b, 8b, and 8c.) SA1-and-SA2 oscillator pairs correlate with allowed interactions between W bosons and leptons. Alignment of $n_{SA\_} = 0$ for the W boson with one of $n_{SA\_} = 0$ and $n_{SA\_} = -1$ correlates with an allowed absorption of charge (from the W boson) by a matter charged lepton. Apparently, either choice between $n_{SA\_} = 0$ and $n_{SA\_} = -1$ can be appropriate, as long as one treats other choices consistently with a first choice. For example, for a choice of $n_{SA\_} = 0$ for a matter charged lepton (such as an electron), the following statements pertain. For matter charged leptons, $n_{SA\_} = -1$ correlates with an ability to shed a unit of charge. For antimatter charged leptons (such as positrons), $n_{SA\_} = -1$ correlates with an ability to add a unit of charge. For antimatter charged leptons, $n_{SA\_} = 0$ correlates with an ability to shed a unit of charge. For neutrinos, parallels to the above four relationships hold to the extent that one follows the instructions that the next four sentences provide. Substitute the word neutrino for the two-word construct charged lepton. Substitute the word antimatter for the word matter. Substitute the word matter for the

Table 9: One possibility for states for 4G, 6G, and 8G long-range forces

(a) States for 4G bosons

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

(b) States for 6G bosons (with $\kappa_{@_0,@_0,@_0,@_0}$ spanning the two items showing the symbol *)

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

(c) States for 8G bosons (with $\kappa_{@_0,@_0,@_0,@_0,@_0,@_0}$ spanning the three items showing the symbol *)

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

Table 10: Another possibility for states for 4G, 6G, and 8G long-range forces

(a) States for 4G bosons

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

(b) States for 6G bosons

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

(c) States for 8G bosons

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

word antimatter. Drop the two parenthetical remarks that begin with the two-word construct such as.

Table 9 shows one possibility for states for 4G, 6G, and 8G long-range forces. Each state comports with equation (12). Here, 4G exhibits a TA3-and-TA4 approximate $SU(2)$ symmetry. That symmetry suggests approximate conservation of fermion generation. Each of 6G and 8G does not exhibit a symmetry that correlates with approximate conservation of fermion generation. For 6G, the symmetry is $SU(4)$. For 8G, the symmetry is $SU(6)$. Each state that table 9 shows comports, via a TA1-and-TA2 entry, with conservation of charge.

Table 10 shows another possibility for states for 4G, 6G, and 8G long-range forces. Each state does not comport with equation (12). Each state does not necessarily correlate with approximate conservation of fermion generation. Each state that table 10 shows comports, via a TA1-and-TA2 entry, with conservation of charge.

Proposed theory emphasizes table 10 and de-emphasizes table 9. The work uses aspects of table 16 in models for components of ΣG bosons. One aspect correlates with approximate conservation of fermion generation.

We extend proposed theory to include simple particles for which $\sigma = -1$ and $m > 0$.

Table 11 posits information regarding simple particles for which $\sigma = -1$ and $m > 0$. Table 11a differs from table 8b with respect to TA1-and-TA2. The expression $\pi_{0,-1}$ replaces $\pi_{@_0,@_{-1}}$. That replacement dovetails with the existence of six matter quarks (and six antimatter quarks), compared with the existence of three matter charged leptons (and three antimatter charged leptons). Interactions between quarks and W bosons parallel interactions between charged leptons and W bosons. The new TA1-and-TA2 entry

(a) States for quarks

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

(b) Ground states for 2T 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	*	*						
SA	0	$\pi_{@_0,@_{-1}}$	$\kappa_{@_0,@_0}$					

(c) Excitations for the 0P boson

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

correlates with conservation of charge for those interactions. People know of such interactions. Ongoing theory comports with the notion that those interactions do not convert antimatter quarks into matter quarks and do not convert matter quarks into antimatter quarks. (Remarks regarding table 21 discuss adding an approximate symmetry that correlates with somewhat conservation of baryon number.) The new TA1-and-TA2 entry allows for interactions with simple bosons that would convert antimatter quarks into matter quarks and would convert matter quarks into antimatter quarks. We posit that the magnitude of the amount of charge transferred is one-third the magnitude of the charge of the W boson. We posit that a charged 2T boson correlates with the transfer of charge. Early in the development of the universe, charged 2T bosons might have catalyzed the formation of baryon asymmetry. Table 11b pertains for 2T bosons. The TA-side information in table 11b parallels the SA-side information in table 6b. The SA-side information in table 11b parallels the TA-side information in table 6b. Regarding quarks, W-family interactions conserve baryon number, interactions with the neutral T-family boson conserve baryon number, and interactions with the charged T-family boson do not conserve baryon number. The SA1-and-SA2 entries for quarks and the SA-1-and-SA2 entry for 2T bosons correlate with conservation of charge for interactions between quarks and T-family bosons. Table 11c pertains to 0P bosons. Table 11c mimics table 7, which pertains for the Higgs boson. Tweak (or, 2T) bosons intermediate interactions that involve quarks. Quarks and 2T bosons can pertain inside hadron-like particles. Pie (or, 0P) bosons intermediate interactions between hadron-like particles. Hadron-like particles and 0P bosons can pertain inside atomic nuclei.

We extend proposed theory to include simple particles for which $\sigma = -1$ and $m \doteq 0$.

Table 12 posits information regarding simple particles for which $\sigma = -1$ and $m \doteq 0$. Table 12a differs from table 11a with respect to TA0 and with respect to SA0. In each case the expression -1 replaces a zero. That replacement dovetails with the notion that so-called arcs (or, 1R particles) have zero charge. Regarding gluons (or, 2U bosons) and cake (or, 0K) bosons, we posit that values of $n_{XA0} = -1$ do not necessarily correlate with no ability to excite. (Regarding gluons, see discussion related to table 42.) These bosons occur, in today's universe, in confined environments. Table 12b pertains for gluons. The statement $n_{SA0} = -1$ echoes the ongoing theory notion that gluons have zero mass. The XA1-and-XA2 entries correlate with no interaction with charge. (Here, XA can be either TA or SA.) The XA3-and-XA4 entries correlate with no interaction with generation or rest mass. The $\kappa_{-1,-1,-1}$ symmetry echoes the ongoing theory notion of $SU(3)$ symmetry for the strong interaction. (See discussion related to table 42.) The choice of TA5-and-TA6 correlates with the notion that SA5-and-SA6 correlates with baryon number. (See table 20.) The SA5-and-SA6 entry correlates with a lack of conservation of color charge. Gluons (or, 2U bosons) intermediate interactions that involve quarks. Quarks and gluons can pertain inside hadron-like particles. Cake (or, 0K) bosons intermediate interactions between hadron-like particles. Hadron-like particles and 0K bosons can pertain inside atomic nuclei.

Results above leave unanswered questions such as the following. Does nature include all the simple particles and long-range forces that table 1 suggests? Does nature include simple particles and long-range forces that table 1 does not suggest? Might further modeling that pertains to 2G dovetail with known details regarding electromagnetism? Might further modeling regarding 4G describe dark energy forces?

Table 12: Simple particles for which $\sigma = -1$ and $m \doteq 0$

(a) States for 1R fermions

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

(b) A representation regarding gluons (with $\kappa_{-1,-1,-1}$ spanning the two items showing the symbol *)

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

(c) A representation regarding the 0K boson

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

Table 13: 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 $SU(2)$

To what extent does our modeling extend to include multicomponent objects? Does our modeling extend to include measured quantities such as energy and momentum?

We address such questions below.

2.3   Kinematics conservation laws

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

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 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 13 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. To some extent, 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. We consider each of these $SU(2)$ symmetries to be one SA-side symmetry.

The following concepts pertain.

- We extend the notion of $\sigma = +1$ to include free-ranging objects other than the $\sigma = +1$ simple particles and long-range forces to which table 1 alludes. The notion of free-ranging correlates with an object having a well-specified definition and modeling, under some circumstances, as if conservation of energy, momentum, and angular momentum pertain for the object.

- Models for the kinematics of objects for which $\sigma = +1$ need to include the possibility that all three conservation laws pertain. The relevance of all three conservation laws correlates with modeling

Table 14: Conservation of energy, momentum, and angular momentum for objects for which $\sigma = +1$

(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						$\kappa_{-1,-1}$	$\kappa_{-1,-1}$

that correlates with the notion of a distinguishable object and with the notion of a free environment. (Objects for which $\sigma = +1$ can exist as components of, let us call them, larger objects for which $\sigma = +1$. 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.)

- Models regarding the kinematics of objects for which $\sigma = -1$ do not necessarily need to embrace all three kinematics conservation laws. (These objects model as existing in the contexts of $\sigma = +1$ larger objects. See, for example, discussion related to table 41.)

- 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. 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. Proposed theory suggests that, for such modeling, for each of the eight added oscillators, $n_{\_} = n_{TA0}$. For such modeling, proposed theory suggests that the TA-side $SU(5)$ symmetry correlates with conservation of energy.

- Table 14 shows representations of kinematics conservation laws for objects for which $\sigma = +1$. 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 (111).) 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).

- Special relativity correlates with boost symmetry, which is 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 not extending the TA-side symmetry from $SU(5)$ to $SU(7)$. Boost correlates with modeling and not with kinematics conservation laws.

- The following modeling can pertain regarding combining two $\sigma = +1$ objects to form a $\sigma = +1$ object.

  - Each of the two original objects contributes two SA-side $SU(2)$ symmetries.
  - The new object embraces two SA-side $SU(2)$ symmetries regarding its internal aspects. The other two original $SU(2)$ symmetries are available regarding the motion 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 $\sigma = -1$ modeling.
  - Similarly, the new object embraces one TA-side $SU(5)$ symmetry regarding its internal aspects. Another $SU(5)$ symmetry is available regarding the motion of the new object.

- The following modeling can pertain regarding combining $\sigma = -1$ simple fermions and $\sigma = -1$ simple bosons to form a $\sigma = +1$ object.
  - For modeling the internals of a hadron (such as a proton), two possibilities exist.
    1. One can model each of individual quarks and individual gluons as correlating with conservation of energy, momentum, and angular momentum. Ongoing theory quantum chromodynamics correlates with this possibility. Modeling includes notions of virtual particles.
    2. One can model each of quarks and the strong interaction as correlating with just one SA-side $SU(2)$ symmetry. (To the extent that modeling for the hadron correlates with boost symmetry, the strong interaction contributes the needed third SA-side $SU(2)$ symmetry.) Modeling that features quarks and potentials pertains. Modeling does not necessarily feature virtual particles.

- The 24-fold symmetry that TA-side $SU(5)$ symmetry suggests might correlate with aspects of simple particles and long-range forces. (Regarding the symmetry, see table 13. Regarding aspects of simple particles and long-range forces, see discussion related to equation (93).)

2.4 Long-range forces, including interactions with baryon number and with lepton number

This unit discusses aspects regarding long-range forces. This unit shows modeling that links free-ranging simple bosons and long-range forces. This unit discusses modeling pertaining to anomalous moments, including anomalous magnetic dipole moments. This unit suggests that some long-range forces interact with baryon number. This unit suggests that some long-range forces interact with lepton number. 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.

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 2. We might also consider an excitation that models 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.

Equation (13) provides notation that we use for such combinations. The symbol ΣG denotes a subfamily of the G-family of solutions to equation (1). 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. The value j correlates with the oscillator pair SA$(j-1)$-and-SAj. (Later, we discuss aspects correlating with the limit $\lambda \leq 8$. For example, see discussion, related to equation (46), about channels. For example, see discussion related to table 16.) For the above example of subtracting spin-1 from spin-2, the notation $\Gamma = 24$ pertains and equation (14) pertains.

$$\Sigma\text{G}\Gamma \tag{13}$$

$$\Sigma = |-2+4| \tag{14}$$

Table 15 points to possibly relevant solutions. The label monopole correlates with one solution per item. The label dipole correlates with two solutions per item. The label quadrupole correlates with four mathematical solutions per item. 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. For example, the solution 0G246, which correlates with $|-2-4+6|$, is not relevant to G-family physics. The label octupole correlates with eight mathematical solutions per item. The solution 0G2468 is not relevant to G-family physics. The table notes a conceptually possible 0G$\emptyset$ solution. The symbol $\emptyset$ denotes the empty set.

Above, the terms monopole through octupole correlate with numbers of solutions and not necessarily 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

Table 15: G-family solutions that may be relevant

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

Table 16: 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
0GØ	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	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$	$\pi_{0,@_0}$

abbreviates the five-word term radial spatial dependence of force. Here, we de-emphasize angular aspects of forces.

Table 16 shows representations for the G-family solutions that table 15 lists. The solutions correlate with symmetries pertaining to ground states. Excitations for a ΣGΓ solution comport with the type of ΣG excitations to which table 10 alludes for the cases of Σ being four, six, or eight. In table 16, 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 $SU(3)$). The symbol A0+ correlates with an oscillator pair for which, for each of the two oscillators, the symbol $@_0$ pertains. The column regarding span pertains regarding aspects of dark matter. (See table 38.) Regarding each $\Sigma > 0$ solution that the table shows, the radial behavior of the potential is $r^{n_{SA0}}$. The RSDF is $r^{n_{SA0}-1}$.

Regarding elementary particle physics, we posit that the series 2G2, 4G4, ... ends with 8G8.

We note two notions that might correlate with that limit. Each notion correlates with components of Γ.

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 two similar, neighboring, non-overlapping, somewhat spherically symmetric objects. A ΣG2468⟦10⟧ force would scale like $(v^3\rho)^2/(vr)^6$, in which v 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 $v = 1$, and r is the distance between the centers of the objects. The factor v^3 provides for scaling for an object that has three spatial dimensions. The force would be independent of v. 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 table 16, 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 (11) pertain. We de-emphasize the notion that 16G⟦16⟧ might

Table 17: $\Sigma\gamma$ 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

Table 18: Interpretations regarding some aspects of G-family solutions

Aspect	Interpretation
$\Gamma = 2$	Charge
$\Gamma = 24$	Magnetic dipole moment
$\Gamma = 246$	Quadrupole distribution with respect to $4 \in \Gamma$
$8 \in \Gamma$	Rotation

be relevant to physics. The solution 16G⟦16⟧ would correlate with TA-side $SU(17)$ symmetry.

We do not know of a reason for proposing that the series 2GΓ, 4GΓ, ... ends with 8GΓ. We do not de-emphasize solutions ΣGΓ for which $10 \leq \Sigma \leq 20$.

Table 17 lists G-family solutions ΣGΓ for which 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 (15).) We use the symbol $\gamma\lambda$ to refer to the set of G-family solutions ΣGΓ for which $\lambda \neq \Sigma$ and λ appears in the list Γ. (See equation (16).)

$$\Sigma\gamma = \{\Sigma G\Gamma | \Sigma \in \Gamma\} \tag{15}$$

$$\gamma\lambda = \{\Sigma G\Gamma | \lambda \neq \Sigma, \lambda \in \Gamma\} \tag{16}$$

Table 18 discusses aspects of table 17. Here, we use wording that dovetails with classical physics (and not necessarily with quantum physics). Here, we use wording that dovetails with Newtonian modeling.

The following statements pertain regarding at least 2G and 4G. Solution 2G2 correlates with a monopole interaction with charge. Solution 2G24 correlates with a dipole interaction with magnetic dipole moment. Solution 2G248 correlates with a quadrupole interaction with an object for which a non-zero magnetic dipole moment pertains, an axis of rotation pertains, and the axis of rotation does not match the axis correlating with the magnetic dipole moment. 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. Solution 4G4 correlates with a monopole interaction with non-rotational aspects of spherically symmetric mass (or of spherically symmetric rest energy). Solution 4G48 correlates with a dipole interaction with rotating spherically symmetric mass. Solution 4G246 correlates with a quadrupole interaction with non-rotational aspects of a distribution of mass for which the maximum moment of inertia does not equal the minimum moment of inertia. 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 of 4G2468a and 4G2468b interacts with rotational aspects of quadrupole distributions of mass based on an axis of minimal moment of inertia.

Regarding possible G-family interactions with simple particles, we combine aspects of equation (11), table 13, and table 16. We posit that TA-side aspects of table 13 and table 16 combine. For example, for 8G8, a TA-side $SU(11)$ symmetry would pertain. (In table 13, seven TA-side oscillators pertain. In table 16, five TA-side oscillators pertain. The tables share their respective $n_{TA0} = 0$ value. Seven plus five minus one is 11.) We posit that a combined symmetry of either $SU(9)$ or $SU(11)$ correlates with possible interactions with multicomponent objects and with no interactions with simple particles. For example, 2G68 can interact with an atom but not with an isolated electron. (We correlate 2G68 with at least the 21-centimeter hyperfine interaction with hydrogen atoms. See discussion related to equation (91).) Each item that appears in table 16 and has a TA-side symmetry of $SU(5)$ or $SU(7)$ does not interact with simple particles. Each item that appears in table 16 and has a TA-side symmetry of None or $SU(3)$ can interact with simple particles.

Table 19: Possible correlations between 0G solutions and simple bosons not belonging to the G-family of long-range 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

Table 19 posits correlations between simple bosons and the $\Sigma = 0$ solutions that correlate with table 16. 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 (80).) To the extent that table 19 pertains, G-family solutions point to all $\sigma = +1$ simple bosons and long-range 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 16 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.

We posit that $\gamma \lambda$ items that appear in table 16 and have a TA-side symmetry listing (in table 16) that is not $SU(5)$ and is not $SU(7)$ correlate with the concept of anomalous moments for simple particles. (Regarding the notation $\gamma \lambda$, see equation (16).) For example, each one of solutions 4G26, 6G24, and 8G26 belongs to $\gamma 2$ and correlates with anomalous magnetic dipole moment. The ongoing theory Standard models 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 symbol α denotes the fine structure constant. (See equation (53).) The second term is proportional to α^2. The third term is proportional to α^3. Solution 4G26 might correlate with the $\alpha/(2\pi)$ term that ongoing theory provides for charged leptons. Solution 6G24 features $4 \in \Gamma$ and varies with charged lepton generation. Solution 6G24 might correlate with a term that is proportional to $\alpha^2/(2\pi)$. (See equation (63), equation (64), and discussion regarding table 35. Note the result $\alpha^2/(2\pi) \approx 8.48 \times 10^{-6}$.) Solution 8G26 might correlate with a term proportional to $\alpha^3/(2\pi)$. Generally, $\Sigma G2\_$ might contribute a term proportional to $\alpha^{(\Sigma-2)/2}$. Each anomalous dipole moment term correlates with the two values of λ that Γ includes. Each anomalous moment term correlates with an anomalous moment with respect to each of the two aspects that correlates with a ΣG for which $\Sigma \in \Gamma$.

We explore the topic of object properties that correlate with 6G and 8G.

Equation (17) provides ongoing theory limits for the sum, across three generations, of neutrino masses. (See reference [50]. Reference [37] provides the lowest of the upper limits that reference [50] lists.) Equation (17) comes from interpretations of astrophysics data. Equation (17) contrasts with the ongoing theory elementary particle Standard Model, which suggests that each one of the three neutrinos has zero mass.

$$0.06 \text{eV}/c^2 \lesssim \sum_{j=1}^{3} m_j \lesssim 0.12 \text{eV}/c^2 \tag{17}$$

We explore two 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. We assume that modeling correlating with table 10 pertains. Aspects of table 16 suggest the following. Each one of 4G4, 4G26, and 4G268 correlates with TA-side $SU(3)$ symmetry. The $SU(3)$ symmetry correlates with approximate conservation of fermion generation. Interactions correlating with 4G4, 4G26, or 4G268 do not catalyze neutrino oscillations. The solution 4G48 correlates with TA-side $SU(5)$ symmetry. Simple particles do not interact directly with 4G48 long-range forces. Interactions correlating with 4G48 do not catalyze neutrino oscillations. Solution 4G2468a and 4G2468b correlate with no TA-side symmetry. Interactions correlating with 4G2468a and 4G2468b might catalyze neutrino oscillations.

Second, we assume a proposed theory notion that $n_{SA0} = -1$ correlates with zero rest energy. Modeling that does not include kinematics suggests that neutrinos do not interact with 4γ. Modeling suggests that interactions between neutrinos and 4γ do not produce neutrino oscillations. Modeling suggests that interactions between neutrinos and 4G do not produce astrophysical effects that ongoing theory correlates with a non-zero sum of neutrino masses.

Independent of assumptions about modeling, equation (18) pertains. Here, the factor of three might correlate with the range $1 \leq j \leq 3$ in equation (17). Equation (18) may reflect equation (17) and a notion

Table 20: Interpretations regarding some aspects of G-family solutions

Aspect	Interpretation
6G	Interacts with baryon number
6G468	Interacts with individual quarks or with baryons
8G	Interacts with lepton number
8G2468a and 8G2468b	Interact with individual neutrinos
8G2468a and 8G2468b	Catalyze neutrino oscillations
8G2468a and 8G2468b	Catalyze effects that people interpret as implying at least one non-zero neutrino mass

that some interaction strengths scale in proportion to $\alpha^{\Sigma/2}$. The factor α^2 in equation (18) correlates with α^4/α^2.

$$3\alpha^2 m_e \approx 0.0816 eV/c^2 \tag{18}$$

Table 20 posits modeling that reconciles discussion above, equation (17), and equation (18). Table 20 extends table 18. The notion that positive numbers appear in equation (17) might suggest that, for interactions between two left-handed simple bosons, the combination of 8G2468a and 8G2468b is attractive.

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 two conceptual mapping steps. First, in the context of proposed theory, modeling for 8G octupole forces maps to modeling for 4G octupole dark energy forces. Relevant ongoing theory modeling does not necessarily correlate with proposed theory 4G dark energy forces. Second, in the context of proposed theory, modeling for 4G octupole forces 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 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 (19) describes results based just on the component that correlates with proposed theory 4G4 effects. Equation (20) assumes that ϵ correlates with one standard deviation regarding the mass of an electron. (Reference [50] provides the data that we use for these calculations.) The lepton number for an electron equals the lepton number for a matter neutrino. Equation (21) correlates with results based just on the component that correlates with proposed theory 8G effects. The result that equation (21) shows is less than the result that equation (20) shows. In this context of ongoing theory, the interaction, between two electrons, based on lepton number is not incompatible with measurements of electron masses.

$$G_N(m_e(1+\epsilon))^2/r^2 \approx G_N(m_e)^2(1+2\epsilon)/r^2 \tag{19}$$

$$|\epsilon| \approx 1.2 \times 10^{-8} \tag{20}$$

$$(\alpha^2)^2 \approx 2.8 \times 10^{-9} \tag{21}$$

Proposed theory suggests that, for Newtonian modeling, the strength of interactions with lepton number scales as r^{-5}. This 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 forces.

2.5 Conservation of lepton number minus baryon number

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

We show representations that correlate with somewhat conservation laws regarding baryon number and lepton number.

Equation 22 shows a conserved quantity. Here, L denotes lepton number and B denotes 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 $B = -1/3$.

$$L - B \tag{22}$$

Table 21: Changes, to representations, to reflect approximate conservation laws regarding baryon number and lepton number

(a) Changes regarding simple bosons having non-zero charge and regarding simple fermions (with $\pi_{(0,-1),(-1,0)}$ spanning the two items showing the symbol *)

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

(b) Changes regarding other simple particles

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

Table 22: Ground state for T-family bosons

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

Each of equation (77) and equation (79) shows an interaction that does not conserve L and does not conserve B.

Table 21 shows changes, to representations, to reflect approximate conservation laws regarding baryon number and lepton number. Tables such as table 6 provide the baselines to which the changes that table 21 shows pertain. In table 21, XA5-and-XA6 items pertain to baryon number. XA7-and-XA8 items pertain to lepton number. The SA-side information in table 21a correlates with the notion that interactions do not necessarily conserve baryon number. The TA-side information in table 21a correlates with conservation of $L - B$. Table 21b reflects the notion that interactions conserve each of L and B. Each change that table 21 shows satisfies $\widehat{A}_{XA}^{ALG} = 0$. (Compare with table 3.) Regarding gluons (or, 2U simple bosons), information in table 21b pertains independently from information that table 12b shows.

We discuss T-family excitations.

Table 22 posits a ground state for T-family bosons. (Compare with table 5.) The magnitude of the charges of the $\mathrm{T}^{\pm}$ boson is one-third the magnitude of the charge of an electron. (See remarks regarding table 11.)

To describe n excitations of the same state of one of the bosons, we use $n_{SA0} = n = n_{TA\_}$, with TA_ correlating with the one boson. Other types of multiple excitations can pertain. We consider three excitations, each to a different state, of one of T^- and T^+. The states might differ by spin-orientation. (The states might differ by momentum. However, so far, we have de-emphasized discussing translational motion.) Modeling for the interaction might correlate with exciting, by one unit each one three SA-side oscillators. The three oscillators are the SA0 oscillator, one of the two SA5-and-SA6 oscillators, and one of the two SA7-and-SA8 oscillators. (See table 21a.) Baryon number increases or decreases by three. Lepton number increases or decreases respectively by one. Conservation of lepton number minus baryon number pertains.

This work might extend to the following concepts. For objects for which $\sigma = +1$, the minimum magnitudes of some non-zero quantities are $|q_e|$ for charge, one for lepton number, and one for baryon number. (Here, we consider that a proton or other hadron with no more than three quarks correlates with $\sigma = +1$.) For objects for which $\sigma = -1$, the minimum magnitudes of some non-zero quantities are $|q_e|/3$ for charge and one-third for baryon number. (Non-zero lepton number pertains only to objects for which $\sigma = +1$.) Each of the quantities charge, lepton number, and baryon number is additive with respect to components of a multicomponent object.

2.6 A table of subfamilies of simple particles and long-range forces

This unit recaps subfamilies of simple particles and long-range forces.

Table 23 alludes to all, but does not directly show some, ALG solutions that proposed theory suggests have physics-relevance regarding simple particles and long-range forces. (See table 1 and discussion that

(a) Spin-zero simple bosons

$\Sigma\Phi$	σ	TA 5, 6	TA 3, 4	TA 1, 2	TA 0	SA 0	SA 1, 2	SA 3, 4	SA 5, 6
0H	$+1$			$\pi_{@_0,@_{-1}}$	0	0	$\pi_{@_0,@_{-1}}$		
(0P)	-1			$\pi_{@_0,@_{-1}}$	0	0	$\pi_{@_0,@_{-1}}$		
0I	$+1$			$\pi_{@_0,@_{-1}}$	-1	-1	$\pi_{@_0,@_{-1}}$		
(0K)	-1			$\pi_{@_0,@_{-1}}$	-1	-1	$\pi_{@_0,@_{-1}}$		

(b) Simple fermions and spin-one simple bosons (with $^{\dagger}U_{TA}$ denoting $\kappa_{-1,-1,-1}$, $^{\dagger}W_{SA}$ denoting $\pi_{0,@_0,@_0}$, and $^{\dagger}T_{TA}$ denoting $\pi_{0,@_0,@_0}$)

$\Sigma\Phi$	σ	TA 5, 6	TA 3, 4	TA 1, 2	TA 0	SA 0	SA 1, 2	SA 3, 4	SA 5, 6
1N	$+1$		$\kappa_{@_{-1},@_{-1}}$	$\pi_{@_0,@_{-1}}$	-1	-1	$\pi_{0,-1}$	$\kappa_{-1,-1}$	
1C	$+1$		$\kappa_{@_0,@_0}$	$\pi_{@_0,@_{-1}}$	0	0	$\pi_{0,-1}$	$\kappa_{0,0}$	
1R	-1		$\kappa_{-1,-1}$	$\pi_{0,-1}$	-1	-1	$\pi_{0,-1}$	$\kappa_{@_{-1},@_{-1}}$	
1Q	-1		$\kappa_{@_0,@_0}$	$\pi_{0,-1}$	0	0	$\pi_{0,-1}$	$\kappa_{0,0}$	
2U	-1	$^{\dagger}U_{TA}$	$\kappa_{@_{-1},@_{-1}}$	$\pi_{@_0,@_{-1}}$	$^{\dagger}U_{TA}$	-1	$\pi_{@_0,@_{-1}}$	$\kappa_{@_{-1},@_{-1}}$	$\kappa_{@_{-1},@_{-1}}$
2W	$+1$		$\kappa_{@_0,@_0}$	$\pi_{@_0,@_{-1}}$	0	$^{\dagger}W_{SA}$	$^{\dagger}W_{SA}$		
2T	-1			$^{\dagger}T_{TA}$	$^{\dagger}T_{TA}$	0	$\pi_{@_0,@_{-1}}$	$\kappa_{@_0,@_0}$	

(c) Long-range forces

$\Sigma\Phi$	σ	TA 5, 6	TA 3, 4	TA 1, 2	TA 0	SA 0	SA 1, 2	SA 3, 4	$\cdots$
2G	$+1$			$\pi_{@_0,@_{-1}}$	0	-1	$\pi_{0,@_0}$		
4G	$+1$			$\pi_{@_0,@_{-1}}$	0	-1		$\pi_{0,@_0}$	
$\cdots$G	$+1$			$\pi_{@_0,@_{-1}}$	0	-1			$\cdots$

follows table 1.) Table 23 shows ground states. The table does not show information pertaining to approximate conservation of lepton number or to approximate conservation of baryon number. (See table 21.) Table 23a shows spin-zero simple bosons. Conservation of charge pertains for each spin-zero simple boson. Each one of the 0H and 0I bosons does not interact with multicomponent objects. Each one of the 0P and 0K bosons does not necessarily interact with individual simple particles. Table 23b shows simple fermions and spin-one simple bosons. The table shows information regarding charge, generation, and color charge. Conservation of charge pertains throughout the table. Table 23c shows information about long-range forces. Conservation of charge pertains throughout the table. Some components of some long-range forces do not interact with individual simple particles. Approximate conservation of generation pertains for some components of some long-range forces.

2.7 Bases for field theories

This unit discusses harmonic oscillator mathematics that can underlie field theories. This unit previews the notion that the mathematics underlies modeling that correlates with known and suggested simple particles and with known and suggested long-range forces.

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 r^2. Here, r denotes a radial spatial coordinate. (See equations (24) and (25).) The r^{-2} operator 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 aspects correlating with the square of a gravitational potential. The r^{-2} operator might model aspects correlating with each long-range force ΣG. (See table 10.) The r^2 operator in equation (24) might model aspects correlating with the square of a strong interaction potential. Ongoing theory includes the concept of asymptotic freedom. The potential correlates with r^1. The force correlates with r^0.

Above, we find that ALG modeling related to the G-family might point to results about $\sigma = +1$ simple bosons that are not G-family bosons. Here, we explore the notion that PDE modeling might point

to results pertaining to other than the G-family and the 2U subfamily. For example, operator aspects that correlate with r^0 might correlate with aspects of the weak interaction.

Proposed theory includes modeling based on an analog, equation (23), to equation (1). Each of A_{TA}^{PDE} and A_{SA}^{PDE} is a quantum operator.

$$0 = A^{PDE} = A_{TA}^{PDE} - A_{SA}^{PDE} \tag{23}$$

The following perspective pertains.

Equations (24) and (25) 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. (For an example of a physics centric use of the symbol ξ_{SA}', see discussion related to equation (95).) 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, in anticipation that the symbols used correlate with spatial aspects of physics modeling and in anticipation that TA-side symbols and mathematics pertain for some modeling.

$$\xi_{SA}\Psi(r) = (\xi_{SA}'/2)(-(\eta_{SA})^2\nabla_r{}^2 + (\eta_{SA})^{-2}r^2)\Psi(r) \tag{24}$$

$$\nabla_r{}^2 = r^{-(D-1)}(\partial/\partial r)(r^{D-1})(\partial/\partial r) - \Omega_{SA}r^{-2} \tag{25}$$

Including for $D = 1$, each of equation (24), equation (25), and the function Ψ pertains for the domain that equation (26) shows. (We de-emphasize exploration of possible solutions for $D \leq 0$.)

$$0 < r < \infty \tag{26}$$

We consider solutions of the form that equation (27) shows. (For $\nu_{SA} \geq 0$, this work can pertain for the domain $0 \leq r < \infty$. For $\nu_{SA} < 0$, this work pertains for the domain that equation (26) defines.)

$$\Psi(r) \propto (r/\eta_{SA})^{\nu_{SA}}\exp(-r^2/(2(\eta_{SA})^2)), \text{ with } (\eta_{SA})^2 > 0 \tag{27}$$

Equations (28) and (29) characterize solutions. The parameter η_{SA} does not appear in these equations. Equation (30) 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 (31) shows pertains. Here, x^2 correlates with r^2 and 4ϵ correlates with $(\eta_{SA})^2$. Reference [58] provides equation (31). The difference in domains, between $-\infty < x < \infty$ and equation (26), is not material here.)

$$\xi_{SA} = (D + 2\nu_{SA})(\xi_{SA}'/2) \tag{28}$$

$$\Omega_{SA} = \nu_{SA}(\nu_{SA} + D - 2) \tag{29}$$

$$D + 2\nu_{SA} \geq 0 \tag{30}$$

$$\delta(x) = \lim_{\epsilon \to 0^+}(1/(2\sqrt{\pi\epsilon}))e^{-x^2/(4\epsilon)} \tag{31}$$

Some applications feature the numbers of dimensions that equations (32) and (33) show. Equation (32) correlates with the notion of three spatial dimensions. Equation (33) correlates with the notion of one temporal dimension.

$$D_{SA}^* = 3 \tag{32}$$

$$D_{TA}^* = 1 \tag{33}$$

We anticipate using equations (34) and (35). Here, each of $2S$ and $2S'$ is a nonnegative integer. The case that features equation (34), $\sigma = +1$, and $S = \nu_{SA}$ is a restating of equation (29). The case

Table 24: 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}

that features equation (34) and $\sigma = -1$ correlates with some aspects of proposed theory modeling. (See discussion related to equation (36).) Similar concepts pertain regarding equation (35) and σ'.

$$\Omega_{SA} = \sigma S(S + D^*_{SA} - 2) = \sigma S(S + 1), \text{ for } \sigma = \pm 1 \tag{34}$$

$$\Omega_{TA} = \sigma' S'(S' + D^*_{TA} - 2) = \sigma' S'(S' - 1), \text{ for } \sigma' = \pm 1 \tag{35}$$

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 (34) - to equation (29), $D \neq D^*_{SA}$.

- 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, $D \neq D^*_{TA}$.

Some applications feature a notion of $D'' = 2$. For these cases, we, in effect, separate some PDE aspects into PDE aspects correlating with oscillator pairs. Examples of such oscillator pairs include the TA0-and-SA0 oscillator pair and the SA1-and-SA2 oscillator pair.

- For some cases correlating with $D^*_{TA} = 1$ and $D^*_{SA} = 3$, $D'' = 2$ pertains for each of the TA0-and-SA0 oscillator pair and the SA1-and-SA2 oscillator pair.

- Solutions for which $\nu_{TA0,SA0} = \nu_{SA1,SA2} = -1$ can correlate with notions of particles for simple bosons.

Table 24 provides details leading to equations (28) and (29). We consider equations (24), (25), and (27). 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 right-most term in equation (24). The term V_{-2} correlates with the right-most term in equation (25). The four $K_{\_}$ terms correlate with the other term in equation (25). The sum of the two $K_{0\_}$ terms correlates with the factor $D + 2\nu_{SA}$ in equation (28).

We discuss PDE modeling that correlates with the notions that Ω_{TA} is nonpositive, $\sigma' = -1$, Ω_{SA} is nonpositive, and $\sigma = -1$.

Proposed theory includes PDE modeling for which equation (36) pertains regarding the TA0-and-SA0 oscillator pair. (See, for example, equation (96).) These applications correlate with the notion that, for equation (23) and appropriate assumptions, one can move, in equation (23), the originally nonnegative Ω_{TA}/t^2 term from correlating with A^{PDE}_{TA} to become a nonpositive Ω_{SA}/r^2 term correlating with A^{PDE}_{SA} and one can move the originally nonnegative Ω_{SA}/r^2 term from correlating with A^{PDE}_{SA} to become a nonpositive Ω_{TA}/t^2 term correlating with A^{PDE}_{TA}. After the moves, Ω_{TA} is nonpositive, $\sigma' = -1$, Ω_{SA} is nonpositive, and $\sigma = -1$. The assumptions include equation (37). Equation (38) defines v_c.

$$t^2/(2(\eta_{TA})^2) + r^2/(2(\eta_{SA})^2) = tr/(|\eta_{TA}| \cdot |\eta_{SA}|) \tag{36}$$

$$t/(|\eta_{TA}|) = r/(|\eta_{SA}|) \tag{37}$$

$$v_c = |\eta_{SA}|/|\eta_{TA}| \tag{38}$$

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 $\hbar^2$. The choice between $\sigma = +1$ and $\sigma = -1$ allows for modeling each one of electrostatic repulsion and electrostatic attraction.

We contrast aspects and uses of QFTs (or, quantum field theories). Ongoing theory QFT features modeling that is linear in energy. Models explain or predict energies that systems exhibit. Proposed theory QFT features modeling that is quadratic in energy. Models explain or predict states or objects that nature embraces. Proposed theory QFT includes so-called branch points. Each branch point points to aspects of ongoing QFT. Each branch point might point to a path from proposed QFT to details of ongoing QFT.

2.8 Interaction vertices

This unit catalogs interaction vertices for interactions that involve only simple particles and long-range forces.

The following remarks pertain regarding interaction vertices that model interactions that involve simple particles and long-range forces. These remarks extend discussion related to equation (34).

Table 25 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 long-range 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 $\nu\_$. (Technically, here we might need to assume that $\nu\_$ for each of gluons and long-range forces is the same as $\nu\_$ for weak interaction bosons.) We note that, in effect, the value of effective ν correlates with aspects of a product of solutions of the form that equation (27) shows. Ongoing theory includes (and table 25 mentions examples of) 1f0b↔1f1b and 0f1b↔0f2b interactions. Proposed theory can embrace ongoing theory 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, $\sigma = +1$ simple boson that proposed theory suggests that nature might embrace. See table 1.) Proposed theory can embrace ongoing theory 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. Table 25 shows an example of a 1f1b↔3f0b interaction that might help catalyze baryon asymmetry. Here, the 1C particle can be a positron. The $1Q^{-2/3}$ particle can be an anti-up quark. The $1Q^{+2/3}$ particle can be an up quark. The 1R particle can be one of three similar simple fermions that proposed theory predicts. The 2T particle is a simple boson that proposed theory predicts. (See discussion related to equation (77).) Here, the superscripts correlate with charge, in units of $|q_e|$ (or, in units of the magnitude of the charge of an electron). Here, each of the three 3f fermions differs from the other two 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.)

Table 25: Interaction vertices for interactions involving only simple particles and long-range forces

Interaction	Effective 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^+ boson produce a neutrino.
1f1b↔3f0b	$-3/2$	$1C^{+1} + 1R^0 + 1Q^{-2/3} \rightarrow 1Q^{+2/3} + 2T^{-1/3}$.
0fnb↔0fnb, for n≥2	$-n$	A Higgs boson creates two photons.

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 calculations of anomalous magnetic dipole moments. The boson is a photon. Some aspects of proposed theory do not necessarily include the notion of virtual particles and do not necessarily include such a sequence.

Proposed theory also points, for the weak interaction, to modeling that does not necessarily require the notion of virtual particles. Equation (39) shows an ongoing theory 1f1b↔1f1b vertex. A muon transforms into a matter neutrino and a W boson. Equation (40) shows an ongoing theory 1f1b↔1f1b vertex. The W boson transforms into an electron and an antimatter neutrino. Proposed theory can embrace the 1f1b↔3f0b vertex that equation (41) shows. Here, the 0B boson might be, for example, a 0I boson. Equation (41) does not show a virtual particle such as a W boson.

$$\mu^- \rightarrow \nu + W^- \tag{39}$$

$$W^- \rightarrow e^- + \bar{\nu} \tag{40}$$

$$\mu^- + 0B \rightarrow \nu + e^- + \bar{\nu} \tag{41}$$

For proposed theory modeling of interactions that involve simple particles and long-range forces in free environments, the PDE notion of the mathematical limit expression $(\eta_{SA})^2 \rightarrow 0$ pertains. (See discussion related to equation (31).) Here, $(\eta_{TA})^2 \rightarrow 0$ 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 long-range forces in confined environments, the PDE notion of $(\eta_{SA})^2 > 0$ can pertain. (See discussion related to equation (36).) The expression that equation (42) 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.

$$|\eta_{SA}| \tag{42}$$

2.9 Aspects regarding simple particles

This unit discusses roles that PDE modeling plays regarding pointing to and describing simple particles other than gluons.

The following remarks illustrate roles, leading to table 1, for PDE modeling. The remarks support the notion that PDE modeling might output solutions that correlate with all simple particles other than U-family simple bosons. The remarks show aspects of using PDE notions regarding field solutions and particle solutions. (See remarks related to equation (27) and solutions for which ν_{SA} is one of $-1/2$, -1, and $-3/2$.)

Table 26 summarizes some simple-boson-centric PDE results for field centric solutions. Each solution correlates with $\nu_{SA} = -1$ and with a positive integer D. We feature solutions to equations (28) and (29). While D need not equal three, each Ω_{SA} comports with $D^*_{SA} = 3$ and with the requirement that $\Omega_{SA} = \sigma S(S + 1)$. For each item that the table lists in the column labeled $\Sigma\Phi$, the number of possible

Table 26: Relationships between some PDE parameters for ΣW, ΣH, ΣI, ΣP, ΣK, and ΣT solutions

D_{SA}^*	ν_{SA}	$D_{SA}^* + 2\nu_{SA}$	D	S	Ω	σ	D	$D + 2\nu_{SA}$	$2S+1$	$\Sigma\Phi$
3	-1	1	$3-\Omega$	1	2	$+1$	1	-1	3	2W
3	-1	1	$3-\Omega$	0	0	$+1$	3	1	1	0H, 0I
3	-1	1	$3-\Omega$	0	0	-1	3	1	1	0P, 0K
3	-1	1	$3-\Omega$	1	-2	-1	5	3	3	2T

Table 27: Fermion-centric PDE solutions

D_{SA}^*	ν_{SA}	$D_{SA}^* + 2\nu_{SA}$	D	S	Ω	σ	D	$D + 2\nu_{SA}$	$2S+1$	$\Sigma\Phi$
3	$-1/2$	2	$(5-4\Omega)/2$	$1/2$	$3/4$	$+1$	1	0	2	1C, 1N
3	$-3/2$	0	$(21-4\Omega)/6$	$1/2$	$3/4$	$+1$	3	0	2	1C, 1N
3	$-1/2$	2	$(5-4\Omega)/2$	$1/2$	$-3/4$	-1	4	3	2	1Q, 1R
3	$-3/2$	0	$(21-4\Omega)/6$	$1/2$	$-3/4$	-1	4	1	2	1Q, 1R

particles, including antiparticles, equals $2S + 1$. For example, 2W correlates, by this count, with three particles - the Z, W$^+$, and W$^-$ particles. We limit solutions for which $\sigma = +1$ to solutions for which $S \leq 1$. Any solutions for which $\sigma = +1$ and $S \geq 2$ would feature D not being a positive integer. Each one of 2U solutions and ΣG solutions correlates with terms in the operators in equations (24) and (25) and does not appear in table 26.

Table 27 summarizes simple-fermion-centric PDE solutions. Per discussion related to equation (29), $\nu_{SA} = -1/2$ correlates with fields and $\nu_{SA} = -3/2$ correlates with particles. For each item that table 27 lists in the column labeled ΣΦ, one of the following two sentences pertains. For $\sigma = +1$, $2S + 1$ equals the number of simple particles (including antiparticles) per generation. For $\sigma = -1$, $2S + 1$ equals half of the number of simple particles (including antiparticles) per generation.

We discuss the extent to which proposed theory should embrace $\sigma = -1$ solutions that tables 26 and 27 do not show.

PDE $\sigma = -1$ boson-centric solutions exist mathematically for each even integer Σ that exceeds two. Such solutions might correlate with simple particles. PDE $\sigma = -1$ fermion-centric solutions exist mathematically for each odd integer Σ that exceeds two. Pairs of such odd integer Σ solutions might correlate with simple particles.

We note two cases related to data. For one case, models pertain to hadron-like particles or to atomic nuclei. For the other case, models pertain to other confined environments. One example of another confined environment might be a neutron star. We know of no phenomena that seem to require modeling that includes solutions for which $\sigma = -1$ and $\Sigma \geq 3$. We de-emphasize solutions for which $\sigma = -1$ and $\Sigma \geq 3$.

2.10 Masses of the weak interaction bosons, the Higgs boson, and the 0I boson

This unit shows modeling that links the masses of the weak interaction bosons, the Higgs boson, and the 0I boson.

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

Table 28 shows rest energies for the known non-zero-mass simple bosons. (See reference [50].)

We discuss approximate ratios for the squares of masses of the Higgs, Z, and W bosons. The most accurately known of the three masses is the mass of the Z boson. Based on the ratios (of squares of masses) that equation (43) shows, the possibly least accurately suggested mass is that of the W boson. Equation (43) correlates with a number that is within four standard deviations of the nominal mass of

Table 28: Rest energies for known non-zero-mass simple bosons

Φ	S	σ	Symbol	Name	Experimental mc^2 (GeV)	N	Calculated mc^2 (GeV)	Difference (standard deviations)
W	1	$+1$	2W1, 2W2	W	80.379 ± 0.012	7	80.042	≈ 3.4
W	1	$+1$	2W0	Z	91.1876 ± 0.0021	9	91.1876	-
H	0	$+1$	0H0	H^0	125.18 ± 0.16	17	125.33	≈ 1.0

Table 29: 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

the W boson. (See table 28.) Proposed theory correlates the numbers in equation (43) 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 29.) Equation (44) shows the size of one unit. The related mass is $30.396 \text{GeV}/c^2$.

$$(m_{H^0})^2 : (m_Z)^2 : (m_W)^2 :: 17 : 9 : 7 \tag{43}$$

$$9.239 \times 10^2 (\text{GeV}/c^2)^2 :: 1 \tag{44}$$

Table 29 summarizes mathematical results that correlate with $D'' = 2$. (Compare with tables 26 and 27.) Here, we correlate with D'' the symbols S'', Ω'', and σ''. Each of S'', Ω'', and σ'' does not necessarily correlate with uses of S, S', Ω, σ, or σ' in models regarding simple particles. For $\Omega'' = 0$, the table uses the letters NR to denote that the sign of σ'' is not relevant.

The following correlations might pertain regarding relative squares of masses. (See table 19.) For each of the W, Z, and 0H bosons, a positive term correlating with $\sigma'' = -1$ and $S'' = j_{\lambda \in \Gamma}$ pertains. For the W and Z bosons, a negative term correlates with spin-one and with a negative term correlating with $\sigma'' = -1$ and $S'' = 0$. For the W boson, a negative term correlates with a charge of magnitude equal to the magnitude of the charge of the electron and with a negative term correlating with $\sigma'' = -1$ and $S'' = 2$.

We explore concepts regarding 0G∅.

One might assume that the 0I solution correlates with $S'' = j_{\lambda \in \Gamma} = 0$. The result $S'' = 0$ correlates with a relative square of mass of one. The mass would approximately equal $30.4 \text{GeV}/c^2$. 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 16.) 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 29, 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.

Per table 16 and equation (3), the 0G∅ solution does not necessarily correlate with excitations that are relevant to physics. We suggest that the notion of physics relevance depends on the models that people use. Models that assume well-defined non-entangled objects might not embrace a 0I simple particle. Models that make other assumptions might embrace a 0I simple particle. Both types of models might benefit from mathematics related to the 0G∅ solution. For example, the 0G∅ solution might play a role in modeling the relative rates of decay of a Higgs boson into various numbers, n, of bosons. (See the row in table 25 pertaining to interactions of the type 0fnb↔0fnb, for n≥2. Here, modeling might assume that the number of incoming 0I bosons is one less that n.) Regarding some aspects of ongoing theory, we suggest that the 0I boson might correlate with the notion of the Higgs mechanism.

2.11 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 forces suggests.

Equation (47) possibly pertains. Here, m denotes mass, τ denotes tauon, e denotes electron, q denotes charge, ε_0 denotes the vacuum permittivity, and G_N denotes the gravitational constant. Equation (47) predicts a tauon mass with a standard deviation of less than one quarter of the standard deviation correlating with the experimental result. (For relevant data, see reference [50].)

$$\beta' = m_\tau / m_e \tag{45}$$

$$(4/3) \times \beta^{12} = ((q_e)^2/(4\pi\varepsilon_0))/(G_N(m_e)^2) \tag{46}$$

$$\beta' = \beta \tag{47}$$

$$m_{\tau,\text{ calculated}} \approx (1776.8445 \pm 0.024) \text{ MeV}/c^2 \tag{48}$$

$$m_{\tau,\text{ experimental}} \approx (1776.86 \pm 0.12) \text{ MeV}/c^2 \tag{49}$$

The factor of 4/3 in equation (46) 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 $((q_e)^2/(4\pi\varepsilon_0))/4$ and four channels pertain. For a 4G4 interaction between two electrons, the strength for each channel is $G_N(m_e)^2/3$ and three channels pertain.

The following notes pertain.

- To the extent that equation (47) 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 (47) links the ratio of two simple particle masses to a ratio of the strengths of two long-range forces.

- Equation (47) links the strength of 2G2 interactions to the strength of 4G4 interactions.

- For each $\Sigma \geq 2$ solution that table 16 lists, the number of channels equals the number of blank SA-side cells in an extended version of table 16 that includes the oscillator pair SA9-and-SA10 and embraces the notion that blank (or, $\kappa_{0,-1}$) pertains for each added cell.

- For 6G6, the number of channels is two. For 8G8, the number of channels is one.

- For $\Sigma = 10$ and $\Gamma = \Sigma = [\![10]\!]$, $\Sigma G\Gamma$ would correlate with zero channels and no interactions.

2.12 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.

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. 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 (50) shows can correlate with interactions in which the incoming boson correlates 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.

$$1\text{f1b}(\Sigma = 2) \rightarrow 1\text{f1b}(\Sigma = 0) \tag{50}$$

We extend our 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 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 $\sigma = -1$ 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.

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 (51) pertains regarding the fine-structure constant α. (Compare with equation (53).) 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 $\alpha^2 m_e$ as the average neutrino mass. (See equation (18).) 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 (51), proportional to $\hbar$.

$$\alpha = ((q_e/\hbar)^2/(4\pi\varepsilon_0 c)) \cdot \hbar \tag{51}$$

Equation (51) might provide a link between the strength of 2G2 and the strength of 2G24. The equation includes the term $(q_e/\hbar)^2$. The Josephson constant K_J equals $2q_e/\hbar$.

2.13 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 (52).) The formula includes two integer variables and seven parameters. One integer variable, M'', correlates somewhat with generation. For the electron and each of the six quarks, the generation equals $M'' + 1$. For each of the muon and the tauon, the generation equals M''. The other integer variable, M', correlates with magnitude of charge. The seven parameters can be m_e, m_μ (or, the mass of a muon), β, α, $d'(0)$, $d'(1)$, and $d'(2)$. Here, α denotes the fine-structure constant. (See equation (53).) 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 square root of the multiplicative product of the two quark masses.

Table 30 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 [50].) For each particle other than the top quark, reference [50] provides one estimate. For the top quark, reference [50] provides three estimates. For each quark, table 30 shows a data range that runs from one standard deviation below the minimum nominal value that reference [50] shows to one standard deviation above the maximum nominal value that reference [50] 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 (52). 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 (57). The concepts of $M' = 3/2$ and $m(M'', 3/2)$ are useful mathematically, though not necessarily directly physics-relevant.) Regarding equations (58), (59), and (60), 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 correlating with reference [50] data. (See equations (48) and (49).)

$$m(M'', M') = m_e \times (\beta^{1/3})^{M'' + (j''_{M''})d''} \times (\alpha^{-1/4})^{(1-\delta(M',3))\cdot((3/2)\cdot(1+M'') + (j'_{M'})d'(M''))} \tag{52}$$

$$\alpha = ((q_e)^2/(4\pi\varepsilon_0))/(\hbar c) \tag{53}$$

Table 30: Approximate rest energies (in MeV) for 1C and 1Q particles

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

Table 31: Ranges of $d'(M'')$ that fit the data ranges that table 30 shows for quark masses

Symbol	Minimum (approximate)	Nominal (table 30)	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

$$j''_{M''} = 0, +1, -1, 0 \text{ for, respectively, } M'' = 0, 1, 2, 3 \tag{54}$$

$$d'' = (2 - (\log(m_\mu/m_e)/\log(\beta^{1/3}))) \approx 3.840679 \times 10^{-2} \tag{55}$$

$$1 - \delta(M', 3) \text{ equals } 0, \text{ for } M' = 3, \text{ and equals } 1, \text{ otherwise} \tag{56}$$

$$j'_{M'} = 0, -1, 0, +1 \text{ for, respectively, } M' = 3, 2, 3/2, 1 \tag{57}$$

$$d'(0) \sim 0.318 \tag{58}$$

$$d'(1) \sim -1.057 \tag{59}$$

$$d'(2) \sim -1.5091 \tag{60}$$

$$m(2, 3) \approx 8.59341 \text{MeV}/c^2 \tag{61}$$

Table 31 shows ranges of $d'(M'')$ that fit the data ranges that table 30 shows for quark masses. (See equations (58), (59), and (60).) 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 32 shows possible masses 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 masses might not be incompatible with experimental results that table 30 shows. To the extent that table 32 comports with nature, fitting the masses of six quarks and

Table 32: Possible estimates for quark masses

M''	Ratio	Value	$d'(M'')$	$m_{M'=2}$ (MeV/c^2)	$m_{M'=1}$ (MeV/c^2)
0	$m_e m_d/(m_u)^2$	1/2	≈ 0.31216454	$m_u \approx 2.203 \times 10^0$	$m_d \approx 4.748 \times 10^0$
1	$m(2,3) m_c/(m_s)^2$	1	-1	$m_c \approx 1.178 \times 10^3$	$m_s \approx 1.006 \times 10^2$
2	$m_\mu m_t/(m_b)^2$	1	$-3/2$	$m_t \approx 1.695 \times 10^5$	$m_b \approx 4.322 \times 10^3$

Table 33: 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.

three charged leptons requires at most five parameters. The five parameters can be m_e, m_μ, β, α, and $d'(0)$. To the extent that table 32 comports with nature, equation (62) pertains.

$$(m_s)^2 m_\mu = m_e m_\tau m_c \tag{62}$$

The charge q_e correlates with β, via equation (46). The charge q_e appears in α, via equation (53). Based on equations (43) and (52) 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.

2.14 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 33 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 20 and to equation (18) suggests modeling that would be compatible with data and with the elementary particle Standard Model assertion that all neutrinos have zero rest masses.

We discuss aspects related to neutrino oscillations.

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. The only ongoing theory catalyst for neutrino oscillations would be gravity.

Proposed theory suggests that each of the 4GΓ components of 4γ might not correlate with neutrino oscillations. (For one explanation, see table 9a. For another explanation, see table 20 and discussion related to equation (18).) Solutions 8G2468a and 8G2468b correlate with interactions with lepton number. Solutions 8G2468a and 8G2468b do not correlate with the $SU(2)$ symmetry that correlates with somewhat conservation of fermion generation. (See table 16. In that table, items for which the TA-side symmetry is not $SU(3)$ do not correlate with the relevant $SU(2)$ symmetry.) Proposed theory suggests that interactions correlating with solutions 8G2468a and 8G2468b catalyze neutrino oscillations. Discussion related to equations (102) and (103) offers an explanation, in the context of ongoing theory modeling, for neutrino oscillations. This modeling differs from modeling that we show in discussion related to equation (18). Discussion related to equations (102) and (103) might assume that people can model effects of 8G-induced neutrino oscillations via the notion of, in effect, an index of refraction.

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

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

Table 34: Possible approximations regarding the 6G24,1 and 6G24,t contributions to $a_{\text{cl}} - (\alpha/(2\pi))$ for charged leptons

Assumption regarding t_{cl}	$a_{6\text{G}24,1}$	$a_{6\text{G}24,\text{t}}$
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}
$\log(m/m_e)$	-1.76×10^{-6}	1.18×10^{-6}
$(\log(m/m_e))^2$	-1.76×10^{-6}	2.21×10^{-7}

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 [2] and [17].)

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

2.15 Anomalous moments

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

Equations (63), (64), and (65) show results of experiments regarding anomalous magnetic dipole moments. (See reference [50].) The subscripts e, 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.

$$a_e - (\alpha/(2\pi)) \approx -1.76 \times 10^{-6} \tag{63}$$

$$a_\mu - (\alpha/(2\pi)) \approx +4.51 \times 10^{-6} \tag{64}$$

$$-0.052 < a_\tau < +0.013 \tag{65}$$

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. Regarding the tauon, equation (66) shows a result correlating with a first-order Standard Model (or, ongoing theory) calculation. (See reference [23].)

$$a_{\tau,\text{SM}} \approx +1.177 \times 10^{-3} \tag{66}$$

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

Proposed theory suggests that contributions to a scale as $\alpha^{(\Sigma-2)/2}$. (Compare with discussion leading to equation (18).) 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. People might be able to extrapolate, based on observed strengths of 6G24, to predict the order α^2 contribution to a_τ.

We assume that, for a charged lepton cl, equation (67) pertains. Here, t_{cl} is the construct that the first column of table 34 identifies.

$$a_{\text{cl}} - (\alpha/(2\pi)) \approx a_{6\text{G}24,1} + a_{6\text{G}24,\text{t}} t_{\text{cl}} \tag{67}$$

Table 34 shows approximate possible values for $a_{6\text{G}24,1}$ and $a_{6\text{G}24,\text{t}}$, based on fitting data that equations (63) and (64) show and using various candidates for t_{cl}. We de-emphasize the notion that 8G26 might also contribute to an actual value.

Table 35: Possible approximations for $a_\tau - (\alpha/(2\pi))$

Assumption regarding first order behavior for $a_{\text{cl}} - (\alpha/(2\pi))$. The term is linear in a lepton's:	First order suggestion for $a_\tau - (\alpha/(2\pi))$	Prediction for a_τ	Approximate comparison $(a_\tau - a_{\tau,\text{SM}})/a_{\tau,\text{SM}}$	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}	!!
$\log(m/m_e)$	$+7.83 \times 10^{-6}$	$+1.169 \times 10^{-3}$	-6.8×10^{-3}	!
$(\log(m/m_e))^2$	$+12.9 \times 10^{-6}$	$+1.174 \times 10^{-3}$	-2.5×10^{-3}	!

Table 35 provides, based on table 34 and equation (67), some possible suggestions for $a_\tau - (\alpha/(2\pi))$. The comparison is with respect to a Standard Model first order calculation. (See equation (66).) 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 $|q_e|$ 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 (52).)

Each one of the results that table 35 shows comports with experimental results. Except for the row regarding m and the row regarding m^2, each row in table 35 might comport with the calculation based on the Standard Model. The (generation)^2-centric result that table 35 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 equation (66) 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 34 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.

2.16 Possible threshold energies for observing effects of tweak (or, 2T) simple particles

This unit discusses possible masses for tweak simple particles. The unit discusses possible threshold energies for detecting effects correlating with tweaks.

We explore possibilities regarding masses for T-family bosons.

Work above correlates with the notion that the charge of the $\text{T}^\pm$ boson is one-third the charge of the W boson. (See discussion related to table 11.) Aspects regarding charge are additive and correlate with $U(1)$ and $\pi_{0,-1}$ symmetry. None of linear, $U(1)$, and $\pi_{0,-1}$ pertains regarding mass. Presumably, none of linear, $U(1)$, and $\pi_{0,-1}$ pertains regarding squares of mass.

The $0\text{G}\emptyset$ 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 29, the column labeled $D + 2\nu$.) We might try to, in effect, 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 $S'' = 7$ would correlate with allowed values of λ of two, four, six, eight, 10, 12, and 14. The equation $S'' = 7$ provides the first possibility (beyond the limit $\lambda \leq 8$) to have G-family-like solutions for which $\Sigma = 0$. For $S'' = 7$, $D + 2\nu = 50$. Proposed theory suggests that equations (68) and (69) might pertain regarding the masses of T-family bosons. 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 [50] regarding the Higgs boson, the rest energies of the T-family bosons might be between ~ 208 GeV and ~ 221 GeV.

$$47/17 \leq (m_{T^\pm})^2/(m_{H^0})^2 \leq 53/17 \tag{68}$$

$$49/17 \leq (m_{T^0})^2/(m_{H^0})^2 \leq 51/17 \tag{69}$$

We discuss aspects for experiments that might create and detect effects involving charged 2T simple bosons. We assume that detection involves using potentially free-ranging objects as inputs into experiments. Here, we use the word potentially to indicate the possibility that an actual object resides in a larger object. An example would be a proton in an atomic nucleus. We assume that detection involves sensing potentially free-ranging objects that experiments produce. Free-ranging objects have charges that are integer multiples of the magnitude of the charge of an electron.

We introduce the symbols that equations (70) and (71) show. The symbol 1Q⊗2U denotes a particle that includes just quarks and gluons. The word hadron pertains for the particle. The word 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 word hadron-like pertains for the particle. The particle does not include quarks.

$$1Q \otimes 2U \tag{70}$$
$$1R \otimes 2U \tag{71}$$

The following equations show interactions that convert a neutron into a 1R⊗2U hadron-like particle that features three arc (or, 1R) simple fermions. Each symbol $x\_$ denotes an unspecified simple boson. For each symbol of the form X^q, the superscript denotes a charge in units of the charge of a positron or proton. Equation (72) shows the creation of two W bosons. Equation (73) shows the use of one of the W bosons to create three tweak (or, 2T) simple bosons. Equation (74) shows the use of the other W boson to convert the up quark in the neutron to a down quark. Equation (75) shows the use of the three tweaks to produce a hadron-like particle that includes three arcs and no quarks. The minimum energy to trigger this set of interactions correlates with the sum of the rest energies of one neutron, one W boson, and three charged tweaks. A range for that minimum energy is 705 GeV to 744 GeV.

$$x_1 + x_2 \rightarrow W^{+1} + W^{-1} \tag{72}$$
$$x_3 + x_4 + W^{+1} \rightarrow 3T^{+1/3} \tag{73}$$
$$W^- + Q^{+2/3} \rightarrow Q^{-1/3} + x_5 \tag{74}$$
$$3(T^{+1/3} + Q^{-1/3} \rightarrow R^0 + x_6) \tag{75}$$

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. The interaction produces one x_5 boson and three x_6 bosons. People might detect effects of the x_5 or x_6 bosons. People might detect escapes or recoils of atomic nuclei. 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.

To convert a proton into a 1R⊗2U hadron-like particle that features three arc (or, 1R) simple fermions requires one additional instance of equation (74). The minimum energy to trigger the set of interactions correlates with the sum of the rest energies of one proton, two W bosons, and three charged tweaks. A range for that minimum energy is 786 GeV to 825 GeV.

The result for protons might correlate with a finite temperature-dependent half-life for protons.

2.17 Relationships between ALG modeling, PDE modeling, kinematics modeling, and physics

This unit summarizes some aspects of ALG modeling and some aspects of PDE modeling. This unit notes constraints that, so far in this essay, pertain regarding modeling. This unit anticipates, later in this essay, relaxing some of the constraints.

We recap aspects of ALG modeling. We recap aspects of PDE modeling. We explore aspects of synergies between ALG modeling and PDE modeling.

ALG techniques and G-family solutions point directly to all long-range forces. ALG techniques and G-family solutions point to all $\sigma = +1$ simple bosons. Absent bounds set by PDE modeling, ALG techniques point to solutions that are not relevant to physics.

PDE techniques assume aspects regarding physics correlating with the G-family and the 2U subfamily. PDE techniques point to all simple particles, other than 2U particles, that proposed theory suggests. PDE techniques point to $\sigma = -1$ solutions that might not be relevant to physics.

PDE techniques might not directly point to how ALG techniques can embrace gluons.

A combination of PDE and ALG techniques points to all long-range forces and simple bosons, except gluons, that proposed theory matches or suggests. To some extent, ALG modeling for gluons reflects mainly results from ongoing theory.

ALG modeling expresses property conservation laws. Examples include conservation of charge and conservation of lepton number minus baryon number. ALG modeling suggests approximate conservation laws. Examples include approximate conservation of generation and approximate conservation of lepton number.

Modeling regarding kinematics conservation laws has bases in ongoing theory and in ALG modeling.

We discuss modeling that we show above in this essay.

Modeling regarding kinematics features kinematics conservation laws. Modeling de-emphasizes motion. Modeling de-emphasizes specific kinematics models. (Kinematics models can have bases in quantum modeling or classical modeling. Kinematics models can feature aspects of Newtonian physics, special relativity, or general relativity.)

Modeling regarding objects features a notion of a well-defined object, with well-defined internal properties, with well-defined possible interactions with other objects, and with well-defined kinematics properties. (Kinematics properties include energy, momentum, and angular momentum.)

Modeling regarding interactions tends to de-emphasize some aspects of modeling multiple quantum interactions.

We discuss ongoing theory modeling for motions of objects. Modeling recognizes actual interactions between objects. Interactions produce effects. Objects can change internal properties. Objects can change kinematics properties. For example, for a model of a planet orbiting a star, conservation of momentum does not pertain for either of the planet or the star.

We discuss modeling that we show later in this essay. Modeling allows for changes to properties. For example, modeling allows for changes to kinematics properties.

3 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 three eras regarding the rate of expansion of the universe. This unit discusses models that might explain data about dark energy density of the universe. This unit discusses other astrophysics phenomena and other cosmology phenomena.

3.1 Models that have bases in one, six, and 36 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.

Work above predicts new simple particles. Work above describes dark energy forces. Work above describes 1R⊗2U hadron-like particles. (See discussion regarding equation (71).) The 1R⊗2U hadron-like particles contain no charges. 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 these ratios correlate with amounts that correlate with gravitational effects. People correlate those effects with the term mass. One of those effects 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 380 thousand years after the big bang. (Reference [4] indicates a five-plus to one inferred ratio regarding 380 thousand years after the big bang.)

Table 36: Cumulative features of various types of modeling

Modeling	New descriptions and new explanations	New subtleties
Ongoing theory	• (Baseline)	
PR1ISe	• New simple particles and long-range forces	
	• Baryon asymmetry	
	• Dark energy forces	
	• Dark energy density	
	• Some dark matter	
PR6ISe or PR36ISe	• More dark matter	• Spans
	• Ratios of dark matter effects to ordinary matter effects	• Dark energy forces
	• Ratios of dark energy density of the universe to density of the universe of ordinary matter plus dark matter	

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 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 long-range 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 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.

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

Table 36 discusses cumulative features of various types of modeling. Generally, each row augments the rows above that row. Regarding PR1ISe, long-range forces include dark energy forces. 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 (92).) Otherwise, regarding bases for aspects that table 36 lists, PR36ISe is similar to PR6ISe.

3.2 Baryon asymmetry

This unit discusses proposed theory explanations for baryon asymmetry.

To the extent that the early universe featured roughly 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.

Proposed theory suggests scenarios that might have led to baryon asymmetry. None of the scenarios conserves baryon number. Each scenario conserves lepton number minus baryon number.

In one scenario, the $2T^{\pm}$ boson converts antimatter quarks to matter quarks. This scenario depends on the physics-relevance of 1R simple fermions. Equation (76) shows an example of a 1f1b→1f1b interaction. (Per remarks above, interactions of the form 1f0b→1f1b correlate with 1f1b→1f1b.) Here, the superscripts correlate with charge, in units of $|q_e|$. The subscripts correlate with lepton number minus baryon number, followed by lepton number, followed by baryon number. (Simple bosons and long-range forces correlate with zero lepton number and with zero baryon number.) Equation (77) shows an example of a 3f0b→1f1b interaction. Here, each of the three simple particles that correlates with 3f differs from the other two simple particles. One might assume that the $2T^{+1/3}$ and $2T^{-1/3}$ bosons annihilate each other.

$$1Q^{+1/3}_{+1/3;0,-1/3} \rightarrow 1R^{0}_{+1/3;0,-1/3} + 2T^{+1/3} \tag{76}$$

$$1C^{+1}_{-1;-1,0} + 1R^{0}_{+1/3;0,-1/3} + 1Q^{-2/3}_{+1/3;0,-1/3} \rightarrow 1Q^{+2/3}_{-1/3;0,+1/3} + 2T^{-1/3} \tag{77}$$

In one scenario, 3f0b→1f1b interactions lead to effects similar to those that result from, in effect, combining equations (76) and (77). This scenario does not depend on the existence of 2T (or, tweak) simple bosons. This scenario does not depend on the existence of 1R (or, arc) simple fermions. Equation (78) pertains.

$$1C^{+1}_{-1;-1,0} + 1Q^{+1/3}_{+1/3;0,-1/3} + 1Q^{-2/3}_{+1/3;0,-1/3} \rightarrow 1Q^{+2/3}_{-1/3;0,+1/3} + 0I \tag{78}$$

In one scenario, 3f0b→1f1b interactions destroy antimatter quarks. This scenario does not depend on the existence of 2T (or, tweak) simple bosons. This scenario does not depend on the existence of 1R (or, arc) simple fermions. Equation (79) shows an example of a 3f0b→1f1b interaction. Three antimatter fermions produce one matter fermion and a boson. Aspects of ongoing theory might suggest that the three quarks differ from each other by generation.

$$3\,1Q^{-2/3}_{+1/3;0,-1/3} \rightarrow 1C^{-1}_{+1;+1,0} + 2W^{-1} \tag{79}$$

We estimate a threshold energy for the scenario that equations (76) and (77) summarize. (Compare with estimating a threshold energy for the scenario that includes equation (75).) The threshold energy correlates with an energy to create two charged tweak particles. The threshold energy might be in the range of 416 GeV to 442 GeV. (See equation (68).) A corresponding energy is about 5×10^{15} degrees Kelvin. Ongoing theory suggests that the creation of baryon asymmetry occurs at about 10^{-4} seconds after the big bang and that a temperature of about 10^{13} degrees Kelvin correlates with that time. (See reference [60].) Proposed theory might suggest a somewhat earlier time for the achievement of baryon asymmetry.

3.3 Spans for objects and long-range forces

This unit discusses the notion that nature embraces more than one isomer for each of some simple particles, some long-range 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 16.) We aim to develop numbers that belong in the table 16 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 (11).) We generalize. We assert that, for each G-family solution for which a symmetry of $SU(j)$ pertains, equation (80) 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 16 and 19 show. The following

Table 37: A catalog of long-range forces

ΣΓ (Σ ∈ Γ)	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
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	
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

sentences pertain. A span of six pertains for the Z boson. A span of one pertains for each of the Higgs boson and 0I boson.

$$g_7/g_j \tag{80}$$

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

Equation (81) shows notation for denoting the span, s, for a simple particle or long-range force.

$$\Sigma(s)\Phi \text{ or } \Sigma(s)\Phi\Gamma \tag{81}$$

Ongoing theory does not consider the notion of a span of more than one. Equation (82) characterizes an ongoing theory photon.

$$2(1)\gamma \text{ or } 2(1)G2 \oplus 2(1)G24 \oplus 2(1)G248 \tag{82}$$

For each of each simple particle, each hadron-like particle, and each long-range force, 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 interacts. The set includes all non-zero-charge simple particles and the ongoing theory photon 2(1)γ.

Table 37 shows the span for each long-range force. The table pertains for each of PR6ISe modeling and PR36ISe modeling. Rows in the table list all Σγ long-range forces before other rows list long-range forces that do not correlate with Σγ.Table 37 lists 2(6)G248 and does not list 2(1)G248.

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

Table 38 summarizes information regarding spans (or equivalently, numbers of isomers) for simple particles, for hadron-like particles, and for some long-range forces. The table summarizes information regarding types of objects with which boson simple particles and some long-range forces 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 T$^\pm$ boson is one-third the magnitude of the charge for each of the W$^\pm$ 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, the table includes just the $\Sigma\gamma$ solutions. Regarding the PR6ISe case, the span for 2G68 is two. Regarding the PR36ISe case, the span for 2G68 is two and the notion of ‖2G pertains. Table 38 shows the extent to which each of the simple bosons and some of the long-range forces 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 solutions for which the TA-side symmetry is $SU(5)$ do not correlate with direct interactions with simple fermions. (See discussion related to table 13 and discussion related to table 16.) Proposed theory suggests that the G-family solution for which the TA-side symmetry is $SU(7)$ does not correlate with interactions with simple fermions and does not correlate with interactions with multicomponent objects, except for interactions that change only the internal entropy of multicomponent objects. (See discussion related to equation (118).) For each simple boson for which $\sigma = -1$ and the table 38 shows a non-one span, the non-one span numbers result from mathematics. The effective span depends on the span correlating with the object (such as a hadron-like object) in which the simple boson exists.

In table 38, the items for which $\sigma = +1$ and the PR36ISe span is 36 are 1N and 1R⊗2U. 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.

No simple fermion has a zero lepton number minus baryon number. That statement might correlate with a lack of relevance for would-be PR216ISe models. Here, 216 equals 6^3.

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 $\gamma2$ solutions. The 2(2)G68 solution does not correlate with interactions with individual simple particles. Table 20 correlates $\lambda = 6$ with baryons and $\lambda = 8$ with leptons. We posit that 2(2)G68 correlates with some electromagnetic (or, $\Sigma = 2$) interactions with atoms and other objects that include both baryons and leptons.

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 PR06ISe 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.

3.4   Densities of the universe

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

Ongoing theory discusses five partial densities of the universe. The symbol Ω_ν denotes neutrino density of the universe. The symbol Ω_γ denotes photon density of the universe. The symbol Ω_b denotes ordinary matter (or, baryonic matter) density of the universe. The symbol Ω_c denotes dark matter (or, cold dark matter) density of the universe. The symbol Ω_Λ denotes dark energy density of the universe. Each of the five densities correlates with data. Equation (83) pertains regarding the total density of the universe, Ω.

$$\Omega = \Omega_\nu + \Omega_c + \Omega_b + \Omega_\gamma + \Omega_\Lambda \tag{83}$$

Proposed theory suggests equation (84). The symbol Ω_h 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.

Table 38: Particles and solutions that correlate with one isomer and particles and solutions that might correlate with more than one isomer; plus, the extent to which simple bosons and some long-range forces interact with simple fermions and with multicomponent objects (with the symbol MCO denoting multicomponent object; with the symbol † denoting that somewhat conservation of fermion generation pertains for 1f1b→1f1b interaction vertices)

Standard Model entities	Possible entities	PR1ISe span	PR6ISe span	PR36ISe span	1b interact w/ 1f	1b interact w/ MCO
1C ($\sigma = +1$)	-	1	1	1	-	-
1N ($\sigma = +1$)	-	1	6	36	-	-
1Q ($\sigma = -1$)	-	1	1	1	-	-
-	1R ($\sigma = -1$)	1	6	36	-	-
2U ($\sigma = -1$)	-	1	6	36	Y†	N
2W: Z ($\sigma = +1$)		1	6	6 ($\parallel$2G)	Y†	N
	2T: 2T^0 ($\sigma = -1$)	1	6	6 ($\parallel$2G)	Y†	N
2W: W$^\pm$ ($\sigma = +1$)	2T: 2T$^\pm$ ($\sigma = -1$)	1	1	1	Y†	N
1Q⊗2U ($\sigma = +1$)	-	1	1	1	-	-
-	1R⊗2U ($\sigma = +1$)	1	6	36	-	-
0H ($\sigma = +1$)	-	1	1	1	Y	N
-	0P ($\sigma = -1$)	1	1	1	N	Y
-	0I ($\sigma = +1$)	1	1	1	Y	N
-	0K ($\sigma = -1$)	1	1	1	N	Y
2G2 ($\sigma = +1$)	-	1	1	1	Y	Y
2G24 ($\sigma = +1$)	-	1	1	1	Y	Y
2G248 ($\sigma = +1$)	-	1	6	6 ($\parallel$2G)	Y†	Y
-	4G4 ($\sigma = +1$)	1	6	6 ($\parallel$4G)	Y†	Y
-	4G48 ($\sigma = +1$)	1	2	2 ($\parallel$4G)	N	Y
-	4G246 ($\sigma = +1$)	1	1	1	Y	Y
-	4G2468a ($\sigma = +1$)	1	1	1	Y	Y
-	4G2468b ($\sigma = +1$)	1	1	1	Y	Y
-	6G6 ($\sigma = +1$)	1	1	1	N	Y
-	6G468 ($\sigma = +1$)	1	1	1	Y	Y
-	8G8 ($\sigma = +1$)	1	1	1	N	≈N
-	8G2468a ($\sigma = +1$)	1	1	1	Y	Y
-	8G2468b ($\sigma = +1$)	1	1	1	Y	Y

$$\Omega_{\mathrm{c}} = \Omega_{\mathrm{h}} + \Omega_{\mathrm{ib}} + \Omega_{\mathrm{i}\gamma} \tag{84}$$

We interpret data regarding recent states of CMB (or, cosmic microwave background radiation) as correlating with equation (85). The symbol Ω_{h} correlates with the plus in the ratio five-plus to one. The relationship $\Omega_{\mathrm{b}} \gg \Omega_{\gamma}$ pertains regarding data. (Reference [50] provides data.)

$$\Omega_{\mathrm{ib}} \approx \Omega_{\mathrm{ib}} + \Omega_{\mathrm{i}\gamma} = 5(\Omega_{\mathrm{b}} + \Omega_{\gamma}) \approx 5\Omega_{\mathrm{b}} \tag{85}$$

Equation (89) estimates Ω_{ib} for the current state of the universe. (Reference [50] provides the data that equations (86), (87), and (88) show.)

$$\Omega_{\mathrm{b}} \approx 0.0484 \pm 0.001 \tag{86}$$

$$\Omega_{\mathrm{c}} \approx 0.258 \pm 0.011 \tag{87}$$

$$\Omega_{\gamma} \approx 0.0000538 \pm 0.0000150 \tag{88}$$

$$\Omega_{\mathrm{ib}} \approx \Omega_{\mathrm{c}} - 5\Omega_{\mathrm{b}} \approx 0.016 \tag{89}$$

Reasons exist for not taking the results that equation (89) shows to be exact. For example, we note the size of the standard deviation in equation (87).

We interpret data regarding CMB about 380 thousand years after the big bang as correlating with equation (90). (Reference [4] provides data.) Regarding this data, the relationship $\Omega_{\mathrm{b}} < \Omega_{\gamma}$ pertains. We assume that, at 380 thousand years after the big bang, (indirect) effects of dark matter photons on ordinary matter CMB had yet fully to manifest themselves.

$$\Omega_{\mathrm{ib}} + \Omega_{\mathrm{h}} \approx 5\Omega_{\mathrm{b}} \tag{90}$$

3.5 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 36 and includes equation (80).) A ratio of five-plus to one seems to pertain for billions of years. (See discussion related to equations (85) and (90).). 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 [11].) 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 [8].)

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 (91) pertains. Solution 2(2)G68 does not correlate with interactions with individual simple fermions. (The TA-side symmetry is $SU(5)$. See table 16.) Solution 2(2)G68 might correlate with hyperfine interactions. (Note, for example, that the six in Γ might correlate with baryon number. 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. Each of six

Table 39: 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

and eight appears in both the Γ for 2(2)G68 and the Γ for 2(6)G468. Solution 2(6)G468 correlates with a quadrupole effect, whereas solution 2(2)G68 correlates with a dipole effect.

$$2\text{G}68 \notin 2\gamma, \ 2\text{G}68 \notin \gamma 2 \tag{91}$$

3.6 The rate of expansion of the universe

This unit discusses dark energy forces and suggests an explanation for three 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 that it does for the two clumps in the first thought experiment.

Table 39 summarizes, regarding the rate of expansion of the universe, eras and 4G forces. 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 [13], [39], [43], and [44].) 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 first three eras and now generally exhibit behavior correlating with RSDF of r^{-2}. Quasar formation via ejection of stuff from near or inside black holes might constitute an exception. Black hole jets might constitute an exception. Blazars might constitute an exception. For these cases, r^{-3} net repulsion might pertain. The column labeled A/R notes net effects, across forces dominating for each era. The column labeled components of 4γ lists solutions that might correlate with significant forces. (See table 17.) Proposed theory suggests that, for the components of 4γ that table 39 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 39 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.

3.7 Galaxies, components of galaxies, and 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 effects to ordinary matter effects. This unit discusses some observations that might pertain regarding dark matter in the Milky Way galaxy.

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 $1R\otimes2U$ dark matter - ratios, that observations suggest, of dark matter effects to ordinary matter effects.) For now, we de-emphasize some phenomena such as $1R\otimes2U$ hadron-like particles and collisions between galaxies.

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 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 is 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, each one of the six isomers of PR6ISe-span-one phenomena expands, essentially independently from the other isomers of PR6ISe-span-one phenomena, based on repulsion correlating with 4(1)G2468a and 4(1)G2468b.

- Then, each isomer of PR6ISe-span-one phenomena starts to clump, essentially independently from the other isomers of PR6ISe-span-one phenomena, based on attraction correlating with 4(1)G246.

- With respect to clumps correlating with any one isomer of PR6ISe-span-one phenomena, 4(2)G48 repels one other isomer of PR6ISe-span-one phenomena and repels some stuff correlating with itself.

- 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 of PR6ISe-span-one phenomena 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 2γ phenomena (or, readily observable electromagnetism). (The previous sentence de-emphasizes some observations - regarding collisions between black holes or neutron stars - that have bases in 4γ phenomena.) People report ratios of amounts (or, densities) of dark matter to amounts (or, densities) of ordinary matter.

We discuss observations correlating with early in the era of galaxy formation.

Reference [21] 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 [9] provides data about early stage galaxies. (See, for example, figure 7 in reference [9]. 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 [22] 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 [29] discusses some MED09 spiral - or, disk - galaxies. A redshift of approximately $z = 1.57$ pertains. (See reference [30].) The redshift correlates with a time of 4.15 billion years after the big bang. (We used reference [22] to calculate the time.) Reference [29] reports ratios of amount of dark matter to amount of ordinary matter of approximately four to one. The observations have bases in gravitational lensing. Proposed theory offers the following possibility. Each galaxy began based on an 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. Notions such as the following notions might pertain.

- Some ratios might not be as big as they might otherwise be because each one of the four relevant dark matter isomers of PR6ISe-span-one phenomena repels, via 4(2)G48, one relevant dark matter isomer of PR6ISe-span-one phenomena.

- Some ratios might not be as small as they might otherwise be because of contributions, which are independent of PR6ISe-span-one phenomena, of 1R⊗2U dark matter.

- Some ratios might reflect conditions specific to MED09 galaxies.

- Some ratios might vary from what they might otherwise be because of effects of collisions, before the emissions of the observed light, between galaxies.

Reference [52] discusses the Dragonfly 44 galaxy. A redshift of $z = 0.023$ pertains. The redshift correlates with a time of 13.4 billion years after the big bang. (We used reference [22] 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 [25].) 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 formed based on a one isomer core that featured the isomer that repels the ordinary matter isomer.

Table 40 features 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 40 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 long-range force. 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 result in 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.

Table 40: 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

The following notions pertain regarding other data of which we know. Here, the ratios are ones of dark matter effects to ordinary matter effects.

- Reference [40] 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.

- Reference [24] 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.

- Each of the galaxy NGC1052-DF2 and the galaxy NGC1052-DF4 correlates with a ratio of between zero to one and one to one. (See references [54], [51], and [53].) The observations have bases in the velocities of stars - or, galaxy rotation curves. These observations seem 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 references [12] and [5].) 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.

- People report other data. We are uncertain as to the extent proposed theory provides insight that ongoing theory does not provide.

  - One example pertains to early stages of galaxies that are not visible at visible light wavelengths. (See reference [57].) 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 provides insight regarding subtleties, such as regarding star formation rates, correlating with this example.

  - We are uncertain as to the extent to which proposed theory provides 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 [27].)

  - We are uncertain as to the extent to which proposed theory provides insight regarding the existence of two types - born and tidal - of ultra-diffuse galaxies. (See reference [48].)

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

Discussion above is not incompatible with the notion that visible stars do not include much dark matter.

Discussion above 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 [56] and [15].)

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 [32].) Proposed theory suggests the possibility that the 4G(1)246 attractive component of long-range 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.

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

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 [10].) 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 [18].) Proposed theory offers the possibility that the object is an originally dark matter centric clump of stuff (that might include at least one dark matter black hole).

For other examples, people report inhomogeneities regarding Milky Way dark matter. (See references [18] and [36].) Researchers note that simulations suggest that such dark matter may have velocities similar to velocities of nearby ordinary matter stars. Proposed theory suggests that these notions are not incompatible with proposed theory notions that dark matter stars, which would be similar to ordinary matter stars, exist.

3.8 Galaxy clusters, ratios of dark matter effects to ordinary matter effects, and filaments

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

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

References [33] and [42] report ratios of five-plus to one. The observations have bases in gravitational lensing.

Reference [47] reports ratios of eight-minus to one. The observations have bases in X-ray emissions.

We suggest that proposed theory is not necessarily incompatible with these galaxy cluster centric ratios.

Proposed theory is not necessarily incompatible 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 of PR6ISe-span-one phenomena has its own baryon-like particles and its own PR1ISe-like photon 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.

3.9 Dark energy density

This unit discusses the notion that dark energy densities might correlate with aspects related to aye (or, 0I) bosons, with dark matter, or with dark energy stuff.

Equation (92) 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 [50] provides the four items of data.) From a standpoint of each of ongoing theory and proposed theory, equation (92) 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 (84).) From a standpoint

of proposed theory, for models for which n (as in PRnISe) exceeds one, Ω_c includes PR1ISe-like photons centric to dark matter. We know of no inferences that would not comport with a steady increase, regarding the inferred ratio correlating with equation (92), from approximately zero, with time since somewhat after the big bang. (Reference [4] implies a ratio of approximately zero correlating with 380 thousand years after the big bang.)

$$\Omega_\Lambda/(\Omega_c + \Omega_b + \Omega_\gamma) \approx 2.3 \tag{92}$$

Some aspects of ongoing theory try to correlate inferred dark energy densities of the universe with phenomena correlating with terms such as vacuum energy, vacuum fluctuations, or quintessence. Proposed theory does not necessarily embrace notions such as vacuum energy. (Double-entry modeling may obviate needs to consider notions such as vacuum energy.)

Interactions with aye (or, 0I) bosons might lead to effects similar to effects that ongoing theory might correlate with vacuum energy, vacuum fluctuations, or quintessence. (See discussion related to equation (50).) To the extent that effects correlating with aye bosons suffice, the effects might suffice regarding each of PR1ISe, PR6ISe, and PR36ISe modeling. Assuming that such interactions 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 producing effects, regarding CMB, that people correlate, via ongoing theory, with non-zero dark energy density. The difference correlates with interactions between ordinary matter and dark matter. Modeling suggests an upper bound of five regarding, in effect, a possible future value for the ratio that correlates with equation (92).

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 [11] 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 and 1R⊗2U particles might provide for such interactions. (See table 38.) In effect, dark energy density correlates with a notion of dark energy stuff. Modeling suggests an upper bound of approximately five regarding, in effect, a possible future value for the ratio that correlates with equation (92).

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 reference [4] shows supports the notion of such growth. Inferences that reference [45] discusses might comport with this aspect of proposed theory.

3.10   Inflationary epoch

This unit discusses phenomena that might correlate with an 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.

Proposed theory might explain the era or some effects of the era. Phenomena might correlate with denaturing of aspects correlating with the $SU(5)$ symmetry that proposed theory correlates with conservation of energy. The number of generators of $SU(5)$ is 24. Equation (93) 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. The factor of six might correlate with the relevance of six isomers of 4G4 and with PR36ISe modeling. One factor of two might correlate with the possibility for two values for handedness for baryons and with aspects of 6γ. One factor of two might correlate with the possibility for two values of handedness for leptons and with aspects of 8γ. The inflationary epoch might correlate with an effective decoupling from, annihilation of, or expulsion of right-handed simple fermions. The inflationary epoch might correlate with a near decoupling of somewhat isomers of PR6ISe phenomena from each other. We use the two-word term near decoupling because interactions mediated by 2G248, neutrinos, and 1R⊗2U hadron-like particles continue to pertain after the inflationary epoch. We use the two-word term somewhat isomers because the PR36ISe span might be 36 for at least one of neutrinos and 1R⊗2U hadron-like particles.

$$(g_7/g_3) \times g_{U(1)} \times g_{U(1)} \tag{93}$$

3.11 Directly detecting dark matter and doubly 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.

Discussion related to equation (75) pertains to the possibility of making dark matter.

We discuss possibilities for observing dark matter effects without creating dark matter.

We are aware of various efforts to directly detect dark matter. 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 (94) shows.

$$2(6)G248 \neq 2(1)G248 \tag{94}$$

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 (or, precessing) magnetic dipole moment, with the axis of rotation perhaps being orthogonal (and not being parallel) 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 precessing dark matter magnetic fields (or - for the PR36ISe case - 2(6)G248 phenomena correlating with precessing 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.

4 Relationships between various theories and models for motion

This unit discusses aspects of kinematics modeling and aspects of dynamics modeling. The unit shows branch points between proposed theory modeling for motion and ongoing theory modeling for motion. This unit discusses dynamics modeling for hadron-like particles, nuclear physics, and quantum transitions. This unit suggests limits on the applicability of general relativity. This unit discusses possible modeling regarding fissionable or bound-state multicomponent objects. This unit suggests modeling regarding refraction. This unit suggests details regarding modeling pertaining to the strong interaction within hadron-like particles.

4.1 Kinematics modeling and dynamics modeling

This unit discusses aspects of kinematics modeling and aspects of dynamics modeling.

Kinematics models and dynamics models tend to discuss translational motion.

Kinematics models feature free-ranging objects in free environments. Dynamics models feature objects in confined environments.

We review kinematics and dynamics modeling that we discuss above in this essay. Modeling features simple particles and long-range forces. We tend to avoid dynamics modeling. We tend to feature models for which kinematics conservation laws pertain to individual objects. We tend to avoid choosing kinematics models.

We anticipate correlating proposed theory with ongoing theory kinematics and dynamics.

Kinematics models can correlate with classical physics or with quantum physics. Kinematics models can correlate with Newtonian physics modified to limit the speed, of the free-environment transmission of effects, to the speed of light. Kinematics models can correlate with special relativity. Kinematics models can correlate with general relativity. Kinematics models can be linear in energy or quadratic in energy. The Dirac equation is linear in energy. The Klein-Gordon equation is quadratic in energy.

The following points pertain.

- Proposed theory might be compatible with all choices of kinematics models.

- Special relativity features boost symmetry. In the context of ongoing theory or in the context of proposed theory, boost symmetry correlates with an additional SA-side $SU(2)$ symmetry. The double-entry bookkeeping aspect of proposed theory can accommodate boost symmetry by adding one SA-side pair of oscillators that correlates with any one of no symmetry, $U(1)$ symmetry, or $SU(2)$ symmetry. We use the two-element phrase boost-related symmetry to correlate with those

three possibilities. The correspondingly added TA-side pair of harmonic oscillators can correlate with no symmetry. Each of the TA-side addition and the SA-side addition might correlate with modeling and might not correlate with observable phenomena.

We discuss some aspects regarding modeling for the kinematics and dynamics of multicomponent systems.

We distinguish from each other kinematics and dynamics. For an object, kinematics correlates with externally observed motion. Kinematics symmetries include conservation of energy, conservation of angular momentum, and conservation of momentum. Dynamics correlates with internal properties. For the object, we posit that dynamics symmetries include conservation of energy, conservation of angular momentum, and conservation of momentum. We posit that proposed theory can treat two sets, each of at least three conserved aspects, as being distinct.

We consider cases of multicomponent objects that involve at least two peer component objects. Here, there are four possibly relevant levels of symmetries - kinematics for the multicomponent object, dynamics for the multicomponent object, kinematics for each of the component objects, and dynamics for each of the component objects that is not an elementary particle. In keeping with the notion of object, each of kinematics for the multicomponent object, dynamics for the multicomponent object, and dynamics for each component object (that is not an elementary particle) correlates with each of the three conserved aspects. However, kinematics for each of the component objects does not necessarily correlate with a complete set of the three conserved aspects.

For example, we consider a multicomponent object that is a binary star system. Kinematics for each star does not correlate with conservation of momentum.

In general, compared with dynamics symmetries for the multicomponent object, the two stars 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 field - in this case a gravitational field - that correlates with interactions between the two stars.

We consider the case of a pion. We consider the pion to be a multicomponent object for which each of the two components is a quark. (Here, we do not distinguish between matter quarks and antimatter quarks.) We consider two branches for this case. For each branch, the field correlates with bosons that correlate with the strong interaction and the electromagnetic interaction (or, with gluons and photons).

For one branch, kinematics for each of quarks and bosons correlates with the three conserved aspects. Ongoing theory QCD (or, quantum chromodynamics) and (to some extent) ongoing theory QED (or, quantum electrodynamics) correlate with this branch. Ongoing theory QCD modeling and QED modeling involve virtual particles. This branch might correlate with an attempt to enforce a notion of $\sigma = +1$ for each of kinematics for quarks and kinematics for gluons.

For the other branch, proposed theory suggests correlating one TA-side $SU(3)$ symmetry and one SA-side $SU(2)$ symmetry with kinematics for quarks and correlating one TA-side $SU(3)$ symmetry and one SA-side $SU(2)$ symmetry with kinematics for bosons. (The notion of $SU(3)$ correlates with a notion of two additional TA-side oscillators and with thinking that correlates with the $SU(5)$ symmetry that table 13 lists.) Those symmetries combine to correlate with the appropriate three symmetries correlating with the three conserved aspects for dynamics of the pion. This branch correlates with the proposed theory notion that each of quarks and gluons correlates with $\sigma = -1$. (See table 1 and discussion related to table 41.) This branch correlates with the notion that some aspects of proposed theory do not necessarily need to consider notions of virtual particles. This branch seems to correlate with modeling that does not necessarily correlate with the three kinematics conservation laws pertaining regarding dynamics within quarks or regarding dynamics within gluons. However, proposed theory does not necessarily need to consider notions of dynamics within simple particles.

4.2   Possible complements to ongoing theory QFT, QED, and QCD

This unit summarizes aspects of possible proposed theory complements to ongoing theory QFT (or, quantum field theory), QED (or, quantum electrodynamics), and QCD (or, quantum chromodynamics).

We assume a definition of QFT that does not necessarily imply a correlation with special relativity. (See, for example, reference [31].)

The following statements summarize aspects of possible complements to ongoing theory QFT.

- Proposed QFT interaction vertices can correlate with aspects of PDE modeling.

- Proposed QFT interaction vertices do not necessarily correlate only, with respect to coordinates, with points. Vertices can correlate with objects that model as existing within a region having

non-zero temporal extent and non-zero spatial extent.

- Proposed QFT does not necessarily need to consider notions of virtual particles.

- PDE modeling correlates with aspects of the four ongoing theory fundamental forces.

- Proposed QFT correlates with the following notions.

    - Modeling correlating with the notion of objects in free environments needs to embrace, for each of those objects, all three ongoing theory kinematics conservation laws.
    - Modeling correlating with the notion of objects in confined environments does not necessarily need to embrace, for each of those objects, all three ongoing theory kinematics conservation laws. Modeling correlating with the notion of objects in confined environments does not necessarily need to embrace the notion of interaction vertices.

The following statements summarize aspects of possible complements to ongoing theory QED.

- Proposed QED can describe anomalous magnetic dipole moments (and other aspects of physics) via sums over finite numbers of terms. (See discussion related to equation (63).)

- Proposed QED might point to new approaches to atomic physics.

    - The next two sentences provide bases for an approach. The $\Omega_{SA} r^{-2}$ term in equation (25) might correlate, at least somewhat, with the square of the potential that impacts an electron. In equation (24), the limit that equation (95) shows can pertain while $(\xi'_{SA}/2)(\eta_{SA})^2$ remains a non-zero constant. (The limit correlates with, in effect, de-emphasizing the strong interaction. Presumably, $(\xi'_{SA}/2)(\eta_{SA})^2$ is proportional to each of $\hbar^2$ and energy squared.) An approach might lead to insight regarding allowed states. An approach might not correlate well with abilities to compute energies for states.

$$(\xi'_{SA}/2)(\eta_{SA})^{-2} \to 0^+ \tag{95}$$

The following statement summarizes aspects of possible complements to ongoing theory QCD.

- Proposed QCD may describe allowed states for hadron-like particles and for atomic nuclei, based on PDE modeling. (Regarding internal states for hadron-like particles, see discussion related to table 13 and discussion related to table 41. Regarding internal states for atomic nuclei, see discussion related to equation (96).)

4.3   Dynamics models for hadron-like particles

This unit discusses an approach, compatible with proposed theory, for modeling the kinematics, in hadrons, of quarks and gluons. This unit also 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 22 suggests that a hadron-like particle has a charge for which the magnitude is either zero or a non-zero integer multiple of $|q_e|$ and 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 presence of both quarks and 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 modeling correlates with symmetries, for each of quarks and gluons, that correlate with special relativity. Proposed theory suggests possibilities for modeling that correlates one subset of those symmetries with kinematics for quarks and another subset of those symmetries with kinematics for gluons. (See discussion related to table 13 and discussion related to table 41.) This proposed theory modeling correlates with the notion that neither one of quarks and gluons behaves like a simple particle for which $\sigma = +1$.

Reference [49] 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.

4.4 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.

Proposed theory does not necessarily correlate with a Pauli exclusion force or with notions of virtual pions. Cake (or, 0K) bosons might correlate with repulsion between hadrons. From a standpoint of modeling, 0K bosons might correlate with interactions with colorless color charge or white color charge. From a standpoint of modeling, 0K bosons might correlate with the identity operator that the relevant (ongoing theory and proposed theory) gluon-related $SU(3)$ symmetry lacks. From a standpoint of modeling, pie (or, 0P) bosons might correlate with attraction between hadrons. The attraction might correlate with a PDE-centric expression proportional to the term that equation (96) shows and with a Yukawa-like $\exp(-r/|\eta_{SA}|)$ potential. (See discussions related to equations (36) and (42).) The Yukawa-like potential can pertain for times longer than it would take light to traverse an atomic nucleus. We suggest that $v_c < c$ pertains. (See equation (38).) From a standpoint of modeling, 0P bosons might correlate with the identity operator that the $SU(2)$ component of a relevant weak interaction $SU(2) \times U(1)$ symmetry lacks.

$$\exp(-tr/(|\eta_{TA}| \cdot |\eta_{SA}|)) \tag{96}$$

4.5 Dynamics models for quantum transitions

This unit discusses the possibility that aspects of proposed theory pertain to temporal aspects of quantum transitions.

People discuss the extent to which quantum transitions correlate with non-zero time intervals. (See, for example, reference [6].) People may have observed quantum transitions that take non-zero time. (See reference [35].)

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 (96). (See discussion regarding equation (36).)

4.6 Models for interactions with gravity

This unit discusses models for non-quantum interactions between objects and gravity.

Equation (97) 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.

$$(G_N m_1 m_2/r^2)(-\overrightarrow{r}/r) = \overrightarrow{F} = m_2\overrightarrow{a} \tag{97}$$

The factor m_2 appears in each of the left-most and right-most parts of equation (97). Observations show that gravity bends the paths of light. Equation (98) pertains, including for photons. Equations (99) and (100) might pertain and might point toward aspects of general relativity. The symbol E denotes energy. The symbol $\overrightarrow{P}$ denotes momentum.

$$(G_N m_1/r^2)(-\overrightarrow{r}/r) = \overrightarrow{a} \tag{98}$$

$$-(G_N E_1 E_2/r^2)\overrightarrow{\hat{r}} = \overrightarrow{F} = E_2\overrightarrow{a} \tag{99}$$

$$(E_-)^2 = (m_-c^2)^2 + (\overrightarrow{P_-} \cdot \overrightarrow{P_-})c^2 \tag{100}$$

We consider the motion of a simple boson for which $\sigma = +1$ or of a quanta that correlates with a long-range force. ALG modeling pertains. Quantum excitation or de-excitation need not necessarily pertain regarding effects of gravity. Modeling regarding energy and momentum might pertain. (See, for example table 13. Discussion related to equation (102) notes notions that might underlie such modeling.)

4.7 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 [28].) Also, people express other concerns regarding modeling pertaining to large-scale physics. For example, reference [41] alludes to possible concerns correlating with the Hubble constant (or, a Hubble parameter).

Proposed theory offers possible insight and resolution regarding such concerns.

Proposed theory suggests that general relativity might not suffice to the extent that modeling correlates significantly with one isomer of 4G4 and correlates significantly with two or more isomers (of PR6ISe-span-one phenomena) of a long-range force $\Sigma G\Gamma$ other than 4G4. For example, for PR6ISe modeling, during the first era of accelerating rate of expansion of the universe, the six isomers of the set of 4(1)G2468a and 4(1)G2468b forces dominate. Each isomer of force correlates with a unique one of six isomers of non-zero-charge (or, PR6ISe-span-one) simple fermions. Effects correlating with any one of the six isomers of PR6ISe-span-one phenomena do not necessarily correlate significantly with the motion of objects correlating with any of the other five isomers of PR6ISe-span-one phenomena.

Proposed theory offers the following possible opportunities, tests, and challenges regarding general relativity.

- The extent to which general relativity correlates with effects of components, other than 4G4, of 4γ might be an open question. For example, for PR1ISe models, to what extent do effects that correlate with 4G48 correlate with the general relativity concept of rotational frame-dragging (or, the Lense-Thirring effect)?

- The span of 4(2)G48 is less than the span of 4(6)G4. This mismatch regarding spans suggests that PR6ISe models based solely on general relativity and PR36ISe models based solely on general relativity might not accurately portray aspects regarding the presently accelerating rate of expansion of the universe. This mismatch might provide a basis for improving on ongoing theory modeling.

- The spans of 4(1)G2468a, 4(1)G2468b, and 4(1)G246 are less than the span of 4(6)G4. This mismatch regarding spans suggests that PR6ISe models based solely on general relativity and PR36ISe models based solely on general relativity might not accurately portray aspects regarding large-scale effects in eras that precede the present era of accelerating rate of expansion of the universe. This mismatch might provide a basis for improving on ongoing theory modeling.

- Six isomers of 4(6)G4 pertain for PR36ISe models. General relativity might pertain somewhat for each PR6ISe isomer and might not pertain across PR6ISe isomers.

- Effects of non-4G4 components of 4γ can be significant for aspects of galaxy evolution.

Proposed theory suggests nominal long-range forces correlating with $\Sigma \geq 6$ (or, $S \geq 3$). (Here, the word nominal contrasts with the word anomalous.) However, under almost all circumstances, nominal long-range forces for which $\Sigma = 4$ or $\Sigma = 2$ might be more significant than nominal long-range forces for which $\Sigma \geq 6$.

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; 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.

4.8 Aspects of dynamics modeling regarding hadron-like particles

This unit discusses modeling regarding components of hadron-like particles. 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 illustrates the notion that simple bosons can contribute any one of three symmetries regarding boost-related symmetry.

We explore dynamics modeling for components of hadron-like particles. (See discussion related to table 13.)

Table 41 reinterprets aspects of table 23. Each row in table 41 correlates with solutions that correlate with phenomena related to dynamics within hadron-like particles. For example, known hadron-like particles correlate with 1Q⊗2U. Known hadron-like particles have internal interactions mediated by 2U simple particles, 2W simple particles, and 2G long-range forces. known hadron-like particles can emit 1C and 1N particles. (The table does not list the 0P and 0K solutions, which proposed theory suggests pertain to interactions between hadron-like particles but not necessarily to dynamics within hadron-like particles. See discussion regarding table 1.) Regarding table 41, each pairing of a boson solution with a fermion solution exhibits each of CP3, CA3, and a choice between B3, B2, and B0. CP3 correlates with $SU(2){:}\pm1$ and with, for the hadron-like particle, one of conservation of angular momentum and conservation of momentum. (Here, the number after the colon denotes a contribution to the relevant $\widehat{A}_{XA}^{ALG}$. See table 3.) Regarding symbols of the form $\pm$, for other than ΣGΓ, the plus pertains to the extent that either $n_{TA0} = 0$ or $n_{SA0} = 0$ and minus pertains to the extent that either $n_{TA0} = -1$ or $n_{SA0} = -1$. (For other than ΣGΓ, there are no cases of mismatches between n_{TA0} and n_{SA0}.) CPA correlates with $SU(2){:}\pm1$ and with, for the hadron-like particle, the other one of conservation of angular momentum and conservation of momentum. CC2 correlates with $U(1){:}0$ and with conservation of charge. The choice between B3, B2, and B0 correlates with a choice of modeling for the kinematics of a hadron-like particle. B3 correlates with $SU(2) : \pm1$, with boost symmetry, and with modeling (for the hadron-like particle) correlating with special relativity. B2 correlates with $U(1){:}0$. Each of a TA-side B0 and an SA-side B0 correlates with $n_{TA0} = n_{SA0}$; with $\chi_{(0,0),(-1,-1)}$ and, with respect to the elementary boson, with $\widehat{A}_{(TA0,SA0)}^{ALG}{=}0$; and, for the hadron-like particle, with $\kappa_{0,-1}$ (or, no symmetry). (See table 3.) In table 41, each entry in the TA4-and-TA3 column and each entry in the SA3-and-SA4 column correlates with $SU(2)$. In table 41, each entry in the TA2-and-TA1 column and each entry in the SA1-and-SA2 column correlates with $U(1)$. The symbol * correlates with a boson channel. (See discussion related to equation (46) and discussion related to equation (111).) CBN2 correlates with $U(1){:}0$ and with somewhat conservation of baryon number. CLN2 correlates with $U(1){:}0$ and with somewhat conservation of lepton number. Conservation of lepton number minus baryon number correlates with a combination of CBN2 and CLN2. G3 correlates with $SU(2){:}\pm1$ and with generation. CA3 correlates with $SU(2){:}\pm1$ and with somewhat conservation of generation. For each of some (but not all) bosons, CP3 correlates with somewhat conservation of fermion generation for interactions with fermions. Each of ECT2s, ECT2, and ECS2 correlates with $U(1){:}0$. The pair ECT2s and ECS2 correlates with conservation of charge. The pair ECT2 and ECS2 correlates with conservation of charge. For each row in table 41, the combination of conservation of momentum and conservation of angular momentum (or, the combination of CP3 and CA3) does not pertain.

Table 41 correlates with the notion that, if such could exist in nature, a free-ranging 1Q or 1R particle would correlate, at least with respect to ongoing theory, with some (at least virtual) bosons. Proposed theory modeling regarding such a 1Q or 1R particle does not include both emitting an elementary boson and absorbing the same elementary boson or a successor to the same elementary boson. (See remarks related to table 25.) In proposed theory, the notion of free environment does not pertain for individual simple fermions for which $\sigma = -1$.

Proposed theory suggests that a hadron-like particle must include at least two (non-virtual) fermions for which $\sigma = -1$. (The notion of virtual correlates with ongoing theory. Aspects of proposed theory do not necessarily include the notion of virtual fermions.) In addition, per the example regarding 1Q⊗2U hadron-like particles, there is no requirement for n_{SA0} for the simple fermions to match n_{SA0} for the elementary bosons.

4.9 Possible modeling for fissionable or bound-state multicomponent objects

This unit discusses aspects of proposed theory modeling regarding multicomponent objects.

For PDE modeling regarding a multicomponent object, equation (101) and the following concepts might pertain. In the equation, P denotes the magnitude of momentum. A_{SA}^{PDE} correlates with $(mc^2)^2 +$

Table 41: Properties and interactions, with respect to hadron-like particles, for simple particles and unimpeded long-range forces

ΣΦ or ΣΦΓ	σ	|←	⋯	TA	⋯	→|	|←	⋯	SA	⋯	→|
		8,7	6,5	4,3	2,1	0	0	1,2	3,4	5,6	7,8
0H	+1			CP3	CC2	0	B0	B2	B3	*	
0I	+1			B3	B2	B0	0	CC2	CP3	*	
1N	+1		CBN2	CA3	ECT2s	−1	−1	ECS2	G3	CLN2	
1C	+1		CBN2	CA3	ECT2s	0	0	ECS2	G3	CLN2	
1R	−1		CBN2	CA3	ECT2	−1	−1	ECS2	G3	CLN2	
1Q	−1		CBN2	CA3	ECT2	0	0	ECS2	G3	CLN2	
2U	−1			B3	B2	B0	−1	CC2	CP3	*	
2W	+1			CP3		0	B0	B2	B3	*	
2T	−1			B3	B2	B0	0		CP3	*	
ΣGΓ	+1			CP3	CC2	0	B0	B2	B3	*	

$(Pc)^2 + f_{SA}$. A_{TA}^{PDE} correlates with $E^2 + f_{TA}$. Here, each one of f_{SA} and f_{TA} is nonnegative. For some applications, $f_{SA} > 0$ correlates with a fissionable system and possibilities for decay. Note that, if $f_{TA} = 0$, E^2 exceeds $(mc^2)^2 + (Pc)^2$. For example, $f_{SA} > 0$ might correlate with models for beta decay via the weak interaction. For some applications, $f_{TA} > 0$ correlates with bound states. Note that, if $f_{SA} = 0$, E^2 is less than $(mc^2)^2 + (Pc)^2$. For example, $f_{TA} > 0$ might correlate with models for the structure of atomic nuclei. We are uncertain as to the extent to which such modeling for multicomponent objects would provide perspective that ongoing theory does not provide.

$$E^2 + f_{TA} = A_{TA}^{PDE} = A_{SA}^{PDE} = (mc^2)^2 + (Pc)^2 + f_{SA} \tag{101}$$

4.10   Modeling regarding refraction and similar effects

This unit discusses some aspects of kinematics and dynamics for zerolike rest mass particles, under assumptions regarding how the particles interact with their surroundings. This unit discusses modeling for the refraction of light. This unit discusses modeling regarding the existence of neutrino oscillations.

We discuss some aspects of kinematics and dynamics for simple particles for which $n_{P0} = -1$ and for long-range forces (for which $n_{P0} = -1$). The equation $n_{P0} = -1$ correlates with the notion of zerolike rest mass.

We explore kinematics and dynamics in contexts in which a zerolike rest mass elementary particle interacts with its surroundings. Known examples include photons in refractive media and gluons in hadrons. Similar considerations might pertain for neutrinos. Generally, we consider that a zerolike rest mass elementary particle and its surroundings constitute the two components of a system. We focus on kinematics or dynamics for the zerolike rest mass particle. We do not necessarily focus on kinematics for the system or dynamics for the system.

Mathematically, there are four cases to consider. The case of $\sigma = +1$ and $n_{TA0} = 0$ pertains for (at least) long-range forces. The case of $\sigma = +1$ and $n_{TA0} = -1$ pertains for neutrinos. The case of $\sigma = -1$ and $n_{TA0} = -1$ pertains for (at least) gluons. The case of $\sigma = -1$ and $n_{TA0} = 0$ is not necessarily physics-relevant. (We do not predict the existence of simple particles for which $\sigma = -1$ and $n_{TA0} \neq n_{SA0}$. Generally, see table 23.)

Each of equations (102) and (103) offers, based on using the range $-1 < n_{P0} < 0$, a possible basis for kinematics modeling regarding the zero rest mass elementary particle. (We contrast $-1 < n_{P0} < 0$ with $n_{P0} < -1$. Uses of the expression $n_{P0} < -1$ pertain for spin-related symmetry applications, for some modeling regarding gluons, and not necessarily for other purposes. Regarding the spin-related symmetry applications, see table 16. Regarding the gluon-related modeling, see table 42.) 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.

$$n_{P0} = -c^2 P^2 / E^2 \tag{102}$$

Solution	TA6	TA5	TA0	SA0	SA3	SA4
2U60	-2	-1	0	-1	-1	-1
2U56	0	-2	-1	-1	-1	-1
2U05	-1	0	-2	-1	-1	-1
2U50	-1	-2	0	-1	-1	-1
2U06	0	-1	-2	-1	-1	-1
2U65	-2	0	-1	-1	-1	-1

$$n_{P0} = -v^2/c^2 \tag{103}$$

For each of the three physics-relevant cases, each of equations (102) and (103) 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 $\sigma = +1$ 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).

For the case of $\sigma = +1$ 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 $SU(2)$ approximate conservation of generation symmetry or to at least one of the TA-side oscillators that correlate with conservation of energy symmetry. The case correlates with neutrino oscillations.

For the case of $\sigma = -1$ and $n_{TA0} = -1$, discussion is not quite as straightforward as is discussion for the other two physics-relevant cases. Discussion related to table 42 and table 43 pertains regarding gluons. (See discussion related to equation (104).)

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 such possible opportunities. We choose not to explore the extent to which modeling might feature mathematics for which at least one of the TA-side harmonic oscillator and the SA-side harmonic oscillator is not isotropic.

4.11   U-family interactions and the strong interaction $SU(3)$ symmetry

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

The 2U solutions correlate with gluons. Here, we provide details correlating with the TA-side $\kappa_{-1,-1,-1}$ symmetry that table 12b shows.

Table 42 shows details regarding 2U solutions. The expression $\kappa_{-1,-1,-1}$ correlates with $A_{TA}^{ALG} = -3/2$. Each one of the six TA-side $\pi_{0,-1,-2}$ permutations pertains. Each permutation correlates with $A_{TA}^{ALG} = -3/2$. Table 42 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 matter simple fermions for which $\sigma = -1$ and antimatter simple fermions for which $\sigma = -1$. The set of the other three permutations correlates with the other choice between antimatter simple fermions for which $\sigma = -1$ and matter simple fermions for which $\sigma = -1$. Regarding matter simple fermions for which $\sigma = -1$, each of oscillators TA6, TA5, and TA0 correlates with a color charge. Relative to an ongoing theory standard representation for gluons, one of TA6 and TA5 correlates with the color red, the other of TA6 and TA5 correlates with the color blue, and TA0 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 (104) and (105) pertains. (Perhaps, compare with discussion, pertaining to refraction, regarding equations (102) and (103).) 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 $\rightarrow$ denotes, in the mathematical sense of a limit, the two-word phrase goes to.

$$(n_{SA0} = -1) \leftarrow (n_{SA0} = -v^2/c^2 \rightarrow 0^-) \tag{104}$$

Table 43: 2U erase or paint ground states

Ground state	TA6	TA5	TA0	SA0	SA3	SA4
2U0 = 2U60⊕2U50	−1	−1	0	0	−1	−1
2U6 = 2U56⊕2U06	0	−1	−1	0	−1	−1
2U5 = 2U05⊕2U65	−1	0	−1	0	−1	−1

$$(n_{TA\_} = -2) \leftarrow (n_{TA\_} = (-1 - v^2/c^2) \rightarrow (-1)^-) \tag{105}$$

Equations (104) and (105) correlate with boson behavior for gluons. In effect, modeling of excitations and de-excitations correlates with a ground state that correlates with equation (106) and with, for the appropriate $n_{TA\_}$, equation (107). (See tables 42 and 43.) 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 42.)

$$n_{SA0} = 0 \tag{106}$$

$$n_{TA\_} = 0 \tag{107}$$

Table 43 shows results of applying, to items in table 42, aspects correlating with equations (106) and (107). Table 43 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 $\sigma = -1$ simple fermion that absorbs the gluon, a color. The paint part correlates with, in effect, an ability to paint, on to the $\sigma = -1$ simple fermion that absorbs the gluon, a color. The value $n_{TA\_} = 0$ denotes an ability for a gluon to erase or paint the color charge correlating with the TA_ oscillator. Equation (108) 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 43, we make the following correlations. (Alternatively, without loss of generality or results, one might reverse the roles of TA6 and TA5.) The symbol r correlates with painting the color red and with a painting application of 2U6. The symbol $\bar{r}$ correlates with erasing the color red and with an erasing application of 2U6. The symbol b correlates with painting the color blue and with a painting application of 2U5. The symbol $\bar{b}$ correlates with erasing the color blue and with an erasing application of 2U5. 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.

$$(r\bar{r} + b\bar{b} - 2g\bar{g})/(6)^{1/2} \tag{108}$$

Ongoing theory correlates an $SU(3)$ symmetry with gluons. Proposed theory embraces the same $SU(3)$ symmetry per discussion nearby above. A $\kappa_{-1,-1}$ symmetry that correlates, in table 12b, with the oscillator pair SA3-and-SA4 reappears in table 43. This $\kappa_{-1,-1}$ symmetry correlates with conservation of fermion generation for interactions mediated by gluons.

5 Relationships between various 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 suggests insight, that proposed theory might provide, regarding the strong CP problem and regarding axions. This unit discusses aspects regarding G-family interactions and channels. This unit suggests modeling that would comport with the notion that nature does not include the following - an elementary particle magnetic monopole, a non-zero electric dipole moment for any elementary particle, and a non-zero neutron electric dipole moment. 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 explores concepts related to the masses of hadron-like particles that include arc simple fermions. This unit explores possibly useful modeling regarding the masses of quarks and charged leptons. This unit lists topics, regarding aspects of the cosmology timeline, for which proposed theory suggests insights. This unit shows a possible link between dynamics modeling that we suggest and a notion of entropy.

5.1 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, approximate conservation of fermion generation, and approximate conservation of lepton number.

We discuss adding to the Standard Model some of the simple particles and long-range 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 long-range 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 (103).)

5.2 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 such violation. 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 47.) Proposed theory suggests insight regarding the electric dipole moment of the neutron. (See discussion related to equation (113).) Proposed theory suggests possible insight regarding the possible existence of magnetic monopoles. (See discussion related to equation (112).) 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 (94).)

5.3 Channels and G-family interactions

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

The notion of channels pertains to, for example, the relative strengths of electromagnetism and gravity. (See discussion related to equation (47).)

Each of equation (109) and equation (110) provides a candidate formula for the number of channels that pertain for the G-family solution $\Sigma G\Gamma$. Equation (109) correlates with table 10. Possible long-range forces correlating with $\Sigma \geq 10$ would not be relevant to physics. (See table 1.) Equation (110) correlates with table 9. Possible long-range forces correlating with $\Sigma \geq 10$ could be relevant to physics. We might not have enough data or theory to choose between candidate formulas. We do not choose between the candidate formulas.

$$5 - (\Sigma/2) \tag{109}$$
$$5 - (\lambda_{max}/2), \text{ with } \lambda_{max} = \max\{\lambda | \lambda \in \Gamma\} \tag{110}$$

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. For this purpose, isotropic weighting pertains regarding oscillator pairs.

We discuss possible aspects of modeling for a 1f1b→1f0b interaction. The following notions pertain.

The incoming state de-excites by transferring one unit of 1b excitation to one of the channels. For that channel, equation (111) pertains.

$$\kappa_{0,-1} \rightarrow \kappa_{0,0} \tag{111}$$

The new SA-side $SU(2)$ symmetry adds an extra kinematics-conservation-like symmetry that cannot last. (See table 13.) The interaction includes converting the $\kappa_{0,0}$ symmetry to something, pertaining 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 (111) and an SA-side application of equation (111). 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.

5.4 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 the following - an elementary particle magnetic monopole, a non-zero electric dipole moment for any elementary particle, and a non-zero neutron electric dipole moment.

Table 37 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 (112) expresses.

The 2G2 solution correlates with electromagnetic (not magnetic) monopole moments. (112)

Table 37 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.

For each hadron for which 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 24, regarding PDE-based modeling that correlates with some aspects of the strong, electromagnetic, and weak interactions.) Equation (113) shows an upper bound on the electric dipole moment for the neutron. (See reference [50]. 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 [49], of reference [1].)

$$0.30 \times 10^{-27} \, |q_e| \, \text{m} \tag{113}$$

5.5 Supersymmetry and string theory

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.

Tables 1 and 37 seem, in themselves, to be incompatible with supersymmetry. People might explore the notion of layering supersymmetry over results that tables 1 and 37 show. However, given aspects of proposed theory, supersymmetry might not be necessary to explain known phenomena.

String theory correlates with notions of space-time frothiness on the scale of the Planck length (or, $R_2(m)$). (See equation (120).) 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 (120).) The Schwarzschild radius might correlate with a size for elementary particles that have zero spin. (See equation (119).) Speculatively, the disparity between these two sizes might lead to means to explore making string theory more relevant to elementary particle physics that it has proven to be.

We suggest perspective about string theory and about proposed theory. (Reference [46] provides perspective about string theory.) Regarding simple particles and long-range forces, proposed theory correlates with the three-word term theory of what. Proposed theory outputs a list of what elementary particles that nature embraces or might embrace. We contrast notions of theory of what with notions

Table 44: 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.

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.

5.6 Other discussion regarding the masses of simple particles and hadron-like particles

This unit explores concepts related to the masses of hadron-like particles that include arc simple fermions. This unit explores possibly useful modeling regarding the masses of quarks and charged leptons.

We discuss rest energies for 1R⊗2U hadron-like particles.

The rest energy of a proton does not differ by 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 [50] 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. The respective spans correlate with PR1ISe modeling, PR6ISe modeling, and PR36ISe modeling. Equation (114) 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 left-most use of the ratio $m_{1R⊗2U}/m_{1Q⊗2U}$ correlates with rest energy (or rest mass) per particle. The right-most use of the ratio $m_{1R⊗2U}/m_{1Q⊗2U}$ occurs as the input to a calculation of an exponential and correlates with a hypothesis regarding the relative number of particles that nature created.

$$\Omega_{ib}/(s \cdot \Omega_b) \sim (m_{1R⊗2U}/m_{1Q⊗2U}) \exp(-m_{1R⊗2U}/m_{1Q⊗2U}) \tag{114}$$

The respective values of $\Omega_{ib}/(s \cdot \Omega_b)$ 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 44 summarizes some possible rest energies for 1R⊗2U hadron-like particles.

We explore concepts related to the lack of equality in equation (115). (See table 30 and equation (52).) Doing so might lead to insight about the term $(j''_{M''})d''$ in equation (52). For the electron, muon, and tauon, the respective values of M'' are zero, two, and three. Regarding equation (115), a notion of

equality - instead of inequality - would correlate with mathematical equality regarding the three values of $\log(m_{M''+1}) - \log(m_{M''})$ for which $0 \le M'' \le 2$. Here, $m_{M''}$ equals $m(M'', 3)$. (See equation (52).)

$$m_\mu^2/m_e^2 < (m_\tau^2/m_\mu^2)^2 \tag{115}$$

We determine a quantity ω_e that has units of mass; that might correlate mathematically, but not physically, with 8G8 strength related to all three charged leptons; and that satisfies equation (116). (8G8 does not interact with individual simple fermions and might not interact significantly with multicomponent objects.) The result $\omega_e \approx 0.3486 \, \text{MeV}/c^2$ pertains. This result is somewhat less than the mass of the electron. This result does not necessarily comport with work regarding $\alpha^2 m_e$. (See discussion regarding equation (18).) As yet, we do not find the exploration of ω_e to be physics-relevant.

$$(m_\mu^2 - \omega_e^2)/(m_e^2 - \omega_e^2) = ((m_\tau^2 - \omega_e^2)/(m_\mu^2 - \omega_e^2))^2 \tag{116}$$

We explore a similar concept regarding quarks and 6G6. Equation (117) pertains. (See equation (52).) The result $\omega_q \approx 3.02 \, \text{MeV}/c^2$ pertains. This result might be somewhat less than the geometric mean of the experimental masses of the up and down quarks. (See table 30. Regarding equation (117), the notion of $m(M'', 3/2)$ correlates with the factor of $3/2$ that appears in equation (52) and with the notion that $j'_{3/2} = 0$.)

$$((m(1,3/2))^2 + \omega_q^2)/((m(0,3/2))^2 + \omega_q^2) = ((m(2,3/2))^2 + \omega_q^2)/((m(1,3/2))^2 + \omega_q^2) \tag{117}$$

We are uncertain as to possible significance for the notion that each of ω_e and ω_q is somewhat similar to the masses of the respectively relevant generation-one simple fermions.

5.7   The cosmology timeline

This unit lists topics, regarding aspects of the cosmology timeline, for which proposed theory suggests insights.

Work that we discuss above makes suggestions about the following aspects of the ongoing theory cosmology timeline.

- The production of baryon asymmetry.

- Eras regarding the rate of expansion of the universe.

- Dark matter baryon-like acoustic oscillations, plus effects of those acoustic oscillations that lead to at least some aspects of filaments.

- Clumping that forms various objects, such as stars and galaxies.

- Galaxy formation and evolution.

Proposed theory suggests the following notions.

- Scenarios regarding clumping suggest that a significant fraction of early black holes contained stuff correlating with essentially just one isomer of PR6ISe-span-one phenomena. Approximately one-sixth of such one-isomer black holes correlate with each one of the six isomers of PR6ISe-span-one phenomena.

- Significant aspects of quasars, black hole jets, and blazars might correlate with effects of the 4G48 repulsive long-range force. Similarly, aspects of radio-wave emitting bubbles might correlate with effects of the 4G48 repulsive long-range force. (See references [16] and [26].)

- Significant aspects of black hole or neutron star collisions might correlate with effects of the 4G48 repulsive long-range force.

Proposed theory also might suggest the following notions.

- Early in the evolution of the universe, the universe that people know might have decoupled from, destroyed, or expelled right-handed simple fermions. (See discussion related to equation (93).)

- 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.

- Proposed theory is not incompatible with possible large-scale flatness for the universe.

Table 45 suggests some phenomena that people might want to feature in cosmology timelines.

Table 45: Some phenomena that people might want to feature in cosmology timelines

Phenomena
• Transition to dominance by left-handed simple fermions. (See discussion related to equation (93).)
• 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 39.)
• Earliest visible galaxies of various types that table 40 suggests.
• Achievement, by some galaxies, of approximately four to one ratios of dark matter density to ordinary matter density. (See table 40.)
• 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 39.)
• 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 39.)

5.8   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 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 (118) 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.

$$j \log(j) \tag{118}$$

6   Possible opportunities to develop deeper insight

This unit discusses modeling that people might use to develop new aspects of physics theory.

6.1   Numbers of dimensions

This unit speculates regarding one aspect 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 (32) and (33).)

For a hypothetical five spatial dimensions and $D_{SA}^* = 5$, for a simple fermion, the particle might correlate with $\nu_{SA} = -5/2$ and modeling might suggest relevance for two fields. One field could correlate

Table 46: 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

with $\nu_{SA} = -1/2$. One field could correlate with $\nu_{SA} = -3/2$. The notion of two fields might correlate with a lack of physics relevance.

6.2 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 (119) correlates with the Schwarzschild radius for an object of mass m. Equation (120) correlates with the Planck length and does not depend on m. Equation (121) includes a factor of m^{-1}. When applied to the mass of 2W bosons, equation (121) correlates somewhat with the range of the weak interaction. When applied to the mass of a charged pion, equation (121) correlates somewhat with a range for the strong interaction. Equation (122) shows the ratio between successive formulas. Equation (123) shows, for the electron, the ratio correlating with equation (122).

$$R_4(m) = (G_N)^1 m^1 \hbar^0 c^{-2} 2^1 \tag{119}$$

$$R_2(m) = (G_N)^{1/2} m^0 \hbar^{1/2} c^{-3/2} 2^0 \tag{120}$$

$$R_0(m) = (G_N)^0 m^{-1} \hbar^1 c^{-1} 2^{-1} \tag{121}$$

$$(G_N)^{-1/2} m^{-1} \hbar^{1/2} c^{1/2} 2^{-1} \tag{122}$$

$$(G_N)^{-1/2} (m_e)^{-1} \hbar^{1/2} c^{1/2} 2^{-1} \approx 1.1945 \times 10^{22} \tag{123}$$

Proposed theory might point to $R_0(m_{H^0})$ as being a minimal size relevant for some modeling of aspects of objects that contain more than one simple fermion. (Here, m_{H^0} denotes the mass of the Higgs boson.)

6.3 CPT-related symmetries

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

Table 46 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 47 might correlate with ongoing theory notions of T, C, and P approximate symmetries. Similarities exist between TSP transformation and T (or, time reversal) transformation, between APM transformation and C (or, charge-reversal) transformation, and between SSP transformation and P (or, parity-reversal) transformation. A significant difference between TSP symmetry and T symmetry and a significant difference between APM symmetry and C symmetry might pertain and might correlate with gluons and with color charge.

Table 47: 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

6.4 Relationships between properties of objects and forces

This unit notes that proposed theory might point to opportunities to further explore relationships between charge and mass. This unit notes that proposed theory might point to opportunities to further explore relationships between strengths of components of long-range forces. This unit suggests a possible opportunity to explore relationships between handedness, chirality, helicity, lepton number or baryon number, rotation, and spin.

We discuss relationships between charge and mass.

The fine-structure constant appears in a formula that links the masses of the six quarks to the masses of the three charged leptons. (See equation (52).) The fine-structure constant includes, as a factor, the square of the charge of the electron. (See equation (53).)

The charge of an electron and the mass of an electron appear in a formula that links the mass of a tauon to the mass of an electron. (See equation (47).)

Generally, the mass of a known charged hadron is less than the mass of a similar uncharged object. One example compares the mass of a charged pion to the mass of a neutral pion. One example compares the mass of a proton to the mass of a neutron. Modeling based on equation (101) might correlate a portion of f_{TA} with non-zero charge.

The mass of the W boson is less than the mass of the Z boson. The square of the mass of the W boson is proportional to $10 - 1 - 2$. (See discussion related to equation (43).) The square of the mass of the Z boson is proportional to $10 - 1$. The two in the expression that is proportional to the mass of the W boson seems to link charge and mass. The one or the ten in the expressions that are proportional to the masses of the W or Z bosons might link spin and mass.

Proposed theory might suggest opportunities to further explore relationships between charge and mass and relationships between strengths of components of long-range forces.

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 (124) and (125) pertain. The symbol m denotes mass. Boson simple particle masses tend to feature relationships regarding squares of masses. Equation (124) points to results that feature squares of masses. For each simple $\sigma = +1$ boson, the equation evaluates approximately to an integer. The equation might correlate with the 2U-related potential that scales like r^1 and pertains regarding $\sigma = -1$ simple fermions in hadron-like particles. Equation (125) 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 pertain regarding simple fermions that have quantum interactions with 2G2 and 4G4 long-range forces.

$$\int_0^{m/(m_Z/3)} 2r^1 dr \tag{124}$$

$$\int_1^{m/m_e} r^{-1} dr \tag{125}$$

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.

6.5 Arrow of time and entropy

This unit notes that proposed theory may provide perspective regarding the topic of arrow of time and regarding the topic of entropy.

We discuss aspects regarding arrow of time.

Equation (96) suggests a $\Psi(t,r)$ that correlates with the TA0-and-SA0 oscillator pair. (See equation (27).) 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.

The proposed theory notion that modeling of conservation of energy correlates 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.

We discuss aspects regarding entropy.

Discussion related to equation (118) might provide insight regarding entropy.

Speculatively, interactions correlating with the 8G8 solution catalyze, in some situations, increases in entropy. (See discussions related to tables 13 and 38.)

6.6 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.

Proposed theory QFT includes volume-like interaction vertices. Especially to the extent that models correlate with $v_c > c$, people might interpret these vertices as correlating with tachyon-like behavior. (See discussions related to equation (38) and equation (42).)

6.7 One notion regarding possible universes beyond our universe

This unit speculates about one notion regarding possible universes beyond our universe.

Regarding the G-family, beyond modeling that includes models for channels, one might correlate the oscillator pairs SA11-and-SA12, SA13-and-SA14, and SA15-and-SA16 with conservation of angular momentum symmetry, conservation of linear momentum symmetry, and boost-related symmetry. (See discussion regarding equation (111).) Doing so might correlate with relevance for an $SU(17)$ symmetry. (Note remarks regarding equation (11).)

Within a context correlating with the symmetries that equation (126) shows, modeling for all known physics might correlate with a notion of confined environment and a notion that we might characterize by $\sigma_{17} = -1$. (Compare with $\sigma = -1$ in, for example, table 23. Regarding the possibility correlating with a TA-side $SU(7)$ symmetry, see table 41 and, perhaps, also note that one might, in table 23, move information regarding the TA8-and-TA7 oscillator pair to the TA6-and-TA5 oscillator pair.)

$$\text{TA-side: } SU(7) \text{ or } SU(17), \text{ SA-side: } SU(17) \tag{126}$$

The ratio of the number of generators of $SU(17)$ to the number of generators of $SU(7)$ is six (or, $288/48$). Regarding discussion regarding equation (126), this factor of six might correlate with a $\pi_{r,b,g}$

symmetry correlating with red, blue, and green color charges and with oscillators TA6, TA5, and TA0. (See table 42.)

In the context of $\sigma_{17} = -1$, the factor of six might correlate with a $U(1)$ symmetry (for which the number of generators is two) and an $SU(2)$ symmetry (for which the number of generators is three). (See discussion related to equation (126).) Speculatively, one or more of the following notions might pertain.

- Our universe is one of either two or six universes in a so-called larger-scale universe that includes, respectively, two or six objects of the scale of our universe.

- A big bang for the larger-scale universe created, in effect, our universe and an anti-universe.

- An ongoing theory somewhat analog of a possible T-symmetry-related conservation of energy pertains across the creation of this our-universe and anti-universe pair.

7 Concluding remarks

This unit discusses possible opportunities based on proposed theory.

Proposed theory might provide impetus for people to tackle broad agendas that the 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 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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