A Technique for Cataloging Types of Particles and Types of Stuff

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Abstract

We develop theory leading to an ability to catalog types of elementary particles. The resulting catalog provides for known interaction-mediating bosons, non-traditional interaction-carrying bosons, and fermions. Some ratios of numbers of instances of various types of particles are 1:6:24:48. Potentially, the actual ratios of densities of baryonic matter, dark matter, dark energy are 1:5:18 and do not depend on time, even though interpretations of data provide ratios that vary with the age of the universe. Potentially there is another type of stuff. Here, 5=6-1, 18=24-6, and there could be 24=48-24 units of the other type of stuff.

Keywords

Associated universe · Baryonic matter · Dark energy · Dark matter · Density of the universe · Elementary particles · Fundamental forces · Strong interaction · Theory of everything · Unified electromagnetism and gravity · Weak interaction

Section 1 Context

This work fills a gap in previous, pattern-based work that leads to a catalog of types of elementary particles and fundamental forces. [1] develops a catalog of elementary-particle "zero-energy empty states." [1] indicates that excitations of such empty states match traditional types of elementary particles and point to non-traditional types of elementary particles. Some of the elementary particles are bosons and some are fermions. [1] develops further results by applying implications of the catalog and implications of other patterns.

In Appendix 2 of [1], development of the catalog is based on {a} a proposal that, for 3-dimension space (for example, within 4-dimensional space-time), the lowest energy states for a spherically symmetric harmonic oscillator would have a wave-function proportional to $r^{-1}\exp(-ar^2)$, in which r denotes the radial coordinate and a is a positive constant; {b} the observation that, in linear coordinates, the harmonic-oscillator occupation numbers $n_x=0$, $n_y=0$, and $n_z=-1$ provide a basis for describing a photon moving parallel to the z-axis; and {c} extrapolating such findings so as develop to a technique for cataloging types of zero-mass and non-zero mass elementary particles.

Such extrapolation suggests, in effect, that for an odd-integer number $D \geq 3$ of dimensions, a spherically symmetric harmonic oscillator could have a wave-function with a term proportional

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to $r^{-d}\exp(-ar^2)$, in which d=(D-1)/2. In Section 6 of [1], we also assume that there can be zero-mass bosons intermediating interactions having long-range spatial dependences of r^{-2d}.

[1] indicates a possibility a useful view of aspects of the evolution of the universe after the big bang. In that view, the ratios of densities of baryonic matter, dark matter, dark energy, and one other possible type of "stuff" are essentially time-independent. Those ratios could be 1:5:18:24. Section 9 of [1] provides a possible reason why ratios interpreted from observational data seem to evolve as the universe ages.

The following material, excerpted and shortened from Section 1 of [1], {a} establishes perspective and vocabulary; {b} discusses the evolution of ratios determined from observations of cosmic microwave background (CMB) radiation; {c} discusses some of the catalogued forces; and {d} notes concepts that may be outside traditional physics research.

> The "t-universe" includes the "known universe," which people traditionally call "the universe." The t-universe possibly also includes an "associated universe." (The prediction of a possible associated universe may be outside traditional physics research.)
>
> The known universe comprises 24 ensembles of "stuff." If the associated universe exists, it comprises 24 ensembles. The t-universe comprises either 24 or 48 ensembles of stuff. (The concept of such 24 or 48 ensembles may be outside traditional physics research.)
>
> One ensemble comprises baryonic matter. This ensemble encompasses all stuff (including molecules, people, and stars) that people and people-developed sensors detect directly via what we call light or photons.
>
> Of the 24 ensembles in the known universe, dark energy comprises 18. Of the other 6 ensembles in the known universe, dark matter comprises 5 and baryonic matter comprises 1.
>
> Physics has yet to directly measure properties of stuff not associated with the baryonic-matter ensemble. People infer, from light-based astrophysical observations, the existence of dark matter and dark energy. Inference, also based on astrophysical observations, indicates that dark matter and baryonic matter interact via gravity.
>
> Traditionally, physics identifies four fundamental interactions (or forces) - the electromagnetic, gravitational, weak, and strong interactions.
>
> People claim that traditional theory shows a common basis for (or "unifies") the three forces other than gravity. People claim physics has yet to satisfactorily link gravity with the other forces.
>
> A means for cataloguing types of forces, elementary particles, and stuff leads to correlations among forces, particles, and types of stuff. (The cataloging technique, some of the cataloged items, and some of the correlations may be outside traditional physics research.)
>
> The catalog of types of forces points to two forces that we designate, respectively, as 4e2 and 4e1. Forces 4e2 and 4e1 extend and complete a series that begins with electromagnetism (4e4) and gravity (4e3). The e-group of forces includes other forces, including ones we designate as 3e3, 3e2, and 3e1. Other groups of forces exist. (The

4e2, 4e1, 3e3, 3e2, and 3e1 forces and some of the other catalogued forces may be outside traditional physics research.)

Each ensemble includes its own version of photons (or light or 4e4). Those photons do not interact directly with the stuff of the other 23 or 47 ensembles. (The notion of multiple analogs of photons may be outside traditional physics research.)

Each of the interaction we call gravity (or 4e3) and the 3e3 interaction is shared by 6 ensembles - the 1 baryonic-matter ensemble and the 5 dark-matter ensembles. The known universe includes 3 analogs to gravity. The associated universe would include 4 analogs to gravity. Thus, the t-universe includes 3 or 7 analogs to gravity. Baryonic matter and dark matter do not interact directly with those 3 or 7 gravity analogs. (The notion of multiple analogs of gravity may be outside traditional physics research.)

Each of the 4e2 and 3e2 forces interacts with the stuff of the 24 ensembles in the known universe. The 24 ensembles of the associated universe would share a force analogous to 4e2 and a force analogous to 3e2. Forces 4e1 and 3e1 apply throughout the t-universe.

In the known universe, stuff is not distributed uniformly. Examples of baryonic-matter clumping include atomic nuclei, atoms, planets and stars, galaxies, and clusters of galaxies.

For any ensemble, intra-ensemble clumping involves all forces (or force analogs) relevant to that ensemble.

Influences on baryonic-matter clumping include interactions between baryonic-matter stuff, interactions between baryonic-matter stuff and dark-matter stuff (including effects of dark-matter clumping), and interactions between baryonic-matter stuff and dark-energy stuff (including effects of dark-energy clumping). The baryonic-baryonic component of baryonic-matter clumping involves all forces. The transmission to baryonic matter of information about dark-matter clumping does not involve some forces, including 4e4. The transmission to baryonic matter of information about dark-energy clumping does not involve some forces, including 4e4, 4e3, and 3e3. Impacts on baryonic-matter clumping triggered by dark-matter (or dark-energy) clumping lag impacts on baryonic-matter clumping triggered by baryonic matter. (This paragraph may be outside traditional physics research.)

Phenomena around the time of the big bang produced baryonic-matter photons known as CMB or cosmic microwave background radiation. Observations today spot non-uniformities in CMB radiation. The current age of the known universe is approximately 13.7 billion (or $1.37 \cdot 10^{10}$) years. Observations of CMB radiation have been made during recent decades. Such observations point to data relevant, in effect, to times throughout the past evolution of the universe, except for a range of time close to the time of the big bang.

When the age of the universe was about 380,000 years, the cumulative impact, on CMB radiation, of baryonic-matter clumping triggered by dark-matter clumping was enough to indicate that there was at least 2.3 times as much dark-matter stuff as baryonic-matter stuff. Over time, the ratio came to its current value of 5. (This paragraph may represent a non-traditional interpretation of data. [4] provides two data points.)

When the age of the universe was about 380,000 years, the cumulative impact, on CMB radiation, of baryonic-matter clumping triggered by dark-energy clumping was negligible compared to the cumulative impact of dark-matter clumping. Today, the cumulate impact of baryonic-matter clumping triggered by dark-energy clumping is enough to indicate that there is approximately 18 times as much dark-energy stuff as there is baryonic-matter stuff. (This paragraph may represent a non-traditional interpretation of data. [4] provides two data points.)

The 1:5:18 ratios pertain to the known universe. Possibly, because of the associated universe, ratios will evolve toward 1:5:18:24. (The concept of such ratios may be outside traditional physics research.)

Astrophysics data imply the existence of a mechanism that works opposite to gravity's attraction between objects. The 3er interaction (which is one of the 3e1 and 3e2 interactions) causes such repulsion. (Traditionally, people have considered that dark energy causes this repulsion.)

In the known universe, the ratio of 3er-repulsion to gravitational-attraction is larger for larger objects. Repulsion exceeds attraction for objects of sizes greater than a scale length that is somewhat less than or approximately $4 \cdot 10^9$ to $3 \cdot 10^{10}$ light years (or $1 \cdot 10^3$ to $8 \cdot 10^3$ Mpc). (Such theoretical prediction of the scale length may be outside traditional physics research.)

In this paper, Section 2 provides a more rigorous development of aspects of the cataloguing technique (than does [1]). Section 3 applies the cataloging to "predict" the ratios of the baryonic-matter, dark-matter, and dark-energy densities of the universe. Section 4 comments on work in earlier sections. Section 5 updates discussion in [1] about observed ratios of types of stuff. Section 6 reprises other results that follow from the cataloging technique and catalog.

Section 2 Core

We assume that there is a relevant 4-dimensional space that embeds in a flat 10-dimensional "p-space". This assumption is based on the assumption that space-time embeds flat (in the sense of the Minkowski metric) in a 10-dimensional space. (P-space may be related to the traditional energy-momentum space that constitutes a tangent space to space-time.)

We assume there is usefulness in considering that each p-space dimension has associated with it a harmonic oscillator. We plan to consider occupation numbers for these oscillators. We plan to use the occupation numbers to explore phenomena such as forces that bosons mediate.

We assume it is meaningful to consider that the oscillators can have positive, zero, or negative occupation numbers. The following expressions establish notation for dimensions and occupation numbers. As yet, there is no assignment of any particular p_k to any particular $\tilde{n}_k$.

P-space dimensions:

$$p_k, \text{ with } k \text{ being an integer and } 0 \leq k \leq 9 \quad (1)$$

Harmonic-oscillator occupation numbers:

$$\tilde{n}_k, \text{ with each } \tilde{n}_k \text{ being an integer and } 0 \leq k \leq 9 \quad (2)$$

We assume there is an applicable symmetry such that each oscillator has the same associated "strength." And, we adopt units such that that strength is unity. (Later, when considering zero-mass particles, it can be useful to think of the "unit of strength" as being pc, in which p is the momentum of the particle and c is the speed of light.) The following equations provide, respectively, for the "energy" for one oscillator and the energy for the entire set of oscillators.

$$E_k = \tilde{n}_k + 1/2 \quad (3)$$

$$E = \sum_{0 \leq k \leq 9} E_k \quad (4)$$

We note the following.

$$\text{If } \sum_{0 \leq k \leq 9} \tilde{n}_k = -5, \quad E = 0. \quad (5)$$

We anticipate sometimes focusing just on oscillators that align with "one plus three" p-space dimensions. Without loss of generality for discussions herein, we assume those "one plus three" p-space dimensions are k = 0, plus k = 1, 2, and 3. We define a total, n, of the occupation numbers for such a subset of oscillators. And we define a "level number," L.

$$n = \sum_{0 \leq k \leq 3} \tilde{n}_k \quad (6)$$

$$L = 6 + n \quad (7)$$

We focus on states that satisfy (5), (8), and (9).

$$\tilde{n}_k \leq 0, \text{ for } 0 \leq k \leq 9 \quad (8)$$

$$1 \leq L \leq 5 \quad (9)$$

We assume that an oscillator for which $\tilde{n}_k$=-1 is an oscillator that cannot be excited, because the factor associated with the raising operator is $(\tilde{n}_k +1)^{1/2}$=0.

Table 1, Table 2, and Table 3 provide a directory noting some empty states for which at least one of $\tilde{n}_1$, $\tilde{n}_2$, and $\tilde{n}_3$ is zero. (Table 11 below addresses other states.)

We do not consider herein excitations of the k=0 oscillator.

For Table 1, exciting an $\tilde{n}_k$=0 oscillator (k=1, 2, or 3) leads to a boson. Multiple excitations of one or more $\tilde{n}_k$=0 oscillators (k=1, 2, or 3) are allowed and provide for, for example, laser-like phenomena.

Table 1 Zero-energy states that excite directly to bosons

For each of these states, the name is of the form IFL. F provides a group name. For the e-group, there are four series, corresponding respectively to I = 4, 3, 2, and 1. Each other group has one series. For the w-group's series and the s-group's series, L satisfies 1 ≤ L ≤ 5. For the other series, L satisfies 1 ≤ L ≤ I. The rightmost column notes phenomena for which table entries provide bases.

		k	0	1	2	3	
Name	Group	$\tilde{n}_k$					Associations
4wL	w-group		<0	0	0	0	• component of the weak force
IeL	e-group		<0	<0	0	0	• electromagnetism, gravity, etc.
4sL	s-group		0	<0	0	0	• component of the strong force

For Table 2, exciting the k=1 oscillator leads to a fermion.

Table 2 Zero-energy states that excite directly to fermions

For each of these states, the name is of the form IFL. F provides the group name, f. The f-group has one series. L satisfies 1 ≤ L ≤ I=4. The rightmost column notes phenomena for which table entries provide bases.

		k	0	1	2	3	
Name	Group	$\tilde{n}_k$					Associations
4fL	f-group		<1	0	-1	-1	• fermion

Table 3 provides bases for components of the strong force and possible precursors to compound particles such as pions and protons.

Table 3 Other zero-energy states that provide bases for forces

For each of these states, the name is of the form IFL. F provides a group name. The qa-group has two members. Each other group has one member. For each group, L satisfies 1 ≤ L ≤ I. The rightmost column notes phenomena for which table entries provide bases.

		k	0	1	2	3	
Name	Group	$\tilde{n}_k$					Associations
2qaL	qa-group		<1	0	-2	-2	• component of the strong force • possible precursor to a meson made from a quark and an anti-quark
1qqq1	qqq-group		0	0	-1	-4	• component of the strong force • possible precursor to a fermion made from 3 quarks
1aaa1	aaa-group		0	0	-4	-1	• component of the strong force • possible precursor to a fermion made from 3 anti-quarks

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Regarding rows in Table 1, Table 2, and Table 3, Appendix 2 of [1] provides some the following information. (In Appendix 2 of [1], {a} the equivalent of $\tilde{n}_0$ is "n_v" and is called a "virtual dimension;" {b} the equivalent of $\tilde{n}_1$ is "n_z"; {c} the equivalent of $\tilde{n}_2$ is "n_x"; and {d} the equivalent of $\tilde{n}_3$ is "n_y".)

For excited states, the particle mass, m, satisfies the following.
$$m = 0 \text{ if, and only if, } \tilde{n}_1 < 0 \quad (10)$$
For e-group excited states and s-group excited states,
$\tilde{n}_1$ corresponds to the direction of motion for a particle. (11)

For e-group excited states, $\tilde{n}_2$ and $\tilde{n}_3$ can be associated with concepts like … (12)
transverse polarization (for photons or gravitons);
excitation of the vector potential (for photons).

For the qa-group, qqq-group, and aaa-group,
$1-\tilde{n}_3$ denotes a number of quarks needed to produce a particle. (13)
$1-\tilde{n}_2$ denotes a number of anti-quarks.

For forces (that is, each entry other than those in the 4fL row) other than 4wL forces, the long-range behavior (in the space component of a flat space-time) of the force scales (based on distance r) as follows. (14)
$$r^{2\tilde{n}_1}$$

Regarding Table 2, an occupied fermion state (for example, $\tilde{n}_0$ =0, $\tilde{n}_1$ =1, $\tilde{n}_2$ =-1, $\tilde{n}_3$=-1) cannot further couple to the transverse vector potential, because $\tilde{n}_2$ =-1 and $\tilde{n}_3$=-1.

We assume that the harmonic oscillators can be considered as paired. From above, two pairs are {a} $\tilde{n}_0$ and $\tilde{n}_1$; and {b} $\tilde{n}_2$ and $\tilde{n}_3$. We assume other pairs are associated, respectively, with {a} $\tilde{n}_4$ and $\tilde{n}_5$; {b} $\tilde{n}_6$ and $\tilde{n}_7$; and {c} $\tilde{n}_8$ and $\tilde{n}_9$.

We posit that the following tables provide a catalog of types of particles. Each of the rightmost columns (the rightmost 4 columns for Table 4; the rightmost 3 columns for each of Table 5, Table 6, Table 7, and Table 8) describes a pair of harmonic oscillators for which {a} the net occupation number is -1 or 0; and {b} no experiments or observations in space-time lead to knowledge of to what extent either oscillator has any particular occupation number.

Table 4 Empty states for which L = 5

Occupation numbers for individually distinguishable oscillators run from -1 to 0. Occupation numbers of pairs are -1 and apply to all rows.

Name	k $\tilde{n}_k$	0	1	2-3	4-5	6-7	8-9
				-1	-1	-1	-1
4w5		-1	0				
4s5		0	-1				

We assume that 4w5 can be considered to enable the masses of the 4w4 carriers (Z and W bosons) of the weak interaction.

Table 5 Empty states for which L = 4
Occupation numbers for individually distinguishable oscillators run from -2 to 0. Occupation numbers of pairs are -1 and apply to all rows.

Name	k / $\tilde{n}_k$	0	1	2	3	4-5	6-7	8-9
						-1	-1	-1
4w4		-2	0	0	0			
4e4		-1	-1	0	0			
4s4		0	-2	0	0			
4f4		0	0	-1	-1			

We assume the following associations. 4w4 associates with the Z and W bosons. 4e4 associates with photons. 4s4 associates with gluons. 4f4 associates with fermions, including leptons and quarks.

Table 6 Empty states for which L = 3
Occupation numbers for individually distinguishable oscillators run from -3 to 0. Occupation numbers of pairs are 0 or -1 and apply to all rows.

Name	k / $\tilde{n}_k$	0	1	2	3	4-5	6-7	8-9
						0	-1	-1
4w3		-3	0	0	0			
4e3		-2	-1	0	0			
3e3		-1	-2	0	0			
4s3		0	-3	0	0			
4f3		-1	0	-1	-1			

We assume 4e3 associates with gravity (and, to the extent they become identified experimentally, gravitons). We assume 3e3 is one of a series of bosons associating with r^{-4} forces. 3e2 and 3e1 (see below) also belong to that series.

Table 7 Empty states for which L = 2

Occupation numbers for individually distinguishable oscillators run from -4 to 0. Occupation numbers of pairs are 0 or -1 and apply to all rows.

Name	k / $\tilde{n}_k$	0	1	2	3	4-5	6-7	8-9
						0	0	-1
4w2		-4	0	0	0			
4e2		-3	-1	0	0			
3e2		-2	-2	0	0			
2e2		-1	-3	0	0			
4s2		0	-4	0	0			
2qa2		0	0	-2	-2			
4f2		-2	0	-1	-1			

Table 8 Empty states for which L = 1

Occupation numbers for individually distinguishable oscillators run from -5 to 0. Occupation numbers of pairs are 0 and apply to all rows.

Name	k / $\tilde{n}_k$	0	1	2	3	4-5	6-7	8-9
						0	0	0
4w1		-5	0	0	0			
4e1		-4	-1	0	0			
3e1		-3	-2	0	0			
2e1		-2	-3	0	0			
1e1		-1	-4	0	0			
4s1		0	-5	0	0			
2qa1		-1	0	-2	-2			
4qqq1		0	0	-1	-4			
4aaa1		0	0	-4	-1			
4f1		-3	0	-1	-1			

Section 3 Consequences

We explore the numbers of ways to associate oscillators and p-space dimensions.

We assume that p-space dimensions are paired. We assume that an association-generating algorithm proceeds, in sequence, from the harmonic-oscillator 0-1 pair to the harmonic-oscillator 8-9 pair. As previously noted, we assume without loss of generality for the purposes of this paper that, for $0 \leq k \leq 3$, p_k and n_k have been paired. There remain 6 choices for pairing instances of p_k with the harmonic-oscillator 4-5 pair. Those choices are p-space 4-5, 5-4, 6-7, 7-6, 8-9, and 9-8. After that choice is made, there are 4 choices of p-space pairs for pairing with the harmonic-oscillator 6-7 pair. (For example, if the pairing for the harmonic-oscillator 4-5 pair uses p-space choice 5-4, then the choices for p-space pairings with the harmonic-oscillator 6-7 pair are p-space 6-7, 7-6, 8-9, and 9-8.) After that, there are 2 choices for pairing with the harmonic oscillator 8-9 pair. (15) and (16) follow from the above work.

Starting with the oscillator pair denoted by j-{j+1}, the number of choices for completing pairing of the p_k with the oscillators k is (15)
(10-j)!!.

For the adjacent pair of oscillator pairs j-{j-1} and {j-2}-{j-3}, the ratio of numbers of choices is (16)
10-j.

Running the algorithm backwards, we find the following. (Here, "states" denotes "empty states." Also, we note that results in and beyond Section 6 in [1] suggest that no L=0 states exist for, at least, the series 4eL.)

L=1 states have some number of instances.
We assume L=1 states have 1 instance. (17)
Thus, each L=1 state has no analogs.

L=2 states have 2 times the number of instances of L=1 states.
Thus, L=2 states have 2 instances. (18)
Thus, each L=2 instance has 1 analog.

L=3 states have 4 times the number of instances of L=2 states.
Thus, L=3 states have 8 instances. (19)
Thus, each L=3 instance has 7 analogs.

L=4 states have 6 times the number of instances of L=3 states.
Thus, L=4 states have 48 instances. (20)
Thus, each L=4 instance has 47 analogs.

Appendices 2 and 3 of [1] derive the numbers 48, 8, and 2 via a pattern-based approach. Based on such numbers, [1] posits from a theoretical perspective various numbers of types of "stuff" comprising the "t-universe." Section 9 of [1] defines a concept of an "ensemble" of stuff. Section 9 of [1] defines a concept of an "egl-L" group of ensembles. Here, L reuses (and is identical to) the L defined in (7). An egl-L group includes one or more ensembles. The t-universe includes 24 ensembles (if there is no associated universe) or 48 ensembles (if there is an associated universe). Each egl-4 group includes 1 ensemble. Baryonic matter comprises one ensemble and one egl-4 group. Each egl-3 group includes 6 ensembles. Each egl-2 group includes 24 ensembles.

Rules pertain as to which fermions and bosons interact. For example, considering the level L=4, each ensemble interacts with its own photons (4e4) but not with photons associated with other ensembles. For instance, baryonic matter does not interact with dark-matter photons. At level L=3, baryonic matter interacts with gravity (4e3) associated with the 6 ensembles that include baryonic matter and dark matter. Baryonic matter does not interact with the 4e3 bosons associated with the other 18 ensembles (if there is no associated universe) or 42 other ensembles (if there is an associated universe).

Table 9 and Table 10 summarize results.

Table 9 Numbers of empty states and types of stuff

L is as defined in (7). (15) provides the "numbers of similar sets …". (16) provides the numbers in the "ratio" column. Each "ratio of identified stuff …" number comes from apportioning the "ratio" in the next row. The "egl-3 group that contains baryonic matter" also contains the 5 ensembles of dark matter. The "egl-2 group that contains baryonic matter" also contains 18 ensembles (or 3 egl-3 groups) of dark energy. In the rightmost columns, "other stuff" refers to the stuff named in the next-to-rightmost column.

L	Number of similar sets of empty states	Ratio	Ratio of identified stuff to unidentified stuff	Indentified stuff	Other stuff	Ratio of baryonic matter to other stuff
4	48		1:5	egl-4 group that is baryonic matter	dark matter	1:5
		6				
3	8		1:3	egl-3 group that contains baryonic matter	dark energy	1:18
		4				
2	2		1:1	egl-2 group that contains baryonic matter	associated universe	1:24
		2				
1	1			egl-1 group that contains the t-universe	-	

Table 10 Matches between forces and types of stuff

L is as defined in (7). The two rightmost columns specify the extent to which forces that interact with baryonic-matter stuff interact with other stuff. In the rightmost column, each entry shows two possible numbers of ensembles. The first number pertains if there is no associated universe. The second number pertains if there is an associated universe. Presumably, one can substitute "ensemble x" for "baryonic matter" throughout those two columns, with "ensemble x" denoting any one of the 24 or 48 ensembles of stuff.

L	Number of similar sets of empty states	Forces	The versions of these forces that interact with baryonic matter interact with the …	The versions of these forces that interact with baryonic matter do not interact with the …
4	48	IF4, including … 4e4 (photons)	egl-4 group that is baryonic matter	other 23 or 47 ensembles
3	8	IF3, including … 4e3 (gravity)	egl-3 group that contains baryonic matter	other 18 or 42 ensembles
2	2	IF2, including … 3e2	egl-2 group that contains baryonic matter	other 0 or 24 ensembles
1	1	IF1, including … 3e1	egl-1 group that contains the t-universe	-

Section 4 Comments - Other Zero-energy States

Table 11 provides a directory of zero-energy empty states for which excitement does not lead to results we herein consider further.

Table 11 Zero-energy states not further considered above

For each "maps to" state, the state can be considered to be similar to a state in one of Table 5, Table 6, Table 7, or Table 8. For each remaining state, at least one of the following pertains regarding first excitements (for $1 \leq k \leq 3$). No excitement is possible. (That is, $\tilde{n}_x=\tilde{n}_y=\tilde{n}_z=-1$.) The excitement of $\tilde{n}_1=0$ would lead to a "would-be particle" with a charge that is not an integer multiple of the charge of a positron. The excitement of any $\tilde{n}_k<-1$ oscillator leads to another empty state.

		k	0	1	2	3	
Name	Group	$\tilde{n}_k$					Associations
			..	0	0	<0	• maps to | {..,<0,0,0} >
			..	0	-1	-2	• non-integer charge; or • excites to another empty state
			..	0	-1	-3	• non-integer charge; or • excites to another empty state
			0	0	-2	-3	• non-integer charge; or • excites to another empty state
			..	<0	0	<0	• maps to | {..,0,<0,<0} >
			..	<0	<0	0	• maps to | {..,0,<0,<0} >
			..	<0	<0	<0	• excites to another empty state; or • (for | {..,-1,-1,-1} >) cannot be excited

Table 5, Table 6, Table 7, and Table 8 exhibit a pattern of "nature's deploying," with respect to paired oscillators, -1:s and 0:s. We hypothesize the following. Deploying a -2 (or -3) would correspond to an implied new pair of space-time real dimensions. Deploying 0:s and -1:s in other than the manner shown in the tables would be redundant for the purposes of this paper.

Section 5 Comments - Ratios of Types of Stuff

At the time [1] was published, the 1:5:18 ratios matched, within observational error, reported interpretations [2] based on measurements of cosmic microwave background (CMB) radiation. Table 12 reprises information in Section 9 of [1].

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Table 12 Observed densities of the universe - older data
This table shows three observed densities [2]. Other densities - the pressureless matter density of the Universe, the CMB radiation density of the Universe, and the neutrino density of the Universe - are not shown. The rightmost column uses 1:5:18 to produce estimated densities.

Type of density	Observed density	Estimated density
Baryon density of the Universe	0.044(4)	1/24 ≈ 0.042
Dark matter density of the universe	0.21(2)	5/24 ≈ 0.21
Dark energy density of the ΛCDM Universe	0.74(3)	18/24 ≈ 0.75

Table 13 reprises results of newer interpretations of observational data [3].

Table 13 Observed densities of the universe - newer data
This table shows three observed densities [3]. Other densities - the pressureless matter density of the Universe, the CMB radiation density of the Universe, and the neutrino density of the Universe - are not shown. The rightmost column uses 1:5:18 to produce estimated densities.

Type of density	Observed density	Estimated density
Baryon density of the Universe	0.045(3)	1/24 ≈ 0.042
Cold dark matter density of the universe	0.22(3)	5/24 ≈ 0.21
Dark energy density of the ΛCDM Universe	0.73(3)	18/24 ≈ 0.75

In Table 13, each estimate is within observational error. The ratio of 0.045:0.22 {a} is approximately 1:4.9; and {b} is consistent with 1:5. The ratio 0.045:0.73 {a} is approximately 1:16.2; and {b} perhaps points to the desirability of further discussion.

Current observations (Table 13) indicate 1:~5:~(15- to 18):not-reported. Possibly, the 1:~(15- to 18) ratio is still evolving. Possibly, people have not looked for evidence of stuff "beyond dark energy." The not-reported number {a} could be small compared to 24; and {b} possibly could explain interpretations (to the extent any such exist) that would indicate that the "reported" ratio of 1:~(15- to 18) is headed toward 1:18+.

Section 6 Continuation

[1] provides a continuation of this paper.

Section 10 of [1] discusses an estimated range for the size of object in the known universe for which repulsion caused by the 3er boson (for which either r=2 or r=1, but for which we have yet to determine which alternative applies) matches attraction caused by gravity (4e3). The range of linear size is about one order of magnitude.

Each of Section 2 of [1] and Appendix 8 of [1] provides a formula approximating the masses of the 6 fundamental baryonic-matter quarks and charged leptons. The latter formula contains one more term than does the former formula.

Work in Sections 2 through Section 5 of [1] suggests the following results. (21) provides a ratio involving the q_e (the charge of an electron), $1/(4\pi\varepsilon_0)$ (the Coulomb constant), m_e (the mass of an electron), and G_N (the gravitational constant).the following equations. (The symbol Y does not appear in [1].)

$$\{(q_e)^2/(4\pi\varepsilon_0)\}/\{G_N(m_e)^2\} = (4/3)(Y^6)^2 \quad (21)$$

$$m_{tauon}/m_e = Y \quad (22)$$

For (21), the following equations pertain.

$$4/3 = L_{4e4}/L_{4e3} \quad (23)$$

$$6 = 10\text{-}L_{4e4} \quad (24)$$

Section 11 of [1] provides the following approximate algebraic expression for Y.

$$Y \approx e^{3e}\text{-}3 \quad (25)$$

Appendix 9 of [1] suggests that work in Appendix 5 of [1] and elsewhere in [1] might suggest masses (as "inferred from or observed by" experiments conducted via baryonic matter) for dark-matter leptons and quarks.

Various sections and appendices (especially Appendix 9) of [1] suggest opportunities for observations and experiments that could help confirm or refute implications of work in [1].

References

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