Extract 1 from

About Much Physics
United Models and Specific Predictions

Thomas J. Buckholtz

Contents in this extract

Some results (from table 1.1 in section 1.3 of the book)

1. Elementary particles not yet discovered exist naturally only in composite particles or composite seas.
2. Composite particles made of gluons and zero-charge low-or-zero-mass fermion analogs to quarks provide for some dark matter.
3. Most dark matter has as a basis five copies of approximately the ordinary matter Standard Model set of elementary particles and composite particles.
4. Galaxies that are dense in ordinary matter stars began as having essentially only ordinary matter and then accrued dark matter based on four dark matter copies of approximately the ordinary matter Standard Model set of elementary particles and composite particles.
5. Dark energy forces consist of dipole, quadrupole, and octupole relatives of monopole gravity. The dipole force is responsible for the recent few billion year era of increasing rate of expansion of the universe. The quadrupole force was responsible for the previous few billion year era of decreasing rate of expansion of the universe. The octupole force was responsible for the earlier few billion year era of increasing rate of expansion of the universe.
6. New theory complements traditional physics theory and avoids potential difficulties such as a large sum of photon ground state energies and conditionally convergent perturbation theory sums.

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About Much Physics

United Models and Specific Predictions

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Contents

Preface

Just one framework for much physics
What a triumph it might be
If indeed it does comport with
Dark matter and gravity

Physics presents opportunities for enhancing the breadth and unity of physics. Opportunities exist to broaden theory to suggest new elementary particles; to explain dark matter, dark energy, aspects of the cosmology timeline, and aspects regarding the evolution of galaxies; and to suggest or explain other phenomena. Opportunities exist to unite aspects of the elementary particle Standard Model, special relativity, quantum mechanics, general relativity, atomic physics, and classical physics.

Such opportunities sum to a broad agenda. Attempts to add such breadth and unity seem to have hit impasses. Perhaps it is time to tackle an unsolved problem, via a new approach.

We try to develop a basis for cataloging known elementary particles and suggesting other elementary particles. The approach involves math that, while not very deep, seems to have been historically de-emphasized, seems to provide a basis for cataloging and suggesting elementary particles, and seems to provide a basis for integrating historically useful physics theories and models.

Aspects, models, and theories that we correlate include elementary particles and their properties, some aspects of the elementary particle Standard Model, dark matter, dark energy, the cosmology timeline, some astrophysics, special relativity, general relativity, quantum mechanics, some atomic physics, and some classical physics.

We hope that this work provides, at least, precedent and impetus for people to try to tackle such a broad agenda. This work may provide a means to tackle such an agenda. This work may provide progress toward fulfilling that agenda.

- Thomas J. Buckholtz

Portola Valley, California USA
May 2018

To Helen Buckholtz

In memory of Joel and Sylvia J. Buckholtz

With gratitude to people who provided useful nudges

With thanks to people who provided opportunities to propagate versions of this work

With appreciation to each of many people who contributed to my being able to attempt this work

Chapter 1

Overview

This unit suggests context for working with our work and provides a summary of our work.

Use this unit to shape decisions about your roles regarding and your interests in our work.

1.1 A brief re *AS1|CUSP e. TRADIT|PHYT* (or: Dear reader ...)

Your Honor (or: Dear reader), we ask that, as you consider your role on the panel of judges (or: your roles in society) that will or can help people settle the matter of *AS1|CUSP e. TRADIT|PHYT*, you consider the following. (AS1|CUSP denotes application set one of CUSP. CUSP abbreviates concepts uniting some physics. TRADIT|PHYT denotes traditional physics theory.)

1. We request you consider synergies between AS1|CUSP and TRADIT|PHYT. We state this case as *AS1|CUSP e. TRADIT|PHYT*, with *e.* as in *et* (or, and). We do not state this case as *AS1|CUSP v. TRADIT|PHYT*, with *v.* as in *vs* (or, versus).
2. We suggest that a framework, CUSP, provides means for you to judge overlaps and synergies between AS1|CUSP and TRADIT|PHYT. You may find that people can consider some TRADIT|PHYT to be AS1|CUSP. You may find that aspects of AS1|CUSP depend on aspects of TRADIT|PHYT.
3. We suggest that, when you think that AS1|CUSP explains observations about nature that TRADIT|PHYT does not explain, you consider issuing a finding of fact.
4. We suggest that, when you think that AS1|CUSP provides a simpler explanation of observations than does TRADIT|PHYT, you consider issuing a finding of fact.
5. We suggest that, when you think that aspects of AS1|CUSP and TRADIT|PHYT conflict, you consider looking more broadly at observations and AS1|CUSP. We stipulate that we are not aware of significant conflict between observations and AS1|CUSP. We stipulate that comparing limited subsets of AS1|CUSP and aspects of TRADIT|PHYT can lead to perceptions of conflict.
6. We suggest that, when you think that work regarding AS1|CUSP, statements about AS1|CUSP, work regarding TRADIT|PHYT, or statements about TRADIT|PHYT are inadequate, you encourage people to develop remedies.
7. We hope that you will find your role rewarding, for society and for yourself.

TBD (or, to be determined)

1. To what extent will you learn about AS1|CUSP?
2. To what extent will you help society decide the outcome of *AS1|CUSP e. TRADIT|PHYT*?
3. To what extent will you help society benefit from uses of CUSP and AS1|CUSP?
4. To what extent will you help society continue to shape CUSP and AS1|CUSP?

1.2 Abstract

We address four physics opportunities. First, suggest new elementary particles and forces. Second, explain phenomena such as dark matter. Third, augment and unite physics theories and models. Fourth, point to opportunities for further research.

We use models based on solutions to equations featuring isotropic pairs of isotropic quantum harmonic oscillators.

First, we show solutions that match the known elementary particles. We propose that other solutions correlate with elementary particles that people have yet to detect and with dark energy forces leading to three known eras - early acceleration, subsequent deceleration, and current acceleration - pertaining to the rate of expansion of the universe.

Second, we extend solutions to encompass known conservation-law symmetries. Extended solutions correlate with known kinematics. We suggest that extended solutions describe dark matter, explain ratios of density of dark matter to density of ordinary matter, correlate with dark energy density, and explain other phenomena.

Third, we propose that our work unites, suggests details regarding, extends, suggests complements to, and suggests limits regarding aspects of traditional physics theory. Those aspects include classical physics, special relativity, general relativity, quantum mechanics, the elementary particle Standard Model, the cosmology timeline, and galaxy evolution scenarios. The work provides possible insight regarding foundation of physics topics.

Fourth, we suggest opportunities for people. We suggest opportunities for observational, experimental, and theoretical physics research. We suggest quantum field theory that features few interaction vertices, sums of few terms as alternatives to conditionally convergent sums of infinite numbers of terms, and no needs to deal with some infinities. We point to possible opportunities to further develop and apply modeling and math we use.

Results

1. Elementary particles not yet discovered exist naturally only in composite particles or composite seas.
2. Composite particles made of gluons and zero-charge low-or-zero-mass fermion analogs to quarks provide for some dark matter.
3. Most dark matter has as a basis five copies of approximately the ordinary matter Standard Model set of elementary particles and composite particles.
4. Galaxies that are dense in ordinary matter stars began as having essentially only ordinary matter and then accrued dark matter based on four dark matter copies of approximately the ordinary matter Standard Model set of elementary particles and composite particles.
5. Dark energy forces consist of dipole, quadrupole, and octupole relatives of monopole gravity. The dipole force is responsible for the recent few billion year era of increasing rate of expansion of the universe. The quadrupole force was responsible for the previous few billion year era of decreasing rate of expansion of the universe. The octupole force was responsible for the earlier few billion year era of increasing rate of expansion of the universe.
6. New theory complements traditional physics theory and avoids potential difficulties such as a large sum of photon ground state energies and conditionally convergent perturbation theory sums.

Table 1.1: Some results

1.3 Summary

This work suggests new physics phenomena; explains known particle, astrophysics, and cosmology phenomena; embraces various models for motion; points to possible alternatives to some quantum dynamics theories; and may provide insight regarding some foundation of physics topics.

Suggested phenomena include elementary particles and composite particles. Explained phenomena include dark matter, dark matter densities, dark energy forces and changes in the rate of expansion of the universe, dark energy densities, and aspects of the evolution of galaxies.

Table 1.1 highlights some results.

This work points to itself via the terms CUSP and AS1|CUSP. CUSP is an acronym for the phrase concepts uniting some physics. CUSP is a mathematical framework for developing models. AS1|CUSP denotes a set of applications of CUSP. TRADIT|PHYT is an acronym for traditional physics theory. COMPLE|PHYT is an acronym for complementary physics theory. The COMPLE|PHYT acronym correlates with aspects of AS1|CUSP that complement aspects of TRADIT|PHYT.

This summary de-emphasizes some aspects of AS1|CUSP that may be useful for explaining known phenomena. Explaining known phenomena does not necessarily require that all suggestions AS1|CUSP makes comport with nature.

AS1|CUSP modeling, TRADIT|PHYT modeling, and quantum field theory

TRADIT|PHYT modeling evolved by adding quantum modeling to classical physics modeling. CUSP and AS1|CUSP begin from explicitly quantum bases. The CUSP framework features modeling based on solutions to equations that feature isotropic pairs of isotropic quantum harmonic oscillators.

Facets of AS1|CUSP feature seemingly appealing aspects. AS1|CUSP modeling comports, based on its roots in harmonic oscillators, with the principle of stationary action. Double-entry aspects, based on pairs of harmonic oscillators, seem to obviate TRADIT|PHYT seeming needs to address possibly infinite sums of boson ground state energies. AS1|CUSP models tend to feature math that is radial in nature and that comports with point-like interaction vertices. Some models treat temporal and spatial aspects on an equal or integrated footing. AS1|CUSP modeling provides easy means to incorporate, at least conceptually, aspects, such as kinematics conservation laws, that people developed in conjunction with TRADIT|PHYT. AS1|CUSP modeling outputs a list of elementary particles that people can incorporate into TRADIT|PHYT.

AS1|CUSP comports with each object having a charge that is an integer multiple of $|q_e|/3$. The symbol q_e denotes the charge of an electron. AS1|CUSP comports with TRADIT|PHYT concepts regarding weak hypercharge. AS1|CUSP comports with each object having a spin that is an integer multiple of $\hbar/2$. AS1|CUSP offers the possibility that a least one model exists that would comport with each elementary boson having a square of mass that is an integer multiple of $(m_{H^0})^2/51$. Here, m_{H^0} denotes the mass of the Higgs boson.

Without considering motion, AS1|CUSP lists solutions that correlate with all known elementary particles and with the possible elementary particles and forces that AS1|CUSP suggests.

AS1|CUSP suggests theory that both complements TRADIT|PHYT quantum field theory and points to possibilities for alternatives to aspects of TRADIT|PHYT quantum field theory. In AS1|CUSP models, there are few types of interaction vertices for interactions involving just elementary particles. In AS1|CUSP models, the number of interaction vertices needed to model a specific phenomenon can be small. For example, in AS1|CUSP models, in effect, an elementary fermion does not reabsorb a boson that the fermion emitted. AS1|CUSP models can feature sums of finite numbers of terms, whereas TRADIT|PHYT models for similar phenomena feature conditionally convergent sums of infinite numbers of terms. AS1|CUSP embraces Newtonian physics, special relativity, and general relativity. AS1|CUSP embraces results from each of and points to possibilities for complements for each of TRADIT|PHYT QED (or, quantum electrodynamics) and TRADIT|PHYT QCD (or, quantum chromodynamics).

AS1|CUSP points to notions that, for a specific particle or object, the value of rest energy and uses, in modeling, of rest energy may vary based on definition of the object and/or based on choice of modeling techniques. For example, regarding neutrinos, definition and modeling might, or might not, consider virtual particles to be part of the object people call a neutrino. To the extent definition and modeling explicitly treat virtual particles, neutrino masses might be zero. (AS1|CUSP includes interactions that can catalyze neutrino oscillations, even if all neutrinos have zero-mass.) To the extent definition and modeling implicitly treat virtual particles, neutrino masses might be non-zero. For some models, interactions between neutrinos and gravity may correlate with square of neutrino energy and square of neutrino momentum and not correlate directly with neutrino rest energy.

Predicted elementary particles and forces

Predicted elementary particles include six low-mass or zero-mass analogs to quarks, one fractional-charge analog to the W boson, and one analog to the Z boson. Regarding photons, gravity, and related phenomena, we tend to use the word force.

We use the word arcs to refer to the analogs to quarks. Each of the six arc particles has spin-1/2, zero charge, and low mass or zero mass. Like quarks, arcs exist only in composite particles or composite seas.

We use the word tweaks to refer to the analogs to weak-interaction bosons. Each of the two tweaks has spin-1 and one-third the square of the mass of the corresponding weak-interaction boson. The tweak analog to the W boson has one-third the charge of the W boson. The tweak analog to the Z boson has zero charge. Like gluons, tweaks exist only in composite particles or composite seas.

Table 1.2 summarizes AS1|CUSP results regarding elementary particles and forces. Table 1.2a shows information organized based on known elementary particles and forces. The symbol Φ denotes a letter that names a family of elementary particles or forces. The symbol S denotes the TRADIT|PHYT spin. The symbol Σ equals the non-negative integer $2S$. Each own-antiparticle particle is its own antiparticle. For each matter particle, there is an antimatter particle. For neutrinos, the symbol $\pi_{0,3}$ denotes two possibilities. Dirac neutrinos correlate with zero own-antiparticle particles and three matter particles. Majorana neutrinos correlate with three own-antiparticle particles and zero matter particles. Each G-family solution correlates with two modes. One mode is left circular polarization. One mode is right circular polarization. Each particle for which $n_{SA0} = 0$ has positive masses in all kinematics models that AS1|CUSP embraces. Each particle for which $n_{SA0} \leq -1$ has zero mass in some, but not necessarily all, kinematics models that AS1|CUSP embraces. Particles for which $\sigma = -1$ appear only in composite particles or in composite seas comprised of $\sigma = -1$ particles. We defer, until we discuss dark matter and three PR..INe models, discussing the concept of span. Table 1.2b shows information about elementary force carriers that AS1|CUSP includes.

Table 1.3 shows information based on mathematics solutions that correlate with the G family. The table uses parentheses (that is, (..)) to call attention to solutions that seem to correlate with physics-relevant forces other than G-family forces. The forces other than G-family forces are the strong interaction; the weak interaction; and, to the extent people categorize interactions mediated by the Higgs boson separately, interactions mediated by the Higgs boson (or, H^0). (Interactions mediated by T-family bosons correlate with 0G246 and 0G268.) The acronym CHAR denotes the net charge of an object. The symbol q denotes net charge. The symbol m denotes rest mass. BNUM denotes baryon number. The symbol B denotes baryon number. WHCH denotes weak hypercharge. The symbol Y_W denotes weak hypercharge. More generally, the acronym WHCHCH correlates with aspects of the TRADIT|PHYT topics of WHCH, handedness, chirality, and/or helicity. In the table, uses of g and α correlate with notation from Standard Model physics and with results regarding charged leptons. The symbol g correlates with the phrase nominal magnetic dipole moment. The symbol α denotes the fine-structure constant. Measurements of the depletion of starlight emitted long ago may dovetail with observations correlating with the 2G68 solution. (Regarding the measurements, see references [2] and [1].) To the extent modeling based on the Einstein field equations and a single value of the cosmological constant adequately models changes in the rate of expansion of the universe, the set of solutions 4G4, 4G26, 4G48, 4G246, 4G268, 4G2468a, and 4G2468b may correlate with Einstein field equation gravity and with dark energy forces. (The table uses the symbol {?} to point to the possibility that 4G26 is less significant than 4G48 and to the possibility that 4G268 is less significant than 4G246.) Measurements of increasing rates expansion of the universe, which pertain to the most recent few billion years of the evolution to date of the universe, may dovetail with observations correlating with the 4G48 solution and/or the 4G26 solution. (Regarding measurements, see references [20] and [22].) Measurements of decreasing rates expansion of the universe, which pertain to the middle few billion years of evolution to date of the universe, may dovetail with observations correlating with the 4G246 solution and/or the 4G268 solution. (Regarding measurements, see references [8] and [23].) The earlier few billion years of increasing rates of expansion may dovetail with the 4G2468a and 4G2468b solutions. The concept that, within an ordinary matter intensive galaxy, dark matter can form a halo may constitute observation of effects correlating with the 2G248 solution and/or the 2G468 solution. For example, a precessing magnetic dipole moment (correlating with the quadrupole 2G248 solution) could correlate with the ordinary matter centric core of the galaxy. (The table uses the symbol {?} to point to the possibility that 2G468 is less significant than 2G248.) The term SDF denotes, for Newtonian physics models, the radial spatial dependence

Known particles	Φ	S	$\Sigma\Phi$	Own-antiparticle particles	Matter particles	G-family modes	n_{SA0}	σ	Span (PR048INe)
Higgs boson	H	0	0H	1	0		0	+1	1
Charged leptons	C	1/2	1C	0	3		0	+1	1
Neutrinos	N	1/2	1N	$\vert\leftarrow$ ... $\pi_{0,3}$	... $\rightarrow\vert$		−1	+1	8
Z boson	W	1	2W	1			0	+1	6
W boson	W	1	2W		1		0	+1	1
Photon	G	1	2G	1		2	≤ -1	+1	varies *
	G	2	4G	1		2	≤ -1	+1	varies *
	G	3	6G	1		2	≤ -1	+1	varies *
	G	4	8G	1		2	≤ -1	+1	varies *
	G	..	..			2	≤ -1	+1	varies *
	G	10	20G			2	≤ -1	+1	1
Quarks	Q	1/2	1Q	0	6		0	−1	1
	R	1/2	1R	0	6		−1	−1	8
Gluons	U	1	2U	0	8		−1	−1	6
	T	1	2T	1 († Z)			0	−1	6
	T	1	2T		1 († W)		0	−1	1

† analog to the .. boson * See table 1.3.

(a) Numbers of AS1|CUSP elementary particles and/or modes

Force	Φ	S	$\Sigma\Phi$	Own-antiparticle particles	Matter particles	G-family modes	n_{SA0}	σ	Span (PR048INe)
Higgs force	H	0	0H	1	0		0	+1	1
Weak force	W	1	2W	1			0	+1	6
Weak force	W	1	2W		1		0	+1	1
Weak force	T	1	2T	1 († Z)			0	−1	6
Weak force	T	1	2T		1 († W)		0	−1	1
Strong force	U	1	2U	0	8		−1	−1	6
Long-range spin-1	G	1	2G	1		2	≤ -1	+1	varies *
Long-range spin-2	G	2	4G	1		2	≤ -1	+1	varies *
Long-range spin-3	G	3	6G	1		2	≤ -1	+1	varies *
Long-range spin-4	G	4	8G	1		2	≤ -1	+1	varies *
..	G	..	..			2	≤ -1	+1	varies *
Long-range spin-10	G	10	20G			2	≤ -1	+1	1

† analog to the .. boson * See table 1.3.

(b) AS1|CUSP elementary forces

Table 1.2: AS1|CUSP suggestions regarding elementary particles and forces

of force. The symbol r is a radial coordinate. This table does not address the topic of SDF for weak interaction forces. AS1|CUSP correlates the range of a weak interaction boson inversely with the mass of the boson. Terms such as monopole and dipole correlate with SDF and with the number of ΣGΓ items that pertain for each GΓ. For example, the term dipole correlates with SDF r^{-3} and with two values of Σ pertaining for one GΓ. For quadrupole, SDF is r^{-4} and, usually, four values of Σ pertain for one GΓ. The symbol $\gamma 2$ correlates with anomalous moment calculations. AS1|CUSP offers the possibility of modeling anomalous moments via G-family aspects correlating with spins greater than one.

Anomalous magnetic moments and a possible complement to aspects of TRADIT|PHYT QED

Some of the solutions that table 1.3 lists may correlate with a straightforward way to model anomalous magnetic dipole moments and other electromagnetic anomalous multipole moments. Regarding lepton anomalous magnetic dipole moments, the items that table 1.3 correlates with $\gamma 2$ may suffice. For each item, the contribution to lepton anomalous magnetic dipole moment scales as α^{S-1}. One application estimates an α^2-component of the anomalous magnetic dipole moment for the tauon that is similar to an estimate people make via the Standard Model. That application uses numeric extrapolation based on known α^2-components of the anomalous magnetic dipole moments for the electron and muon. Thus, AS1|CUSP may point to possibilities for a complement to some aspects of TRADIT|PHYT QED.

Other elementary particle phenomena

AS1|CUSP describes mechanisms that catalyze neutrino oscillations, even to the extent each neutrino flavor models as having zero mass. AS1|CUSP links the range of the weak interaction and the masses of weak interaction bosons. AS1|CUSP explains the weak mixing angle.

TRADIT|PHYT kinematics, conservation laws, and AS1|CUSP instance-symmetry isomers

AS1|CUSP embraces known kinematics by adding, to AS1|CUSP models that correlate with elementary particles and elementary forces but do not consider kinematics, symmetries correlating with TRADIT|PHYT kinematics and conservation laws. One $SU(2)$ symmetry correlates with conservation of angular momentum. One $SU(2)$ symmetry correlates with conservation of momentum. People can add another symmetry that, depending on the choice and interpretation of the symmetry, correlates with modeling kinematics correlating with Newtonian motion, special relativity, or general relativity. Regarding special relativity, the symmetry is an $SU(2)$ symmetry and correlates with boost. Because of a feature of CUSP that people might say parallels accounting's double-entry bookkeeping, adding the two conservation law symmetries and the possibly boost symmetry adds another symmetry. The other symmetry is an $SU(7)$ symmetry. In AS1|CUSP, this $SU(7)$ symmetry supplants the one-generator Poincare-group symmetry that, regarding TRADIT|PHYT, people correlate with conservation of energy. The $SU(7)$ symmetry correlates with conservation of energy and correlates with possibilities for 48 instance-symmetry isomers of some elementary particles and forces.

Ordinary matter, dark matter, and dark energy

AS1|CUSP includes three models regarding dark matter and dark energy. We label the models as PR001INe, PR006INe, and PR048INe, in which the number denotes the number of instances of the electron particle that are physics-relevant to our universe. For each model, we use the word ensemble to denote an instance of the set of elementary particles and forces for which the number of physics-relevant instances equals the number of physics-relevant instances of the electron.

PR001INe correlates with TRADIT|PHYT. For each elementary particle and elementary force, one instance is physics-relevant. One ensemble pertains. The one ensemble includes all elementary particles and forces. Dark matter consists of composite particles that feature at least one of arcs and tweaks. Composite particles containing just arcs and gluons have some similarities to (hypothetical) axions. Composite particles containing tweaks might have some similarities to (hypothetical) WIMPs. Observations correlating with dark energy densities might correlate with TRADIT|PHYT concepts such as (so-called) vacuum energy. (Note: AS1|CUSP models do not necessarily require non-zero vacuum energy.) Regarding tables 1.2 and 1.3, the span for each item is one.

PR006INe correlates with concept that, for each span-1 or span-8 item in tables 1.2 and 1.3, six instances are physics-relevant. Six ensembles pertain. One ensemble correlates mostly with ordinary matter. The five new (compared to PR001INe) ensembles correlate with dark matter. Span-6 items and span-2 items correlate with forces that intermediate interactions between ordinary matter and dark matter. (See tables 1.2 and 1.3.) The 4G4 item correlates with gravity. PR006INe explains each of the DM|DI-to-OM|DI (or, dark matter density or impact to ordinary matter density or impact) ratios that table 1.4 shows. (Regarding symbols such as DM|DI, see table 1.4.) To the extent the first two ratios that table 1.4 shows exceed five to one, arc-based or tweak-based composite particles provide for the excess. Observations correlating with dark energy densities might correlate with TRADIT|PHYT concepts such as (so-called) vacuum energy.

PR048INe correlates with concept that, for each span-1 item in tables 1.2 and 1.3, 48 instances are physics-relevant. Here, 48 ensembles pertain. The 42 new (compared to PR006INe) ensembles correlate with so-called dark energy stuff. In effect, PR048INe correlates with uniting eight instances of the physics correlating with PR006INe. Zero-charge elementary fermions transmit information between the eight instances. PR048INe retains PR006INe aspects pertaining to dark matter.

Known			$\Sigma\Phi\Gamma$	S	SDF	Interaction	Span
Phenomena (In effect, the solution correlates or interacts with ...)	Example symbol	Use other than ΣG	($\Sigma = 2S$)				(PR006INe or PR048INe)
(strong interaction forces)		(2U)	("0G0")	(1)	(r^0)	-	(6)
CHAR {or, charge}	q		2G2	1	r^{-2}	monopole	1
gravity, rest energy	m		4G4	2	r^{-2}	monopole	6
BNUM {or, baryon number}	B		6G6	3	r^{-2}	monopole	2
WHCH {or, weak hypercharge}	Y_{W}		8G8	4	r^{-2}	monopole	1
nominal magnetic dipole moment	$g \approx 2$		2G24	1	r^{-3}	dipole	1
anomalous magnetic dipole moment	$\propto \alpha^2$	$\gamma 2$	6G24	3	r^{-3}	dipole	1
			2G46	1	r^{-3}	dipole	6
			10G46	5	r^{-3}	dipole	6
atomic spin states			2G68	1	r^{-3}	dipole	2
			14G68	7	r^{-3}	dipole	2
anomalous magnetic dipole moment	$\propto \alpha^1$	$\gamma 2$	4G26	2	r^{-3}	dipole	6
gravity and/or dark energy forces {?}			”	”	”	”	”
anomalous magnetic dipole moment	$\propto \alpha^3$	$\gamma 2$	8G26	4	r^{-3}	dipole	6
gravity and/or dark energy forces			4G48	2	r^{-3}	dipole	2
			12G48	6	r^{-3}	dipole	2
anomalous magnetic dipole moment	$\propto \alpha^2$	$\gamma 2$	6G28	3	r^{-3}	dipole	2
anomalous magnetic dipole moment	$\propto \alpha^4$	$\gamma 2$	10G28	5	r^{-3}	dipole	2
precessing magnetic dipole moment			2G248	1	r^{-4}	quadrupole	6
			6G248	3	r^{-4}	quadrupole	6
			10G248	5	r^{-4}	quadrupole	6
			14G248	7	r^{-4}	quadrupole	6
precessing dipole moment {?}			2G468	1	r^{-4}	quadrupole	6
			6G468	3	r^{-4}	quadrupole	6
			10G468	5	r^{-4}	quadrupole	6
			18G468	9	r^{-4}	quadrupole	6
(weak interaction forces)		(Z, $\in$2W)	(0G246)	(1)	-	-	(6)
gravity and/or dark energy forces			4G246	2	r^{-4}	quadrupole	1
			8G246	4	r^{-4}	quadrupole	1
			12G246	6	r^{-4}	quadrupole	1
(weak interaction forces)		(W, $\in$2W)	(0G268)	(1)	-	-	(1)
gravity and/or dark energy forces {?}			4G268	2	r^{-4}	quadrupole	6
			12G268	6	r^{-4}	quadrupole	6
			16G268	8	r^{-4}	quadrupole	6
(weak interaction forces)		(H^0, $\in$0H)	(0G2468)	(0)	-	-	(1)
gravity and/or dark energy forces			4G2468a	2	r^{-5}	octupole	1
gravity and/or dark energy forces			4G2468b	2	r^{-5}	octupole	1
			8G2468a	4	r^{-5}	octupole	1
			8G2468b	4	r^{-5}	octupole	1
			12G2468	6	r^{-5}	octupole	1
			16G2468	8	r^{-5}	octupole	1
			20G2468	10	r^{-5}	octupole	1

Table 1.3: G-family solutions, organized by SDF

DM|DI:OM|DI approximate ratio		AS1|CUSP explanation	Basis for ratio
Phenomenon	Ratio		(phenomenon observed)
• Universe	$\gtrapprox 5:1$	Correlates with the ratio of five DM|ENS to one OM|ENS, plus the possible existence of OM|ENS-DM|DI|ST. (See discussion related to tables 9.2 and 9.3.)	CMB radiation (Reference [9].)
• Galaxy clusters	$\gtrapprox 5:1$	Correlates with the ratio of five DM|ENS to one OM|ENS, plus the possible existence of OM|ENS-DM|DI|ST. (See discussion regarding table 13.6.)	Gravitational lensing (References [17] and [21].)
• Some long-ago newly formed galaxies	$\gtrapprox 0:1$	Correlates with an era in which galaxies formed. (See table 1.5 or table 13.3.)	Galaxy rotation (Reference [10].)
• A galaxy that has at least as much OM|DI|ST as DM|DI|ST and possibly is nearly entirely OM|DI|ST	$\gtrapprox 0:1$, $< 1:1$	Correlates with a lack of accumulation of DM|ENS|ST. (See table 13.3.)	Galaxy rotation (Reference [25].)
• Some galaxies	$\lessapprox 4:1$	Correlates with the ratio of five DM|ENS to one OM|ENS; effects on one DM|ENS|ST, of $4(2)\mathrm{G}r^{-3}$ early during galaxy formation; and eventual accumulation of DM|DI|ST correlating with the other four DM|ENS|ST. (See table 1.5 or table 13.3.)	Gravitational lensing (Reference [14].)
• Absorption of starlight	$\approxeq 1:1$	Correlates with absorption via interactions mediated by 2G68. (See discussion related to table 13.2.)	Depletion of starlight (Reference [2], as interpreted by reference [1].)
• Dark matter galaxies	1 :> 0	Correlates with a galaxy formation scenario for DM|ENS-centric galaxies that parallels a galaxy formation scenario for OM|ENS-centric galaxies. (See table 1.5 or table 13.3.)	Galaxies with few visible stars (Reference [24].)
		• OM denotes ordinary matter. • OM|DI denotes ordinary matter density or impact. • OM|DI|ST denotes stuff that people correlate with the term ordinary matter. • OM|ENS denotes the ordinary matter ensemble. • OM|ENS|ST denotes stuff correlating with the OM|ENS. • DM denotes dark matter. • DM|DI denotes dark matter density or impact. • DM|DI|ST denotes stuff that people correlate with the term dark matter. • DM|ENS denotes one or more dark matter ensembles. • DM|ENS|ST denotes stuff correlating with one or more DM|ENS.	

Table 1.4: AS1|CUSP explanations for observed or inferred ratios of density of dark matter to density of ordinary matter or inferred ratios of impact of dark matter to impact of ordinary matter

PR048INe suggests that observations of non-zero dark energy density correlate with gradual transmission, to ordinary matter and dark matter, of information about stuff, similar to ordinary matter and dark matter, that we call dark energy stuff.

Galaxy formation and galaxy evolution

AS1|CUSP suggests mechanisms underlying the formation and evolution of some galaxies. Early on, an ordinary matter galaxy can be essentially all ordinary matter. The galaxy then accumulates dark matter ensemble stuff, leading to about 79 percent of the galaxy being dark matter. (See table 1.5. The scenario comports with data to which table 1.4 alludes.)

Envisioning dark matter and dark energy stuff

Regarding each of PR006INe models and PR048INe models, each of the respectively 6 and 48 physics-relevant instances is essentially identical, regarding elementary particles and composite particles, to each other instance. Some differences, such as differences correlating with baryon asymmetry may exist. Presumably, a galaxy that features stuff other than ordinary matter stuff could include physics-savvy beings who could infer, from their perspective, dark matter densities and dark energy densities. Relationships between instances are reciprocal. Two different instances are exactly one of each other's dark matter or each other's dark energy stuff. People can, by looking at ordinary matter they see, envision much about what people consider to be dark matter and much about what people consider to be dark energy stuff.

Other astrophysics and cosmology phenomena

To the extent the universe started with no baryon asymmetry, interactions involving the charged arc (or, 2T) elementary particle converted antimatter quarks into matter quarks and were essential to creating ordinary matter baryon asymmetry.

To the extent the universe had an inflationary epoch, the epoch might correlate with the creation of baryon asymmetry, with at least one phase change within a composite sea of not-free-ranging elementary fermions and not-free-ranging elementary bosons, and/or with the dissolution of such a composite sea. AS1|CUSP suggests two types of not-free-ranging elementary fermions and two types of not-free-ranging elementary bosons. (See the items for which, in table 1.2a, $\sigma = -1$.) Thus, AS1|CUSP suggests possibilities for at least four phases for such composite seas.

Dynamics, composite particles, and a possible complement to aspects of TRADIT|PHYT QCD

AS1|CUSP aspects related to composite particles point to the combining of dynamics symmetries correlating with quarks and dynamics symmetries correlating with gluons to form kinematics symmetries appropriate to free-ranging composite particles. Regarding COMPLE|PHYT models, the symmetries related to quarks fall short of the symmetries related to free-ranging composite particles. Regarding COMPLE|PHYT models, the symmetries related to gluons fall short of the symmetries related to free-ranging composite particles. In TRADIT|PHYT QCD, people use free-ranging kinematics symmetries to model quarks and gluons. A COMPLE|PHYT approach that combines the more-limited quark dynamics symmetries and the more-limited gluon dynamics symmetries points to possibilities for a COMPLE|PHYT complement to QCD.

Other aspects of modeling

AS1|CUSP includes a double-entry bookkeeping version of $SU(3) \times SU(2) \times U(1)$ symmetry regarding known elementary bosons. AS1|CUSP points to commonalities among kinematics theories and to possible limitations regarding the applicability of specific kinematics theories. AS1|CUSP points to possibilities for including, in the elementary particle Standard Model, elementary particles that AS1|CUSP suggests.

Physics constants

AS1|CUSP includes arithmetic relationships between some physics constants. For example, AS1|CUSP predicts the tauon mass to more accuracy than the measured mass. The suggested standard deviation reflects the standard deviation for measurements of the gravitational constant.

Foundation of physics

AS1|CUSP possibly contributes insight regarding foundation of physics topics including CPT-related symmetries, arrow of time, numbers of dimensions, and multiverses.

Opportunities for research

AS1|CUSP points to opportunities, throughout and beyond topics mentioned above, for research. Bases for opportunities include further analyzing known data, making new observations, conducting new experiments, developing new precision measurement techniques, and developing new theories and models. Bases for opportunities include further developing and applying mathematics underlying CUSP and AS1|CUSP.

Scenario

The following steps contribute to the formation and evolution of an originally OM|ENS-centric (or, ordinary matter ensemble centric) galaxy. Here, we focus on the stuff that becomes a galaxy cluster that includes the galaxy. We assume that each of the six OMDM|ENS (or, one ordinary matter ensemble and five dark matter centric ensembles) contributes approximately one-sixth of the stuff in the galaxy cluster. The steps feature effects of the following forces. SDF abbreviates radial spatial dependence of force.

SDF	Effect	Relevant instances	Span (ensembles per instance)	Force	Solutions
r^{-5}	Repulsion	6	1	Gravity and/or dark energy force	4G2468a, 4G2468b
r^{-4}	Attraction	6	1	Gravity and/or dark energy force	4G246
r^{-3}	Repulsion	3	2	Gravity and/or dark energy force	4G48
r^{-2}	Attraction	1	6	Gravity	4G4
r^{-4}	Repulsion	1	6	Force generated by precessing magnets	2G248

1. Repulsion correlating with the 4G2468a and 4G2468b solutions dominates regarding the stuff that will be the cluster. For each of the six relevant ensembles, stuff repels other stuff that correlates with the ensemble. The stuff that will become the galaxy cluster expands.
2. For each of the six relevant ensembles, starting on a small scale and progressing to larger scales, attraction correlating with the 4G246 solution dominates and catalyzes clumping within stuff correlating with the ensemble. (Later, sufficiently massive clumps can become main components of galaxies.) Little significant interaction occurs between stuff correlating with one ensemble and stuff correlating with another ensemble.
3. Repulsive forces correlating with the 4G48 solution repel OM|ENS|ST clumps from other OM|ENS|ST clumps and repel clumps that correlate with one DM|ENS (out of five DM|ENS) from clumps that correlate with the OM|ENS. (The phenomenon of OM|ENS|ST repels OM|ENS|ST via interactions correlating with the 4G48 solution might contribute to OM|ENS-centric galaxies not being smaller than they actually are.)
4. The OM|ENS-centric galaxy forms, primarily from stuff correlating with one OM|ENS|ST clump. (Reference [10] discusses observations, based on light that is approximately 10 billion years old, of early states of newly formed galaxies for which galaxy rotation curves correlate with little presence of dark matter. Reference [25] discusses an OM|ENS-centric galaxy that recently contained at least as much OM|ENS|ST as DM|DI|ST and possibly recently contained much less much DM|ENS|ST than OM|ENS|ST.)
5. The OM|ENS-centric galaxy might accrue, via attraction correlating with 4G4 solution, DM|ENS|ST gas and DM|ENS|ST objects, most significantly from the four instances of DM|ENS-centric stuff that do not correlate with one DM|ENS|ST that interacts with OM|ENS|ST via forces correlating with the 4G48 solution. (Reference [14] discusses observations correlating with the notion that the fraction of DM|DI|ST in some OM|ENS-centric galaxies is about 0.79. We note that 0.79 is about four parts in five. We think that 0.79 contrasts with the 0.83, or five parts in six, that might pertain if 4G48-related repulsion between OM|ENS|ST and one DM|ENS|ST is not physics-relevant. As noted above, 4G48-related repulsion may contribute to OM|ENS-centric galaxies not being smaller than they actually are.)

    - Regarding the radial distribution of the accrued DM|ENS|ST gas and objects within the OM|ENS-centric galaxy, we suggest the following concepts. The core of the galaxy features OM|ENS|ST that can include black holes, gas, dust, stars, and planets. Rotation of that OM|ENS|ST can produce effects similar to effects a precessing bar magnet produces. The force correlating with the 2G248 solution has a span of six and repels DM|ENS|ST gas and objects. A dark matter halo forms, based on a balance between effects, on DM|ENS|ST gas and objects, of gravitational attraction caused mostly by OM|ENS|ST and of 2G248 repulsion caused mostly by OM|ENS|ST. (At this stage, the phenomenon of OM|ENS|ST repels OM|ENS|ST via interactions correlating with the 2G248 solution might contribute to OM|ENS-centric galaxies not being smaller than they actually are.)

- Possibly, the OM|ENS-centric galaxy includes DM|ENS|ST stars that emit DM|ENS-centric photons. (Reference [24] discusses Dragonfly 44, a DM|ENS-centric galaxy that includes some OM|ENS|ST stars. People estimate that 0.999 (out of one) of the stuff in Dragonfly 44 is dark matter. Note, also reference [15].)
- Possibly, the OM|ENS-centric galaxy might accrue DM|ENS|ST gas and DM|ENS|ST objects from the instance of DM|ENS-centric stuff that correlates with one DM|ENS that interacts with OM|ENS|ST via forces correlating with the 4G48 solution. (We are not aware of observations with which this possibility would comport.)
- Possibly, the OM|ENS-centric galaxy collides with a non-OM|ENS-centric galaxy and, regarding the OM|ENS-centric galaxy, the composition changes and/or the shape changes.
- Possibly, roles mentioned above for (respectively) 4G48, 4G246, and 2G248 also include participation by (respectively) 4G26, 4G268, and 2G468.

Table 1.5: A PR006INe or PR048INe scenario for formation and evolution of an ordinary matter centric galaxy

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