A Model for Creation: Part I

Paul Bernard White[1]

March 4, 2019
(Updated:)[2]

Abstract

Four initial postulates are presented (with two more added later) which state that construction of the physical universe proceeds from a sequence of discrete steps or "projections" --- a process that yields a sequence of discrete *levels* (labeled 0, 1, 2, 3, 4). At or above level 2 the model yields a (3+1)-dimensional structure, which is interpreted as ordinary space and time. As a result, time does not exist below level 2 of the system, and thus the quantum of action, *h*, which depends on time (since its unit is time·energy), also does not exist below level 2. This implies that the quantum of action is not fundamental, and thus, e.g., that the physical universe cannot have originated from a quantum fluctuation. When the gravitational interaction for the model is developed, it is seen that the basic ingredient for gravity is already operating at *level 1* of the system, which implies that gravity, too, is not fundamentally quantum mechanical (since, as stated, *h* only kicks in at level 2) --- perhaps obviating the need for a "quantum theory of gravity". Further arguments along this line lead to the conclusion that quantum fluctuations cannot be a source of gravity, and thus cannot contribute to the cosmological constant, thereby averting the "cosmological constant problem". Along the way, the model also provides explanations for dark energy, the beginning and ending of inflation, quark confinement, and more. Although the model dethrones the quantum, it nevertheless *elevates* an idea in physics that was engendered *by* quantum mechanics: the necessary role of "observers" in constructing the world.

Contents

---

1 pbwx@att.net / ORCID: 0000-0002-2681-3670 / BSc Physics

2 There may be a newer/updated version of this paper at: http://www.paulbwhite.org/papers/
A much shorter/abridged version of this paper is: A Derivation of Space and Time (10 pages)

1 Introduction

Systems that are based on information typically contain a basic information *element* and a basic information *structure*. In Biological systems, for example, the basic information element is the nucleotide molecule, and the basic information structure is a *sequence* of nucleotides (e.g. a codon, or a gene). Likewise, for computer systems the basic information element is the bit, and the basic information structure is a sequence of bits (e.g. an 8-bit byte). And in natural language the basic information element is the letter or phoneme, and the basic information structure is a sequence of letters or phonemes (e.g. a word or a sentence).

Such systems must also have a way of translating or computing the information elements and structures into meaningful output. In biology this is accomplished by the operations of ribosomes, enzymes, etc., acting on the nucleotide strings. For computers, the operations of logic gates on the bit strings typically perform this function. And in natural language the operations of lexical analysis, parsing, and context translate a string of letters/phonemes into meaning.

Likewise, if the *physical universe* is based on information (as many have speculated, e.g. [1], [2], [3]), then the following questions arise: (a) What is the basic information element for this system?; (b) what is the basic information structure for the system?; and (c) how are these elements and structures translated (or computed) into the meaningful output that we call the physical universe?

In answer to questions (a) and (b) above, I propose the following two postulates:

1. For creation of the physical universe, the basic information element is a type of *projection* --- more specifically, *a projection from a prior level*.
2. The basic information structure is a *sequence* of such projections.

With respect to the first postulate, we may refer to both projections and levels as "elements" (or *basic* elements) of the system, but will reserve the term "basic *information* element" for the projections alone.

We now add two more postulates:

3. Each such projection is a *one*-dimensional *vector*, constituting a *different*, but related, one-dimensional space. (The basic relations between these projections/vectors are stated in the next postulate.)
4. Prior things (e.g., projections, levels, and constructions from them) are *independent* of subsequent things; and, conversely, subsequent things are *dependent* on prior things. (The terms prior, subsequent, dependent, and independent denote here *logical/ontological* relations. See e.g. [4].)

Using these four postulates (and two more that will be stated later), we develop a model for the basic construction of the physical universe --- including the construction of ordinary space and time themselves, a quantum of action, fundamental particles and interactions, inflation, dark energy, the cosmological constant, etc. As development of the model progresses, the essential role of "observers" in the construction process becomes more and more clear. With respect to question (c) above, it will be shown that a method for translating sequences of projections into physical meaning is by taking into account the *relations* between projections --- specifically, their dependence and independence relations (i.e. postulate 4). In particular, such relations will allow us to derive a (3+1)-dimensional structure which, in the context of the model, is best interpreted as the ordinary space and time dimensions of our experience.

From now on, I will often refer to the model for constructing the ***p***hysical universe, developed herein, as *system P*, and the world so constructed from it as *world P*.

2 Levels, projections, and relations: the structure and basic properties of system P

To construct our model for the physical universe (i.e. system P), we must begin with a *state* at which the things of the universe do not exist (otherwise our construction would be circular), i.e. a state that is absent the energy, elementary particles, and even space and time, as we know them. We will call this state *level 0 of system P* (or "losp", which comes from "**l**evel **0** of **s**ystem **P**", where we pronounce the zero as the letter 'o'); or, when it is clear that we are talking about system P, simply *level 0*. We do not, however, presume that level 0 is a state of nothingness, or that nothing exists at level 0. We merely claim that nothing that comes into being with the construction of the physical universe exists at level 0; for level 0 is by definition a state that is immediately *prior* to the construction of the physical universe.

Recalling our first three postulates, we say that a projection from level 0, to be denoted as $\mathbf{p}_0$, generates a *new* state, which we call *level 1*. Likewise, a projection from level 1, denoted as $\mathbf{p}_1$, generates another new state, which we call *level 2*. And a projection from level 2, denoted as $\mathbf{p}_2$, yields *level 3*; and so on. (Note that the choice of the letter "**p**" in our denotation here refers not to "projection" per se, but to system *P*; later, especially in Part II [5], the sequel to the present paper, we will use different letters to denote projection in different systems.) So, in general, the projection $\mathbf{p}_k$ represents a sort of *displacement* from level k that generates level $k + 1$ (for $k = 0, 1, 2, \ldots$); thus, relative to each other, level k is *prior*, and level $k + 1$ is *subsequent*; also, relative to each other, $\mathbf{p}_k$ is prior, and $\mathbf{p}_{k+1}$ is subsequent. (Again, the terms "prior" and "subsequent" refer to logical/ontological priority and subsequence.)

In Fig. 1, where levels are represented by horizontal lines, and projections are represented by vertical arrows from a prior level to the next subsequent level, we illustrate the construction of levels 1 through 4 via projections $\mathbf{p}_0$ through $\mathbf{p}_3$. To the right of each level in Fig. 1 is shown the sequence of projections that is required to construct that level (the round brackets indicate a sequence, as is common in mathematics). Thus, the sequences of projections that are needed to create levels 0, 1, 2, and 3 are ( ), ($\mathbf{p}_0$), ($\mathbf{p}_0$, $\mathbf{p}_1$), and ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$), respectively; and the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) constructs all of the levels (above level 0) in Fig. 1.

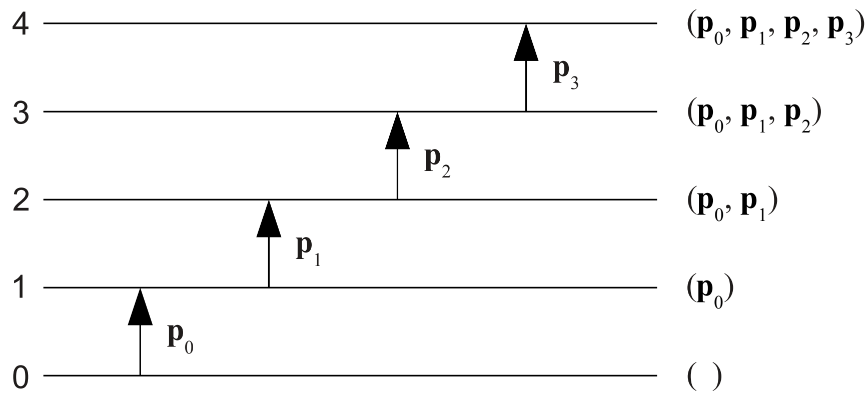

Fig. 1 Construction of levels 1 through 4 of system P via the projection sequence $(\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3)$. The projection sequence that is required to construct a given level is shown to the right of that level.

As just described, the *order* of construction in system P starts with level 0 at the bottom of Fig. 1 and proceeds in the upward direction. Thus, level 0 is *prior* to all other elements (levels or projections) in system P, and *subsequent* to none; $\mathbf{p}_0$ is subsequent to level 0, but prior to level 1, $\mathbf{p}_1$, level 2, etc.; and so on. So, in general, a given element *x* in system P is subsequent to everything below it in Fig. 1, but prior to everything above it. By postulate 4, this means that element *x* is *dependent* on everything below it in the Figure, but *independent* of everything above it. Thus, e.g., level 0 is independent of all other elements in system P, and dependent on none.

Since level 0 is our *starting point* (or starting *state*) for constructing system P, then we must say that it is a *nonconstructed* element of *that* system, whereas the subsequent projections and levels ($\mathbf{p}_0$, level 1, $\mathbf{p}_1$, level 2, etc.) are *constructed* elements of system P. So anything subsequent to level 0 is a *constructed* entity of the system.

2.1 Some properties of system P

Let *x* be a thing of system P (e.g., *x* is a level, a set of one or more projections, or something constructed from them). By postulate 4, things that are subsequent to *x* are (logically/ontologically) *dependent* on *x*. Such dependence implies that *x* is **in effect**, effective, operative, or **operant** at those subsequent things; or, alternatively, we say that those subsequent/dependent things are *within the* **scope** *of x*. Conversely, since things that are *prior* to *x* are *independent* of it, we say that *x* is *not* in effect or operant at those prior things; or, alternatively, we say that those prior/independent things are *not* within the scope of *x*. All of this is summarized in what will be called the **scope rule** for system P, stated as follows:

> A given thing in system P is in effect/operant at (i.e., contains within its scope) those things which are *subsequent*, and is not in effect at (does not contain within its scope) those things which are *prior*.

From this we may deduce the following corollary to the scope rule:

> A given *element* in system P (i.e., a projection or level) is in effect/operant at (contains within its scope) those elements that are *above* it in Fig. 1, and is not in effect at (does not contain within its scope) those elements that are *below* it in Fig. 1.

Thus, e.g., since all of the *constructed* elements of system P (i.e. $\mathbf{p}_0$, level 1, $\mathbf{p}_1$, level 2, etc.) are subsequent to level 0 (or, conversely, level 0 is prior to them), then level 0 is in effect/operant at all of those things; or, all of those things are within the scope of level 0. Likewise, $\mathbf{p}_1$, level 2, $\mathbf{p}_2$, level 3, etc., are within the scope of level 1; but level 0 is *not* within the scope of level 1. And so on.

Since $\mathbf{p}_k$ is *not* in effect at level k, but *is* in effect at level $k + 1$, then level $k + 1$ represents the *state* at which the projection $\mathbf{p}_k$ first comes into effect; by the scope rule, $\mathbf{p}_k$ then *stays* in effect for all subsequent levels. Thus, the projection $\mathbf{p}_0$ first comes into effect at level 1, and stays in effect for levels 2, 3, and 4; likewise, $\mathbf{p}_1$ first comes into effect at level 2, and stays in effect for levels 3 and 4. Let us say that the level at which a projection first comes into effect is its *native level*. Thus, level 1 is the native level for $\mathbf{p}_0$; level 2 is the native level for $\mathbf{p}_1$; and so on. That is, the native level for $\mathbf{p}_k$ is level $k + 1$. Moreover, the concept of native level can be extended to things that are *constructed from* projections; thus, e.g., something that is constructed using $\mathbf{p}_0$ and $\mathbf{p}_1$ (and no other projections) is native to level 2, since those two projections are first *jointly* in effect at that level. We note also that the projections that are in effect/operant at a given level are the *same* as the ones that are required to *construct* that level (as described earlier, and as listed in the sequences to the right of each level in Fig. 1).

In constructing the sequence of projections ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$), since any projections that are in effect at level k are also in effect at the subsequent level $k + 1$, then we can think of the latter level as *inheriting* all of the projections that are in effect at the former level. And since this is true of projections, then it is also true of anything that is associated with or constructed from them. This aspect of system P --- whereby that which is in effect at one level (or, if you will, *generation*) is passed on to the next subsequent level (and thus, by extension, to *all* subsequent levels) --- will be called the **inheritance rule**.

As described above, the scope of a given element *contains* the scope of the next subsequent element, and is contained (or nested) *within* the scope of its immediately prior element. Thus, the scopes of the sequence of elements in system P can be pictured as a (matryoshka-doll-like) structure of concentric spheres; the outer sphere being the scope of level 0, the first inner sphere being the scope of $\mathbf{p}_0$, the next inner sphere being the scope of level 1, and so on. Again, since this applies to *elements* of system P, it also applies to things that are associated with or constructed from them. This leads to the following general statement, which will be referred to as the **nesting rule** for system P:

> Subsequent things (e.g. levels, projections, and any constructions derived from them) are *internal to* or *nested* (and thus embedded, contained, encapsulated, confined) *within* the scope of prior things; and, conversely, prior things contain, encapsulate and confine (within their scope) subsequent things.

Thus the nesting rule may also be called the *confinement* rule.

Since the sequence of projections, ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$), that constructs system P springs out of level 0 of that system, then we can say that level 0 (or losp) is the *origin* of system P. And since, by the nesting/confinement rule, all of the constructed elements/entities of that system are nested/confined within level 0, then we can also say that level 0 is the *boundary* of system P. Thus, level 0 is the origin *and* boundary of system P; so, in that sense, although level 0 is a necessary part of the ontology of system P, it is not technically *within* system/world P.

Finally, when a set of things in system P (i.e. elements, or things constructed from them) is arranged from prior to subsequent, then we will say that the things are arranged in their *order of priority*. If a thing is neither prior nor subsequent to another thing, then we say that they are *of the same order*, or *coordinate*.

3 Constructing spaces in system P

Following postulate 3, let us model each projection as a one-dimensional *vector*; i.e. we model each $\mathbf{p}_k$ ($k = 0, 1, 2, \ldots$) as a one-dimensional vector going from level k to level $k + 1$. Thus, $\mathbf{p}_0$ is a one-dimensional vector from level 0 to level 1; $\mathbf{p}_1$ is a one-dimensional vector from level 1 to level 2; and so on. These vectors are represented graphically by the vertical arrows in Fig. 1.

Moreover, each $\mathbf{p}_k$ constitutes a *different* one-dimensional space. Though they are different in this respect, the $\mathbf{p}_k$ are nevertheless *related* by the dependence and independence relations that have been postulated and discussed.

3.1 Constructing a (3+1)-dimensional structure at level 2

Since $\mathbf{p}_0$ is the only projection in effect at level 1, and since (by postulate 3) it is *one* dimensional, then it is fair to say that system P is *one dimensional* at level 1.

Since both $\mathbf{p}_0$ and $\mathbf{p}_1$ are in effect at level 2, and since (by postulate 3) each of these constitutes a different one-dimensional space, then it might seem --- at first glance --- that system P should be *two* dimensional at level 2. But this would be wrong.

To get the correct dimensionality at level 2, we must take into account the *relations* between $\mathbf{p}_0$ and $\mathbf{p}_1$, as per postulate 4 --- i.e. the fact that $\mathbf{p}_0$ is *independent* of $\mathbf{p}_1$, and that this relation is *asymmetric* ($\mathbf{p}_1$ is *dependent* on $\mathbf{p}_0$). Since $\mathbf{p}_0$ and $\mathbf{p}_1$ are *vectors*, we interpret that these relations imply a kind of (asymmetric) *linear* independence, with the following property: from the perspective of $\mathbf{p}_1$, the vector $\mathbf{p}_0$ may be collinear with $\mathbf{p}_1$, but is also free to be *noncollinear* with $\mathbf{p}_1$. With these considerations in mind, we ask the question: What is the *direction* of $\mathbf{p}_0$ with respect to $\mathbf{p}_1$? Or, in other words, how does $\mathbf{p}_0$ "look" relative to $\mathbf{p}_1$?

Since $\mathbf{p}_0$ may be both collinear and noncollinear with $\mathbf{p}_1$ (from the latter's perspective), then $\mathbf{p}_0$ may have a component parallel to $\mathbf{p}_1$, and may also have a component *perpendicular/orthogonal* (i.e. at 90 degrees) to $\mathbf{p}_1$. But, by symmetry, the perpendicular component can be anywhere in a two-dimensional *plane* orthogonal to $\mathbf{p}_1$. The two dimensions of this orthogonal plane, plus the one dimension parallel to $\mathbf{p}_1$, makes three dimensions. Thus, from the viewpoint of $\mathbf{p}_1$ (and from the perspective of level 2), $\mathbf{p}_0$ has *three* dimensions; i.e., $\mathbf{p}_0$ constitutes a *three*-dimensional space (whereas, recall that $\mathbf{p}_0$ has only one dimension at level 1). We might say, therefore, that the view of $\mathbf{p}_0$ from the perspective of $\mathbf{p}_1$ "bootstraps" the former from a one-dimensional vector into a three-dimensional space.

In summary, to construct its interpretation of $\mathbf{p}_0$, we can think of $\mathbf{p}_1$ as applying postulates 3 and 4 in succession: first, by postulate 3, $\mathbf{p}_0$ is a one-dimensional vector; second, by postulate 4, $\mathbf{p}_0$ is independent of $\mathbf{p}_1$ --- which allows the former to have a component that is orthogonal to $\mathbf{p}_1$, with the result that $\mathbf{p}_1$ sees $\mathbf{p}_0$ as three dimensional.

Conversely, we can ask, how does $\mathbf{p}_1$ "look" relative to $\mathbf{p}_0$? Since $\mathbf{p}_1$ is *dependent* on $\mathbf{p}_0$, then the former is *not* free to have a component that is orthogonal to the latter, and so $\mathbf{p}_0$ sees $\mathbf{p}_1$ as being collinear; or, more simply, $\mathbf{p}_0$ sees $\mathbf{p}_1$ strictly as per postulate 3: as a *one*-dimensional vector.

So, at level 2 we have the three dimensions of $\mathbf{p}_0$, plus the one dimension of $\mathbf{p}_1$, for a total of *four* dimensions. Since system P is a model for constructing the physical universe, we interpret that the three dimensions of $\mathbf{p}_0$ are just the three dimensions of *ordinary space*, and the one dimension of $\mathbf{p}_1$ is the dimension of *time*; thereby yielding at level 2 the signature 3+1 space and time dimensions of our experience. The dimension of time, therefore, being a consequence of $\mathbf{p}_1$ (and $\mathbf{p}_0$), does not exist at levels 0 and 1, but only comes into existence at level 2; likewise, since ordinary, three-dimensional space is a consequence of $\mathbf{p}_0$ and $\mathbf{p}_1$, it also does not exist at levels 0 and 1, but only comes into existence at level 2.

Note that, although $\mathbf{p}_0$ itself is independent of $\mathbf{p}_1$, the triple dimensionality of $\mathbf{p}_0$ at level 2 is *not* independent of $\mathbf{p}_1$. That is, in the process described above, $\mathbf{p}_0$ only manifests as *three* dimensional when it is related to, or juxtaposed with, $\mathbf{p}_1$. Thus, the triple dimensionality of $\mathbf{p}_0$ at level 2 (i.e. the triple dimensionality of ordinary space) is in fact *dependent* on $\mathbf{p}_1$. Conversely, both $\mathbf{p}_0$ and $\mathbf{p}_1$ are *prior* to, and thus independent of, ordinary space.

We have shown, among other things, that $\mathbf{p}_0$ manifests differently at levels 1 and 2. At level 1 it is *one* dimensional. But when juxtaposed with $\mathbf{p}_1$ at level 2 it manifests as a *three*-dimensional space. Note that $\mathbf{p}_0$ itself does not change from level to level: it represents a projection from level 0 to level 1 wherever it appears (i.e. wherever it is in effect). This is analogous to, e.g., the G nucleotide in biology, which is always the same molecule wherever it appears, but yields a different output (i.e. amino acid) depending on what other nucleotides/letters it is juxtaposed with in a sequence. In other words, like the letter G in a DNA sequence, the *meaning* of $\mathbf{p}_0$ is context dependent; which is just what we might expect for an element of a *language*, thus supporting our earlier notion that the basis of the physical universe is, to some degree at least, informational in nature.

We might say that level 2 has *two* dimensions as *input* (one dimension for $\mathbf{p}_0$, plus one for $\mathbf{p}_1$), but has *four* dimensions as *output* --- three for $\mathbf{p}_0$, and one for $\mathbf{p}_1$. Which brings us back to question (c) in the introduction: How are the basic information elements of the model (which at level 2 are the inputs $\mathbf{p}_0$ and $\mathbf{p}_1$) translated (or, if you will, *computed*) into the meaningful output that we call the physical universe? We now see that at least a partial answer is that the *relations* between prior and subsequent elements are what translate them into meaningful output. In the present case, the independence relation between $\mathbf{p}_0$ and $\mathbf{p}_1$ at level 2 translates/transforms the manifestation of the former from a one-dimensional entity into a three-dimensional space.

We can thus say that the construction of each space at level 2 requires the participation of an *observer*, in the sense that $\mathbf{p}_1$ "observing" $\mathbf{p}_0$ constructs ordinary, three-dimensional space, and $\mathbf{p}_0$ "observing" $\mathbf{p}_1$ constructs one-dimensional time. With ordinary space *itself* constructed by an observation of sorts, it becomes more plausible that, e.g., the *position* of an object *within* ordinary space might also be constructed by some type of observation, as seems to be the case in quantum mechanics (more about that in section 4.11).

We have just described how the spaces and dimensionalities at level 2 are constructed. Now we will do the same for levels 3 and 4.

3.2 The spaces of levels 3 and 4

At level 3, the projections $\mathbf{p}_0$, $\mathbf{p}_1$, and $\mathbf{p}_2$ are in effect.

The relations between $\mathbf{p}_0$ and $\mathbf{p}_1$ at level 3 are the same as they are at level 2 (i.e. $\mathbf{p}_0$ is independent of $\mathbf{p}_1$, but not the converse). Thus, at level 3 --- as at level 2 --- $\mathbf{p}_0$ will appear to $\mathbf{p}_1$ as a three-dimensional space (i.e. ordinary space), and $\mathbf{p}_1$ will appear to $\mathbf{p}_0$ as a one-dimensional space (i.e. time). In other words, the spaces that exist at level 2 also exist at level 3. Indeed, as per the inheritance rule, we might say that level 3 *inherits* these spaces from level 2; or, more precisely, level 3 inherits $\mathbf{p}_0$, $\mathbf{p}_1$, and the relations between them from level 2, and uses them to *construct* ordinary space and time.

Let us denote ordinary, three-dimensional space as S^3_{01p}, where the superscript indicates the number of dimensions; the 0 followed by 1 in the subscript indicates that this is the space of $\mathbf{p}_0$ as seen by $\mathbf{p}_1$; and the "p" in the subscript reminds us that we are talking about a space in system *P*. Likewise, let us denote time as S^1_{10p}, where, again, the superscript indicates the dimension of this space; and the 1 followed by 0 in the subscript indicates that this is the space of $\mathbf{p}_1$ as seen by $\mathbf{p}_0$.

Focusing again on level 3, we start by discussing the relations between $\mathbf{p}_0$ and $\mathbf{p}_2$ at that level. The former is independent of the latter, so $\mathbf{p}_0$ is *three* dimensional from the viewpoint of $\mathbf{p}_2$. We thus have the generation of a *new* three-dimensional space at level 3, which we denote as S^3_{02p}.

Likewise, $\mathbf{p}_1$ is independent of $\mathbf{p}_2$; so the latter will see $\mathbf{p}_1$ as three dimensional (whereas, as already stated, $\mathbf{p}_1$ has only one dimension from the viewpoint of $\mathbf{p}_0$). This yields yet another three-dimensional space at level 3, which we denote as S^3_{12p}. In addition, at level 3 we also have the *one*-dimensional space, S^1_{20p}, of $\mathbf{p}_2$ as seen by $\mathbf{p}_0$; and the one-dimensional space, S^1_{21p}, of $\mathbf{p}_2$ as seen by $\mathbf{p}_1$. We now ask, *where* are these spaces located relative to each other? The *three*-dimensional spaces at level 3 have the order of priority S^3_{01p}, S^3_{02p}, S^3_{12p}; [3] so, by the nesting rule, S^3_{12p} is nested/contained/confined within S^3_{02p}, which in turn is nested/confined within S^3_{01p} (ordinary space); or, to put it another way, S^3_{01p} (ordinary space) contains S^3_{02p}, which in turn contains S^3_{12p}. The *one*-dimensional spaces, S^1_{20p} and S^1_{21p}, being modes of $\mathbf{p}_2$, are nested/contained within S^3_{02p}, and possibly also within S^3_{12p}.

Now let us move up to level 4, where the projections $\mathbf{p}_0$, $\mathbf{p}_1$, and $\mathbf{p}_2$ are still in effect. So the spaces of level 3 also exist at level 4. In addition, the projection $\mathbf{p}_3$ is in effect at level 4, so the relationship between it and the prior projections $\mathbf{p}_x$ ($x = 0, 1, 2$) generates three new, three-dimensional spaces, which we denote collectively as S^3_{x3p}; and we note that these spaces will be internal to, or nested within, S^3_{12p}. Lastly, there are the three, one-dimensional spaces of: $\mathbf{p}_3$ as seen by $\mathbf{p}_0$, denoted as S^1_{30p}; $\mathbf{p}_3$ as seen by $\mathbf{p}_1$, denoted as S^1_{31p}; and $\mathbf{p}_3$ as seen by $\mathbf{p}_2$, denoted as S^1_{32p} -- which may be denoted collectively as S^1_{3yp} ($y = 0, 1, 2$).[4]

3.3 The number of dimensions at levels 2, 3, and 4

At level 2 the *four* dimensions of S^3_{01p} and S^1_{10p} are in effect. At level 3, the same four dimensions at level 2 are in effect, plus the eight additional dimensions of S^3_{02p}, S^3_{12p}, S^1_{20p}, and S^1_{21p}, which makes a total of *twelve* dimensions at level 3. And at level 4, the same twelve dimensions at level 3 are in effect, plus the 12 additional dimensions of S^3_{x3p} ($x = 0, 1, 2$) and S^1_{3yp} ($y = 0, 1, 2$), for a total of 24 dimensions at level 4.

The *union* of spaces at levels 2 and 3 is the *twelve*-dimensional set

$$\{ S^1_{10p},\ S^3_{01p},\ S^3_{02p},\ S^3_{12p},\ S^1_{20p},\ S^1_{21p} \},$$

3 Obviously, S^3_{01p} is prior to the other two, since it is native to level 2, whereas the others are native to level 3. S^3_{02p} is prior to S^3_{12p} since the former is a manifestation, or mode, of $\mathbf{p}_0$, whereas the latter is a mode of $\mathbf{p}_1$ (and the former projection is prior to the latter).

4 Note that, for a space S^z_{xyp}, the superscript, z, is actually redundant information, since it is always equal to 3 if $x < y$, and is equal to 1 if $x > y$.

and the union of spaces at levels 2, 3, and 4 is the *twenty-four*-dimensional set

$$\{ S^1_{10p},\ S^3_{01p},\ S^3_{02p},\ S^3_{12p},\ S^1_{20p},\ S^1_{21p},\ S^3_{x3p}\ S^1_{3yp} \}.$$

And we note that the 10 "extra" spaces (or 20 extra dimensions) of these sets (i.e. the spaces/dimensions that are native to levels 3 and 4) are *nested/confined* --- and, indeed, as will be concluded in section 4.3.4, *compacted* --- within ordinary space, S^3_{01p}. The dimensionalities of system P thus bear some similarity to dimensionalities in string theory [6]. Does this suggest that the projections of the present model have some relation to *strings*? Possibly --- but we will not specifically expand on the string idea any further in this paper.

As alluded to, more will be said about the nested spaces of levels 3 and 4 in section 4, where we construct the *particles* of system P.

3.4 Isotropy and homogeneity of ordinary space

Recall that S^3_{01p} (ordinary, three-dimensional space) is created when $\mathbf{p}_0$ is viewed from the perspective of $\mathbf{p}_1$. So it follows that (a) the creation/construction of S^3_{01p} is *dependent* on $\mathbf{p}_0$ and $\mathbf{p}_1$; and (b) $\mathbf{p}_0$ and $\mathbf{p}_1$ are *prior to*, and thus (by postulate 4) *independent of*, S^3_{01p}.

Suppose now that an outcome of constructing S^3_{01p} is that $\mathbf{p}_0$ (or $\mathbf{p}_1$) manifests with a particular orientation or direction within that space. Since this would make $\mathbf{p}_0$ (or $\mathbf{p}_1$) functionally dependent on S^3_{01p}, and thus contradict (b) above, we conclude that the construction of S^3_{01p} (ordinary space) cannot result in $\mathbf{p}_0$ (or $\mathbf{p}_1$) having a particular direction/orientation within that space. Presumably, then, there is no way for the process that constructs S^3_{01p} to establish a distinctive (i.e. special, preferred, or favored) direction within that space. We thus conclude that, as constructed above, ordinary space is perfectly *isotropic*.

Now suppose that an outcome of constructing S^3_{01p} is that $\mathbf{p}_0$ (or $\mathbf{p}_1$) manifests with a particular *position* within that space. This, again, would make $\mathbf{p}_0$ (or $\mathbf{p}_1$) functionally dependent on S^3_{01p}, and thereby contradict (b) above; and so we conclude that the construction of S^3_{01p} cannot result in $\mathbf{p}_0$ (or $\mathbf{p}_1$) having a particular position within that space. Presumably, then, the process that constructs S^3_{01p} cannot establish a distinctive (i.e. special, preferred, or favored) position within that space. We thus conclude that, as constructed above, ordinary space is perfectly *homogeneous*.

In addition, the construction of S^3_{01p} cannot result in either $\mathbf{p}_0$ or $\mathbf{p}_1$ manifesting as *vectors*, or *vector fields*, within that space; for if they did, then these projections/vectors would be functionally dependent on S^3_{01p}, which would again contradict (b). Given that *vector* fields have been ruled out, it seems we have little choice but to assume that $\mathbf{p}_0$ and $\mathbf{p}_1$ manifest within S^3_{01p} as uniform *scalar* fields --- *uniform*, because any *non*uniformity would make the manifestations of $\mathbf{p}_0$ or $\mathbf{p}_1$ functionally dependent on S^3_{01p}, which would, again, violate/contradict their independence from that space. Presumably, the uniform scalar field for $\mathbf{p}_0$ is just (raw, unstructured) ordinary space itself, and the uniform (one-dimensional) scalar field for $\mathbf{p}_1$ is just proper time.

Lastly, let us recall that $\mathbf{p}_0$ sees $\mathbf{p}_1$ as a one-dimensional *vector*. This, presumably, would impart some *directionality* to $\mathbf{p}_1$ --- which, as we have concluded, could not manifest as a direction within ordinary space. Since $\mathbf{p}_1$ has been associated with *time*, we interpret that this directionality of $\mathbf{p}_1$ (with respect to $\mathbf{p}_0$) is just the "arrow" of time.

3.5 Rapid expansion of ordinary space within the first instant of time

Recall that $\mathbf{p}_0$ at level 1 is *one* dimensional --- having, let us say, a length of p_0. The time dimension, being a result of $\mathbf{p}_1$, does not exist at this level/stage. Given that a one-dimensional object has *zero* volume, then the physical universe at this stage of development has a volume of zero.

Since the time dimension comes into existence with the projection $\mathbf{p}_1$, then the *advent* of $\mathbf{p}_1$ defines the time point $t = 0$, at which point p_0 has the value $p_0(t = 0)$, which may be denoted as $p_{0,0}$. So, at exactly $t = 0$, or within the first instant after it, the existence/perspective of $\mathbf{p}_1$ causes $\mathbf{p}_0$ to manifest as the *three*-dimensional space S^3_{01p}, with a volume that should be proportional to $p^3_{0,0}$. Thus the volume of S^3_{01p} (ordinary space) goes from zero to around $p^3_{0,0}$ within a time interval of zero, or near-zero, length --- which constitutes a potentially very large, perhaps infinite, rate of spatial expansion. I propose, therefore, that this rapid spatial expansion, triggered by the advent of $\mathbf{p}_1$ at $t = 0$, is the process known as *inflation* [7].

Note that, under the above mechanism, inflation has a natural beginning: the advent of $\mathbf{p}_1$ at $t = 0$. And it also has a natural *ending*: it ends when the volume of ordinary space is around $p^3_{0,0}$. So inflation only lasts for the time (if any) that it takes (from the perspective of $\mathbf{p}_1$) for the *one*-dimensional space of length $p_{0,0}$ to become the *three*-dimensional space of approximate volume $p^3_{0,0}$.

4 Constructing particles in system P

In constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for system P, let us assume that *energy* is needed to create each of the projections $\mathbf{p}_k$ (for $k = 0, 1, 2, ...$). We can think of this energy as being stored along the length of $\mathbf{p}_k$, and/or as being stored in the *level* that is created by $\mathbf{p}_k$. So we can speak of "$\mathbf{p}_k$ energy", and/or we can speak of the energy, $E_{[k+1]p}$, that $\mathbf{p}_k$ inputs into level k+1 (the "p" part of the subscript merely indicates that this is energy for system *P*).

We can think of the projection $\mathbf{p}_0$, then, as a *process* through which energy E_{1p} is input into level 1 of system P. Likewise, $\mathbf{p}_1$ is a process that inputs energy E_{2p} into level 2; $\mathbf{p}_2$ is a process that inputs energy E_{3p} into level 3; and so on.

Let us collectively refer to the energy that is input into level 2 and above as $E_{\geq 2p}$; thus

$$E_{\geq 2p} = E_{2p} + E_{3p} + E_{4p} + \ldots.$$

The total energy, E_{tp}, that is input into system P is therefore $E_{tp} = E_{1p} + E_{\geq 2p}$. We assume that all of these energies are nonzero and positive, so the energy of system P at level 1 and above, due to contributions from the sources mentioned, is positive.

4.1 Relations between energies

Now that we have labeled the various energies that are involved in constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for system P, we discuss some properties of, and relations among, these energies, as follows:

- Due to the scope rule, $\mathbf{p}_k$ energy is in effect, or operant, at level k+1 and above; so level k+1 is the *native* level for $\mathbf{p}_k$ energy. Thus, $\mathbf{p}_0$ energy is native to level 1 (i.e., it is operant at level 1 and above); $\mathbf{p}_1$ energy is native to level 2 (operant at level 2 and above); $\mathbf{p}_2$ energy is native to level 3 (operant at level 3 and above); and so on.
- In constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for system P, *all* of the needed energy presumably *enters* (i.e., is input or "piped" into) that system via the projection $\mathbf{p}_0$; in other words, all of that energy begins its life in the system as $\mathbf{p}_0$ energy, at level 1. Some of this $\mathbf{p}_0$ energy is then projected up to level 2, via $\mathbf{p}_1$, thereby making it *also* "$\mathbf{p}_1$ energy"; and some of this $\mathbf{p}_0$/$\mathbf{p}_1$ energy at level 2 is further projected up to level 3, via $\mathbf{p}_2$, thereby making it also "$\mathbf{p}_2$ energy"; and so on. Alternatively, in constructing the said sequence, we can say that $\mathbf{p}_k$ energy is also $\mathbf{p}_{k\text{-}1}$ energy, $\mathbf{p}_{k\text{-}2}$ energy, ..., $\mathbf{p}_0$ energy. Thus, *all* of these $\mathbf{p}_k$ energies are essentially also "$\mathbf{p}_0$ energy".

The central role of $\mathbf{p}_0$ as the portal or "pipe" through which the energy that constructs the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) comes into the system, merits the following description/definition of "$\mathbf{p}_0$ energy":

> $\mathbf{p}_0$ energy is energy (a) that *enters* system P at level 1, and so is native to level 1; (b) whose *entry* into the system is thereby dependent *only* on the projection $\mathbf{p}_0$; and (c) whose entry into the system is thus *independent* of $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$, etc.

We note that, as already alluded to above, the *subsequent* forms of energy that are involved in constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) --- i.e., $\mathbf{p}_1$ energy, $\mathbf{p}_2$ energy, etc. --- also, essentially, satisfy this definition of $\mathbf{p}_0$ energy. That is, *in constructing the said sequence*, these subsequent forms of energy share the provenance of being energy that entered system P via the $\mathbf{p}_0$ portal --- and so, by the definition above, are essentially "$\mathbf{p}_0$ energy". Figuratively, we might say that, due to their common provenance in the projection $\mathbf{p}_0$, those subsequent forms of energy *inherit* the nature, likeness, or "mantle" of $\mathbf{p}_0$ energy (a result which might thus be attributable to the inheritance rule).

4.2 A quantum of action

Recall that the dimension of time is associated with $\mathbf{p}_1$. Since $\mathbf{p}_1$ does not exist at levels 0 and 1, then time also does not exist there; i.e., all time intervals are zero at those levels. Indeed, we can say that levels 0 and 1 are *independent of time*. But $\mathbf{p}_1$ *does* exist at level 2 and above; so time exists there, and *all* time intervals at those levels are *nonzero* (and presumably positive).

Thus, at level 1, energy is nonzero, but time is zero. At level 2 (and above), however, both energy and time (intervals) are *nonzero*. Consequently, at level 2 and above, the *product* of energy and time --- the quantity known as *action* --- is nonzero, and thus has a positive lower bound; i.e., at level 2 (and above) the action is *quantized*. We thus have the derivation of an action *quantum*, which we interpret to be the basis for the empirically-known "quantum of action", commonly referred to as *Planck's constant*, and denoted as h.

In the present model, therefore, the quantum of action, h, depends on both $\mathbf{p}_0$ and $\mathbf{p}_1$, and so does not exist at levels 0 and 1, but only comes into being at level 2. Thus, quantum mechanics, which is based on h, also comes into being at level 2 of system P. And therefore, due to the scope rule, both h and quantum mechanics are operant at level 2 and above; i.e., they are *native* to level 2. Note that the advent of h at a *later* stage (level 2) in the construction of system/world P is in contrast to the usual notion in which the quantum of action is assumed to (magically) operate at *all* phases in the construction of the physical universe.

The late advent of h in system P has the following immediate consequences:

- Because h is not operant at levels 0 and 1, then system P is not quantum mechanical at those primal levels, and so system P is not fundamentally quantum mechanical. Since system P is our model for constructing the physical universe, we conclude that the physical universe is not fundamentally quantum mechanical, and thus cannot have originated from a quantum effect (e.g., a "quantum fluctuation") --- because the *source/origin* of system P is at level 0, and h does not exist there.

- The energy of quantum vacuum fluctuations (or zero-point energy) necessarily depends on h, which (as we have found) depends on both $\mathbf{p}_0$ and $\mathbf{p}_1$, and is native to level 2; that is, quantum vacuum energy *enters* system P at *level 2 or above*, and its entry into the system is dependent on $\mathbf{p}_0$ *and* $\mathbf{p}_1$. Now recall our recent definition of "$\mathbf{p}_0$ energy": It enters system P at level 1; and its entry into the system depends only on $\mathbf{p}_0$, thereby making that entry independent of $\mathbf{p}_1$. Clearly, then, the energy of quantum fluctuations is *not* $\mathbf{p}_0$ energy (essentially or otherwise); rather, due to their dependence on $\mathbf{p}_1$, such fluctuations can presumably only produce $\mathbf{p}_k$ energy forms that are native to *level 2 or above* --- i.e., $\mathbf{p}_1$ energy, $\mathbf{p}_2$ energy, $\mathbf{p}_3$ energy, and so on. This result will later be shown to have important implications for the cosmological constant problem.

4.3 Energy distribution within ordinary space

We know how the different terms in E_{tp} are distributed among the *levels* (i.e. E_{kp} is input into level k), but how are they distributed initially and presently on large and small scales within ordinary space, S^3_{01p}? The following six factors of the model likely dominate the distribution of energy within S^3_{01p}:

1. The projection $\mathbf{p}_0$ is independent of S^3_{01p} (ordinary space).
2. In addition, $\mathbf{p}_0$ is independent of $\mathbf{p}_1$.
3. The projections $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$, etc., are *dependent* on $\mathbf{p}_0$.
4. At levels 0 and 1, neither time nor h exist.
5. At level 2 (and above), both time and h exist, and are thus in effect/operant.
6. At level 3 the space S^3_{12p} is nested/confined within S^3_{02p}, which in turn is nested/confined within S^3_{01p} (ordinary space).

The role of these factors in shaping energy distribution is elaborated in the next few subsections.

4.3.1 Large-scale distribution of energy within ordinary space

If the $\mathbf{p}_0$ process were to distribute its energy E_{1p} *nonuniformly* within S^3_{01p}, then $\mathbf{p}_0$ would be favoring particular directions or positions within that space. But, as concluded in section 3.4, the independence of $\mathbf{p}_0$ from S^3_{01p} (factor 1) implies that it *cannot* favor particular directions or positions within that space. We conclude, therefore, that the $\mathbf{p}_0$ process must distribute its energy E_{1p} *uniformly* throughout the volume p_0^3 of S^3_{01p} (ordinary space).

Moreover, given our earlier conclusion that the construction of S^3_{01p} cannot result in $\mathbf{p}_0$ manifesting as a vector field within that space, then presumably its associated energy (E_{1p}) also cannot manifest as a vector field in ordinary space. Consequently, it seems that E_{1p} must manifest within S^3_{01p} as a uniform *scalar* field --- *uniform* for the same reasons given in section 3.4.

Since, in constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$), the projections $\mathbf{p}_1$, $\mathbf{p}_2$, and $\mathbf{p}_3$ are *dependent* on $\mathbf{p}_0$ (factor 3), and their associated energies all enter the system via the $\mathbf{p}_0$ portal, then they presumably "follow the lead" of $\mathbf{p}_0$ and also distribute their energies uniformly (on the large scale) throughout S^3_{01p}.

Note that the *uniform* distribution of E_{1p} energy throughout S^3_{01p} (ordinary space) might strictly apply *only* to that energy which comes into the system *after* the advent of $\mathbf{p}_1$ (with the concomitant advent of time and S^3_{01p} itself). *Prior* to the advent of $\mathbf{p}_1$, the E_{1p} energy is distributed (perhaps nonuniformly) along the line of $\mathbf{p}_0$ (as described earlier). Given its priority, this linear distribution might manifest at the advent of S^3_{01p}, and remnants of it might survive the inflation process, thereby imprinting some large-scale anisotropy on the cosmic microwave background (CMB) --- perhaps yielding, e.g., the so-called "axis of evil" [8], [9].

We can thus divide the production and distribution of E_{1p} energy into two logical phases, or epochs: (1) the epoch *prior* to the advent of $\mathbf{p}_1$, in which E_{1p} is distributed along the line of $\mathbf{p}_0$, and (2) the epoch *after* the advent of $\mathbf{p}_1$, in which E_{1p} is distributed uniformly throughout the volume p_0^3 of ordinary space, S^3_{01p}.

4.3.2 Small-scale distribution of $E_{\geq 2p}$ energy

Recall that both time and h exist at level 2 (factor 5). The presence of time means that the input of energy E_{2p} into level 2 from $\mathbf{p}_1$ can be, and we assume *is*, time-dependent and time-limited --- and thus *finite*. So $\mathbf{p}_1$ inputs a finite amount of energy E_{2p} into level 2. Furthermore, we expect the presence of h to *partition* this energy into smaller bits or chunks, yielding a *multiplicity* of what we will generically refer to as level-2 entities, objects, or particles. Given their dependence on $\mathbf{p}_1$, these objects will see $\mathbf{p}_0$ from the perspective of $\mathbf{p}_1$, and so they will see themselves as nested/enveloped/contained/embedded within the three-dimensional space of $\mathbf{p}_0$ (as seen from the perspective of $\mathbf{p}_1$) --- that is, they will see themselves as embedded within S^3_{01p} (ordinary space). Lastly, since *time* exists at level 2, we assume (as per special relativity) that the level-2 objects possess *mass*.

The same considerations apply at level 3. The presence of time means that $\mathbf{p}_2$ can (and, we assume, *does*) input a *finite* amount of energy E_{3p} into level 3, and the presence of h partitions this energy into a multiplicity of level-3 objects/particles. And, as with the level-2 objects, their dependence on $\mathbf{p}_1$ will cause these level-3 objects to see themselves as embedded within S^3_{01p} (ordinary space). Moreover, the presence of *time* at level 3 means that the level-3 objects possess mass. And likewise for the energies E_{4p}, E_{5p}, etc. (if any) at levels 4 and above.

In general, then, the presence of h causes the distribution of the energies $E_{\geq 2p}$ to be granular or chunky on the small scale.

4.3.3 Further aspects of E_{1p} energy

Unlike the situation just described for level 2 and above, the *absence* of h at level 1 (factor 4) means that the energy E_{1p} *cannot* be broken into chunks; and so the energy E_{1p} at level 1 constitutes a *single*, continuous entity. In addition, since time does *not* exist at level 1, we assume that the single entity at level 1 is *massless*.

Recall now that $\mathbf{p}_0$ is native to level 1, but *time* is native to *level 2* (factor 5). Thus, $\mathbf{p}_0$ is *prior* to time. By postulate 4, this means that the $\mathbf{p}_0$ process, which pumps energy E_{1p}

into level 1, *is independent of time*, and is therefore a *continual* process --- i.e. it never stops, and so it must be happening right now. Consequently, the quantity E_{1p} is *always* increasing. Moreover, since E_{1p} is the energy of $\mathbf{p}_0$ at level 1, and since $\mathbf{p}_0$ (as seen by $\mathbf{p}_1$) *is* ordinary space, then it is clear that E_{1p} is just the energy of space itself; hence, an always-increasing E_{1p} should yield a continual *expansionary* pressure on space. Indeed, an increase in E_{1p} may produce an increase in the *length* of $\mathbf{p}_0$, and thus an increase in p_0^3 (the size/volume of the physical universe).

As concluded in section 4.3.1, the $\mathbf{p}_0$ process must (in the second epoch) distribute its energy E_{1p} *uniformly* throughout space. Since this process is also independent of time, then it is *constant in time*. So the continual influx of E_{1p} energy into the system via the $\mathbf{p}_0$ process yields an input of energy per unit volume of space that is uniform throughout space, and constant in time; in other words, E_{1p} yields a *cosmological constant*. Taken all together, the above results suggest that we interpret E_{1p} to be the phenomenon known as *dark energy* [10]; i.e.,

$$\text{dark energy} = E_{1p}.$$

Moreover, since the $\mathbf{p}_0$ process and E_{1p} are *level-1* phenomena, but h only becomes operant at *level 2* (factors 4 and 5), then dark energy/E_{1p} is prior to --- and thus independent of --- h and quantum mechanics, and so is *not* a zero-point energy.

4.3.4 Further aspects of E_{3p} energy distribution

As stated in section 4.3.2, the presence of h at level 3 partitions the energy E_{3p} into a multiplicity of smaller chunks --- the level-3 objects/particles. Furthermore, we determined that these particles have *mass*. Let us say that a generic level-3 object has the energy ε_{3p}.

In section 3.2, we found that the spaces S_{02p}^3 and S_{12p}^3 come into existence at level 3, and that the latter is nested within the former, which in turn is nested within S_{01p}^3 (ordinary space) (factor 6). Thus, S_{12p}^3 is a subset of S_{02p}^3, which is a subset of S_{01p}^3. We now ask: with respect to a level-3 object/particle, *where* is the S_{02p}^3 space located?

In section 4.3.2, we found that a level-3 object sees itself as being embedded within S_{01p}^3 (ordinary space). Since S_{01p}^3 is prior to, and thus independent of, S_{02p}^3, then the space that a level-3 object sees itself as embedded in is independent of, and thus *outside the scope of*, the (subsequent) S_{02p}^3 space. This means that the S_{02p}^3 space must be *internal to*, *confined*, or compacted *within* the level-3 object. And since the S_{12p}^3 space is nested within S_{02p}^3, then it too is confined/compacted within a level-3 object. A level-3 object thus partitions S_{01p}^3 (ordinary space) into *two* zones: the *outside* or exterior zone, which it sees itself as embedded in; and an *inside* zone, which corresponds to the restricted scope of the S_{02p}^3 space, and forms the *interior* of the object.

Since S_{01p}^3 and S_{02p}^3 are three-dimensional spatial modes of the projection $\mathbf{p}_0$, which is independent of *h*, then we assume that (within their respective scopes) each of those spaces manifests as a *single*, continuous, three-dimensional space (i.e., having no discontinuities or chunkiness). On the other hand, since S^3_{12p} is a spatial mode of the projection $\mathbf{p}_1$, for which *h is* operant, then we will assume that S^3_{12p} manifests (in some ways, at least) as *three*, discrete, *one*-dimensional spaces.

It is thus reasonable to assume that at least some of the energy, ε_{3p}, of a level-3 object will be distributed into *each* of these three, discrete, one-dimensional spaces of S^3_{12p}, resulting in a *triplet* of energy nodes or particles *within* the object. Consequently, each level-3 object will have *internal structure* that includes a triplet of subparticles that are *confined* within the object. We interpret, therefore, that level-3 objects are the particles known as *baryons*, and their three subparticles are the objects known as *quarks*. In this way, the present model accounts for the existence of baryonic quarks, and also their *confinement* within the baryons.

4.3.5 Substructure at level 4

Since everything at level 3 is inherited by level 4, then level-4 objects would, like level-3 objects, also have a substructure of three discrete particles or quarks. However, in section 3.2 it was stated that level 4 generates three new, three-dimensional spaces, which were denoted as S^3_{x3p} (x = 0, 1, 2), and that these spaces are internal to S^3_{02p} and S^3_{12p}. It seems likely, therefore, that the three subparticles/quarks within level-4 objects would themselves contain internal structure (whereas the quarks at level 3 would have no internal structure).

4.4 Some particles of system P

We have identified the objects at level 3 of system P as the baryons, and the single entity at level 1 as dark energy. What about the objects at level 2?

We first note that there are no internal spaces at level 2 (in contrast to level 3), so level-2 objects have no internal structure; i.e. they are *structureless*. Second, as concluded in section 4.3.2, the level-2 objects have *mass*. We therefore identify the objects at level 2 as the *leptons*. Fig. 2 illustrates the identification of objects at different levels of system P with known (or, in the case of dark energy, *suspected*) object/particle classes.

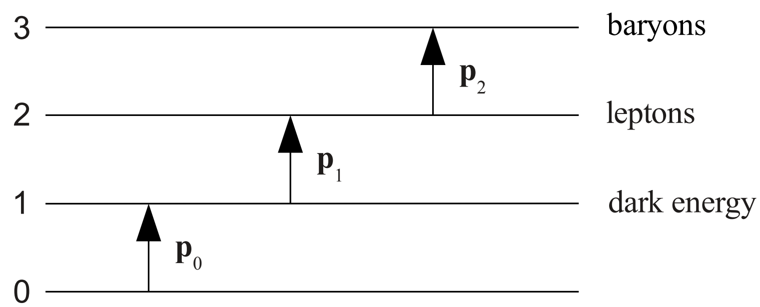

Fig. 2 Identification of the level-1 object as dark energy, the level-2 objects as leptons, and the level-3 objects as baryons.

4.4.1 Associating particle properties with projections

We have already established that, in constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$), it is the projection $\mathbf{p}_0$ that inputs energy into the system. We therefore associate $\mathbf{p}_0$ with energy.

The main difference between a lepton and a baryon is that the latter has the property known as *baryon number* (or baryon *charge*), and the former does not. In system P, the main difference between a level-2 object and a level-3 object is that the latter has the projection $\mathbf{p}_2$, whereas the former does not. We therefore associate baryon charge with $\mathbf{p}_2$.

Likewise, a main difference between dark energy and leptons is: The latter possess the properties known as *lepton number* (or lepton *charge*), mass, and possibly electric charge; whereas the former presumably possesses none of these properties. In system P, the main difference between the level-1 and level-2 entities is that the latter have the projection $\mathbf{p}_1$, whereas the former does not. We therefore associate lepton charge, electric charge, and mass with $\mathbf{p}_1$.

In special relativity, however, mass is associated with the intertwining of time and space. In system P, time is associated with $\mathbf{p}_1$ and space is associated with (i.e., is a manifestation of) $\mathbf{p}_0$. Thus, in system P it might be useful to assume that mass is associated with the intertwining or *conjunction* of $\mathbf{p}_1$ and $\mathbf{p}_0$, which we denote as $\mathbf{p}_1\mathbf{p}_0$.[5] This conjunction and its relation to mass might also be interpreted in the following way: Since $\mathbf{p}_1$ is dependent on $\mathbf{p}_0$, we could say that $\mathbf{p}_1$ is *coupled* to $\mathbf{p}_0$; or, rather, we could say that $\mathbf{p}_1$ is coupled to the *scalar energy field* ($E_{1\mathrm{p}}$) that we earlier associated with $\mathbf{p}_0$ --- and that this coupling yields mass for objects at level 2 and above (where $\mathbf{p}_1$ is in effect). In this way, the present model might account for some aspects of the Higgs mechanism.

Given that the conjunction of $\mathbf{p}_1$ and $\mathbf{p}_0$ might be meaningful, then at level 3 the conjunctions of $\mathbf{p}_2$ with the other projections that are in effect ($\mathbf{p}_0$ and $\mathbf{p}_1$) might also be meaningful. There are *three* such conjunctions at level 3: $\mathbf{p}_2\mathbf{p}_0$, $\mathbf{p}_2\mathbf{p}_1$ and $\mathbf{p}_2\mathbf{p}_1\mathbf{p}_0$ (which may collectively be abbreviated as simply $\mathbf{p}_2\mathbf{x}$, where $\mathbf{x}$ stands for each of $\mathbf{p}_0$, $\mathbf{p}_1$, and $\mathbf{p}_1\mathbf{p}_0$). Since we have identified the level-3 objects as baryons, and since baryons are

5 As in *logical* conjunction, the order of the conjuncts does not matter here; so $\mathbf{p}_1\mathbf{p}_0 \equiv \mathbf{p}_0\mathbf{p}_1$.

believed to possess a triplet of *color charge* (one for each quark), then it might be useful to associate color charges with the three conjunctions $\mathbf{p}_2\mathbf{x}$ at level 3.

Fig. 3 shows the projections and conjunctions that are in effect at levels 0 through 3. In Fig. 4, we translate the projections and conjunctions of Fig. 3 into the properties/attributes/charges that we have associated with them.

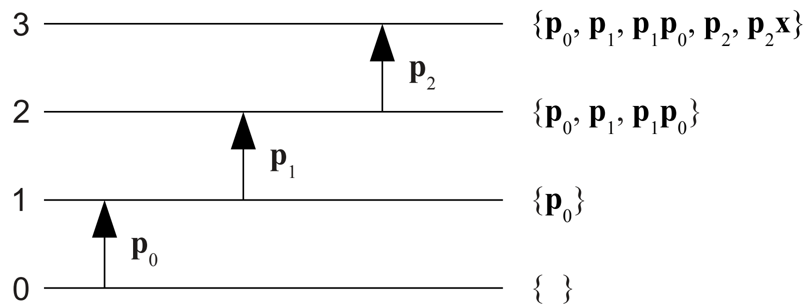

Fig. 3 The projections and conjunctions of projections that are in effect at levels 0 through 3 of system P. The **x** in $\mathbf{p}_2\mathbf{x}$ (at level 3) stands for each of $\mathbf{p}_0$, $\mathbf{p}_1$, and $\mathbf{p}_1\mathbf{p}_0$.

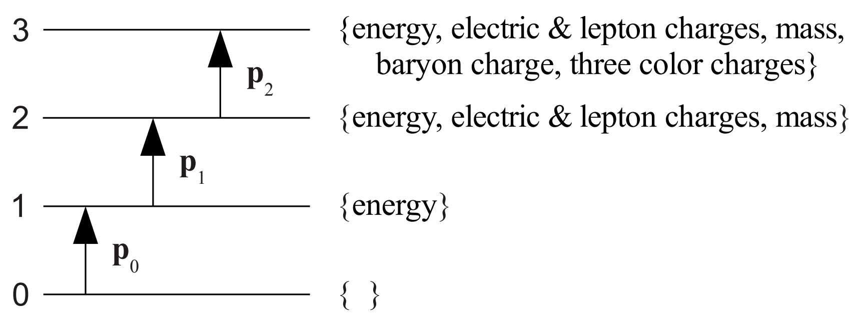

Fig. 4 The projections and conjunctions of Fig. 3 translated into the properties/attributes/charges that we have associated with them.

Of course, electric, lepton, and baryon charges can have values that are positive, negative, or zero. At level 3 in Fig. 4, if we set lepton charge to zero, and baryon charge to positive or negative, and let electric charge vary among its possible values, then we get bundles of properties that fit with the baryons (and antibaryons); which reinforces our identification of the level-3 objects as baryons. At level 2 in Fig. 4, if we restrict lepton charge to nonzero values, and let electric charge vary among its possible values, then we get bundles of properties that fit with the various leptons; which reinforces our identification of the level-2 objects as leptons. Thus, we say that the set of projections and conjunctions that are operant at a given level yield a *class* of objects/particles at that level --- i.e., at level 1 the set $\{\mathbf{p}_0\}$ yields the class of object known as dark energy; at level 2 the set $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0\}$ yields the lepton class; and at level 3 the set $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0, \mathbf{p}_2, \mathbf{p}_2\mathbf{x}\}$ yields the baryon class of objects.

From this association of projection/conjunction sets with object/particle classes, we see that the presence of $\mathbf{p}_1$ is necessary but not sufficient for the presence of (nonzero, i.e. +/-) electric and lepton charges; e.g., although $\mathbf{p}_1$ is in effect at level 2, electric charge can be zero there (as for neutrinos); and although $\mathbf{p}_1$ is in effect at level 3, lepton charge is always zero there. From this pattern, we presume also that $\mathbf{p}_2$ is necessary but perhaps not sufficient for the presence of finite (nonzero) baryon charge; that is, while baryon charge seems to always be finite at level 3, we reserve the possibility that it may be zero at higher-numbered levels.

4.4.2 Partitioning of properties/charges within level-3 objects

I now propose that, at level 3, not only is *energy* partitioned/distributed among the three, one-dimensional spaces of S^3_{12p} (as asserted in section 4.3.4), but so too are the other charges and properties at level 3 --- electric charge, baryon charge, the three color charges (with, we assume, one color charge going to each of the one-dimensional spaces), and spin[6] --- thereby forming (as already noted) a triplet of baryon subparticles with those properties, i.e. the quarks.

4.5 Analogy of system P with biological genetics

By analogy with biological genetics, we might think of the individual projections $\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, etc. as "codons". Different combinations of these codons yield "genes" for particle properties/attributes/charges; e.g., $\mathbf{p}_0$ by itself is the gene for energy; $\mathbf{p}_1$ by itself is the gene for electric and lepton charge; $\mathbf{p}_2$ is the gene for baryon charge; the conjunction $\mathbf{p}_1\mathbf{p}_0$ is the gene for mass; and the conjunctions $\mathbf{p}_2\mathbf{x}$ are the genes for three color charges.

The set of genes at a given level yields the "genome" for an object/particle class or "genus" at that level. Thus, the genome at leve1 0 is { }; the genome for dark energy at level 1 is $\{\mathbf{p}_0\}$; the genome for leptons at level 2 is $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0\}$; and the genome for baryons at level 3 is $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0, \mathbf{p}_2, \mathbf{p}_2\mathbf{x}\}$[7]. The object classes or genomes at each successive level constitute "generations" of entities. Thus, dark energy at level 1 is the first-generation entity; leptons at level 2 are entities of the second generation; and baryons at level 3 are entities of the third generation. Each such generation inherits the genes (indeed, the complete genome) of the prior generation. Moreover, epigenetic analogies may also apply. For example, we may think of the lepton-charge characteristic of $\mathbf{p}_1$ as being "turned on" at level 2, allowing its expression there, but "turned off" at level 3, suppressing its expression.

---

6 How *spin* is derived in the model will be described below. But for now we just take it as given.

7 If, however, it turns out that the conjunctions $\mathbf{p}_1\mathbf{p}_0$ and $\mathbf{p}_2\mathbf{x}$ are *not* meaningful, then the genome for the leptons at level 2 would be simply $\{\mathbf{p}_0, \mathbf{p}_1\}$, and the genome for baryons at level 3 would be $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_2\}$. But, for the present, we will assume that such conjunctions might be meaningful, and thus will include them in the genomes.

4.6 Real and virtual particles

Let us define a *real* object/particle as one whose energy entered system P in the "normal" way --- i.e., via the projection $\mathbf{p}_0$, native to level 1. As discussed earlier, in constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for system P, some of this "$\mathbf{p}_0$ energy", as we have called it, is further projected up the levels, thereby also becoming $\mathbf{p}_1$ energy, $\mathbf{p}_2$ energy, etc. --- but, due to its provenance, always retaining its essential nature as "$\mathbf{p}_0$ energy". This process yields *real* entities/particles at each level: dark energy at level 1, with genome $\{\mathbf{p}_0\}$; real leptons at level 2, with genome $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0\}$; and real baryons at level 3, with genome $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0, \mathbf{p}_2, \mathbf{p}_2\mathbf{x}\}$.

The other way that energy enters system P is (as described earlier) via the quantum of action, h, which depends on $\mathbf{p}_0$ *and* $\mathbf{p}_1$, and is thus native to level 2. This is the quantum vacuum energy, or energy of quantum fluctuations, which produces *virtual* particles. Since the entry of this energy into the system *bypasses* the normal $\mathbf{p}_0$ process, then it is *not* "$\mathbf{p}_0$ energy", and cannot produce dark energy, $\{\mathbf{p}_0\}$, at level 1. Rather, such quantum vacuum energy can only produce $\mathbf{p}_k$ -energy forms (and corresponding virtual particles) that are native to level 2 and above --- i.e., $\mathbf{p}_1$ energy (virtual leptons), $\mathbf{p}_2$ energy (virtual baryons), etc.[8] Although virtual particles do not contain $\mathbf{p}_0$ energy, they are *still* dependent on $\mathbf{p}_0$, and so it seems appropriate to include the $\mathbf{p}_0$ component in their genomes. As such, the genomes for virtual leptons and virtual baryons will be denoted in the same way as their real counterparts; i.e., as $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0\}$ and $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0, \mathbf{p}_2, \mathbf{p}_2\mathbf{x}\}$, respectively.

4.7 Fundamental interactions

The projections that we have discussed so far may be described as *forward* projections, since (as described in postulate 1) they go from a prior level to a subsequent level (i.e., they are directed *away* from level 0). We associated these projections with the input of energy into higher/subsequent levels. We now want to introduce the concept of *reverse* or *backward* projection, which goes in the opposite direction: from a subsequent level to a prior level (i.e., *toward* level 0). Specifically, I propose that each forward projection $\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, etc., has a corresponding backward projection, which we denote as $-\mathbf{p}_0$, $-\mathbf{p}_1$, $-\mathbf{p}_2$, etc., respectively. Basically, for an object that has $\mathbf{p}_k$ in its genome, we define $-\mathbf{p}_k$ as "the backward projection of $\mathbf{p}_k$ energy onto level k" (for $k = 0, 1, 2, ...$). That is, such a backward projection, $-\mathbf{p}_k$, takes $\mathbf{p}_k$ energy --- which is *above* level k --- and places it *at* level k, yielding an object/particle at that level.

Note that, if $\mathbf{p}_k$ energy were to produce *its own* backward projection onto level k, it would be a violation of the scope rule, because level k is *prior* to (and thus outside the scope of) $\mathbf{p}_k$ energy. How, then, does backward projection occur without violating the scope rule? The short answer is that $\mathbf{p}_k$ energy does not perform the backward projection by itself. The longer answer is as follows: Since the *forward* projection sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) springs *from* level 0, then there must exist a projection-generating *engine* of sorts, *operant at level 0*, which produces that sequence of forward projections, and

8 The origin of, e.g., *photons* (real and virtual) is explained in section 4.7.

which, we assume, is also capable of producing *backward* projections. By the scope rule, this engine (operant at level 0) is then operant *throughout* system P, and thus contains both level k and $\mathbf{p}_k$ energy within its scope, and is thereby able to cause the backward projection of $\mathbf{p}_k$ energy onto level k without violating the scope rule. The nature of this projection engine is developed further in Part II [5].

Backward projection in the present model is in some ways similar to "projection" as we know it from ordinary geometry. Consider a three-dimensional sphere for example: it becomes a *two*-dimensional circle when projected onto the x-y plane; and the circle becomes a *one*-dimensional line when projected onto the x-axis. So, with each "backward" projection the space dimensions of the object are reduced by one. Similar things happen with backward projection in the present model.

In addition to forward and backward projections, let us also define a *lateral* or *intra*level projection of $\mathbf{p}_k$ energy, which places that energy onto $\mathbf{p}_k$'s *native* level (which, it may be recalled, is level $k + 1$), thereby yielding an object/particle at that level. Backward and lateral/intralevel projections may be classified together as *nonforward* projections.[9] We assume that *all* projections of system P, including the lateral type, are performed by the projection engine described above.

4.7.1 The electromagnetic interaction

Objects at level 2 or above (e.g., leptons and baryons, with genomes $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0\}$ and $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0, \mathbf{p}_2, \mathbf{p}_2\mathbf{x}\}$, respectively), whether real or virtual, have the projection $\mathbf{p}_1$ in their genome, and have $\mathbf{p}_1$ energy. We now ask, what happens when $\mathbf{p}_1$ energy, associated with these objects, is backward projected onto level 1 (the operation that we have denoted as $-\mathbf{p}_1$)? We could denote the genome for the resulting object as $\{\mathbf{p}_0\}$, but that would confuse it with the genome for dark energy, and also obscure the object's/energy's *history* (of, inter alia, being the product of a *backward* projection). A better way to denote its genome is therefore $\{\mathbf{p}_0, -\mathbf{p}_1\mathbf{p}_1\}$. This object has energy, but no electric charge (due to the net absence of $\mathbf{p}_1$ in its genome), and (due to the absence of $\mathbf{p}_1\mathbf{p}_0$) is massless. Its "source", if you will, is $\mathbf{p}_1$, which we have associated with electric charge. We interpret, therefore, that the object denoted by the genome $\{\mathbf{p}_0, -\mathbf{p}_1\mathbf{p}_1\}$, resulting from backward projection of $\mathbf{p}_1$ energy onto level 1, is the *photon*. So, in this sense, we say that *the photon is a level-1 object* that is produced by *backward* projection (in contrast to dark energy, which is a level-1 entity produced by *forward* projection). Furthermore, we interpret that the backward projection of $\mathbf{p}_1$ energy onto level 1 (i.e. $-\mathbf{p}_1$) is just the *electromagnetic interaction* (actually, it is the *emission* phase of that interaction; the absorption phase will be discussed later). In general, then, it is suggested that backward projection is the basis for at least some of the fundamental interactions.

At level 2 the dimensionality of $\mathbf{p}_0$ (with respect to $\mathbf{p}_1$) is 3, and the dimensionality of $\mathbf{p}_1$ (with respect to $\mathbf{p}_0$) is 1 (i.e. the dimensions of ordinary space and time, respectively). When $\mathbf{p}_1$ energy is backward projected onto level 1, the dimension of time (associated

9 These new types of projection will later be incorporated into a *fifth* postulate.

with $\mathbf{p}_1$) vanishes to zero. Likewise, the component of $\mathbf{p}_0$ parallel to $\mathbf{p}_1$ also vanishes, leaving only *two* space dimensions (which may thus be called the *residual* dimensions, or the *residual 2-space*, of $\mathbf{p}_0$ with respect to $\mathbf{p}_1$), both of which are orthogonal to $\mathbf{p}_1$. In other words, the backward projection of $\mathbf{p}_1$ energy onto level 1 produces an object for which the time dimension does not exist, and whose space dimensions are reduced from three to two --- which agrees with the result implied by special relativity for the photon, further supporting our interpretation that photons are the result of backward projection of $\mathbf{p}_1$ energy onto level 1.

Light (i.e. electromagnetic radiation) is thus energy that starts out at level 2 (or above) and is backward projected onto level 1 (where time does not exist). Its origin at level 2 or above (where time *does* exist) endows this energy with a *history*, an aspect of which is its exposure to h, which (I propose) endows light energy with its quantum properties. Dark energy, in contrast, is a *strictly* level-1 entity/phenomenon, so we can say that *it is energy without a history*. Its lack of a history at level 2 or above means that dark energy has never been exposed to h, and so it is not quantized, and has no quantum properties (e.g., as determined earlier, it has no quantum chunkiness).

It seems, then, that the quantum properties and two-dimensional space of light/photons may all be residual aspects (or, if you will, *residues*) that stem from the energy's history at level 2 or above.

4.7.2 The strong interaction

Objects at level 3 or above (e.g. baryons, with genome $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0, \mathbf{p}_2, \mathbf{p}_2\mathbf{x}\}$), whether real or virtual, have the projection $\mathbf{p}_2$ in their genome, and have $\mathbf{p}_2$ energy. We now ask, what happens when $\mathbf{p}_2$ energy, associated with these objects, is backward projected onto level 2 (the operation that we have denoted as $-\mathbf{p}_2$)?

As stated earlier, when $\mathbf{p}_1$ is related to $\mathbf{p}_2$ the dimensionality of the former is 3 (i.e. S^3_{12p}), and the dimensionality of the latter is 1 (i.e. S^1_{21p}). When $\mathbf{p}_2$ energy is backward projected onto level 2, the one dimension associated with $\mathbf{p}_2$ vanishes to zero, and the three dimensions associated with $\mathbf{p}_1$ are reduced to *two*. Since we earlier interpreted that, at level 3 (or above), the three, one-dimensional spaces associated with $\mathbf{p}_1$ (from the viewpoint of $\mathbf{p}_2$) were responsible for the *triple*-quark substructure of baryons, I now propose that the reduction of these dimensions down to two --- when $\mathbf{p}_2$ energy is backward projected onto level 2 --- is responsible for the production of objects with a *double*-quark substructure. Consequently, we interpret that the objects produced by backward projection of $\mathbf{p}_2$ energy onto level 2 are the *mesons* (which, indeed, are thought to have a double-quark --- actually, quark-antiquark --- substructure). So, in this sense, *the mesons are level-2 objects*, whose genome may be denoted as $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0, -\mathbf{p}_2\mathbf{p}_2\}$ --- which comports with the mesons possessing energy, electric charge, mass, and two opposite baryon charges (i.e., $\mathbf{p}_2$ and $-\mathbf{p}_2$, for a net of *zero* baryon charge).

Since the $\mathbf{p}_2$ and $-\mathbf{p}_2$ components of the meson are presumably distributed/separated among its double-quark substructure, then, in this sense, we can think of mesons as level-2 objects that contain remnants of *level-3-type* substructure (i.e., the two quarks). This is probably allowed by the nesting rule, since the (subsequent) level-3-type substructure is embedded/contained within the (prior) level-2 structure, not the other way around. As long as the $\mathbf{p}_2$ and $-\mathbf{p}_2$ components are separated within the meson substructure, we will assume that energy associated with them can behave like any other $\mathbf{p}_2$ energy; e.g., it can be backward projected onto level 2, yielding other mesons.

In the above description (of backward projection of $\mathbf{p}_2$ energy onto level 2), we utilized the residual 2-space of $\mathbf{p}_1$ with respect to $\mathbf{p}_2$ (to account for the double-quark substructure of mesons), but we neglected to mention another such space that arises in this process: the residual 2-space of $\mathbf{p}_0$ with respect to $\mathbf{p}_2$; i.e., the 2-space that remains when, due to backward projection of $\mathbf{p}_2$ energy onto level 2, the component of $\mathbf{p}_0$ in the direction of $\mathbf{p}_2$ vanishes. We have thus identified *three* residual 2-spaces: the residual 2-space of $\mathbf{p}_0$ with respect to $\mathbf{p}_1$, which may be referred to as the *first* residual 2-space; the residual 2-space of $\mathbf{p}_0$ with respect to $\mathbf{p}_2$, which may be referred to as the *second* residual 2-space; and the residual 2-space of $\mathbf{p}_1$ with respect to $\mathbf{p}_2$, which may be referred to as the *third* residual 2-space. The numbering/ranking of these residual spaces reflects their order of priority. Given such priority relations, together with the nesting rule, we conclude that, where applicable: the third residual 2-space is nested/encapsulated/confined within the second, and the second is nested/encapsulated/confined/compacted within the first.

When $\mathbf{p}_2$ energy is backward projected onto level 2, only the second and third residual 2-spaces are applicable (since $\mathbf{p}_1$ is *operant* at level 2, and thus the space of $\mathbf{p}_0$ with respect to $\mathbf{p}_1$ --- i.e., *ordinary* space --- is fully three dimensional). By the priority relations established above, the third residual 2-space, which yields the double-quark substructure of mesons, would be *confined* within the second --- a result which might explain the confinement of quarks within mesons.

Consider now a process in which $\mathbf{p}_2$ energy is backward projected onto level 2, and then immediately backward projected onto level 1 --- a *sequence* of backward projections which may be denoted by $(-\mathbf{p}_2, -\mathbf{p}_1)$. The result of this process is an object at level 1 whose genome may be written as $\{\mathbf{p}_0, -\mathbf{p}_1\mathbf{p}_1, -\mathbf{p}_2\mathbf{p}_2\}$ --- which therefore is energetic but massless (due to the presence of $\mathbf{p}_0$, but absence of $\mathbf{p}_1\mathbf{p}_0$), and possesses zero electric, lepton, and baryon charges. I propose that this object is the *gluon*.

In this gluon-production process, the third residual 2-space would cease to exist (since $\mathbf{p}_1$ is not operant at level 1). So whatever is left over from the backward-projection sequence (double color charge?) would be confined within the *second* residual 2-space, which would be confined within the first. This result might explain the confinement of gluons and their color charges.

In summary, we interpret that the strong interaction as mediated by mesons is the result of backward projection of $\mathbf{p}_2$ energy onto level 2; and the strong interaction as mediated by gluons is the result of a sequence of backward projections, $(-\mathbf{p}_2, -\mathbf{p}_1)$, of $\mathbf{p}_2$ energy onto level 1.

4.7.3 The weak interaction, and electroweak unification

The weak interaction is known to be mediated by the W and Z bosons. Given that the W and Z possess mass, have zero baryon number, and have no internal structure (as far as we know), it follows that they are *level-2* objects in the present model. Thus the weak interaction involves the projection of energy onto *level 2*, which thereby yields objects/particles at that level (i.e. the W and Z). We know that leptons participate in the weak interaction, and (according to the present model) that they are also level-2 objects, having the genome $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0\}$, thereby possessing $\mathbf{p}_1$ energy and (for a *real* lepton) $\mathbf{p}_0$ energy. Since leptons and the W/Z are all level-2 objects, then (unlike the interactions described above) the weak interaction cannot be attributed to *backward* projection --- of either the leptons' $\mathbf{p}_0$ energy or its $\mathbf{p}_1$ energy (since such backward projections would yield objects at levels 0 and 1, respectively --- i.e. *not* at level 2, where the W and Z reside). Rather, the weak interaction must be attributable to a lateral/*intra*level projection, of either $\mathbf{p}_0$ or $\mathbf{p}_1$ energy. But $\mathbf{p}_0$ is native to level 1, so a *lateral* projection of $\mathbf{p}_0$ energy would place the energy at *level 1*, not level 2. So it seems that we must attribute the weak interaction to a lateral/intralevel projection of $\mathbf{p}_1$ energy.

Since the *electromagnetic* interaction has *also* been attributed to a nonforward projection of $\mathbf{p}_1$ energy, then we can say that the electromagnetic and weak interactions have the *same* source --- $\mathbf{p}_1$ (or $\mathbf{p}_1$ energy). Consequently, as we have associated electric charge with $\mathbf{p}_1$, it seems that we must also associate the *weak charge* with $\mathbf{p}_1$. As such, the present model offers an explanation for the known "electroweak unification": the electromagnetic and weak interactions are related or "unified" because they *both* stem from the projection of $\mathbf{p}_1$ energy --- where the former interaction is attributed to *backward* projection of such energy (i.e. onto level 1), and the latter interaction is attributed to *lateral* projection of such energy (i.e. *within* level 2). In addition, the lateralness (or, if you will, *handedness*) of an *intralevel* projection might explain why the weak interaction violates left-right symmetry, or parity.

Although it may be useful at some future time to develop a special notation to indicate in their genomes that the W and Z particles are products of *lateral* projection of $\mathbf{p}_1$ energy, for now we will just denote them as having the same genome as level-2 objects that are produced by *forward* projection --- i.e. $\{\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_1\mathbf{p}_0\}$.

4.7.4 The gravitational interaction

Following the pattern of the interactions above, we should attribute gravity to a nonforward projection of one of the $\mathbf{p}_k$ energies ($k = 0, 1, 2, \ldots$). Since dark energy is a source of gravity, and is a *level-1* phenomenon, then the energy type to which we attribute gravity must be present/available/operant at level 1 --- a condition that *only* $\mathbf{p}_0$ energy satisfies. So it follows that we should attribute gravity to a nonforward projection of $\mathbf{p}_0$ energy: either backward projection onto level 0, *or* lateral/intralevel projection onto level 1. But which one? For reasons to be provided in section 4.13, we choose the latter --- that is, we attribute the gravitational interaction to the *lateral/intralevel* projection of $\mathbf{p}_0$ energy onto level 1. This means that the "graviton" (in common with the photon and the gluon) is a *level-1* object/particle that is produced by nonforward projection. Thus, the strong, electromagnetic, and gravitational interactions all utilize nonforward projection onto level 1 (the strong interaction also utilizes nonforward projection onto *level 2*, as described above).

Our model for gravity yields the following results and explanations concerning that interaction:

> **Cosmological constant**: Since the source of gravity is $\mathbf{p}_0$ energy, and since, as determined earlier, the quantum vacuum (or zero-point) energy is *not* $\mathbf{p}_0$ energy, then the energy of quantum vacuum fluctuations is *not* a source of the gravitational interaction (i.e., it does not gravitate). Therefore, quantum fluctuations cannot contribute to the cosmological constant, Λ.
>
> Or, putting this argument more figuratively, we might say: Energy that enters system P through the "front door" (i.e., via $\mathbf{p}_0$, at level 1) inherits the mantle of "$\mathbf{p}_0$ energy", and is thereby a source of the gravitational interaction; but energy that *sneaks in* through a "side door" (i.e., via h, at level 2 or above) does *not* inherit the mantle of "$\mathbf{p}_0$ energy", and therefore is *not* a source of the gravitational interaction --- and so cannot contribute to the cosmological constant.
>
> As far as we can tell from the present model then, the only contribution to Λ comes from the (non-quantum-mechanical, non-zero-point) dark energy/E_{1p} that the $\mathbf{p}_0$ process continually inputs into level 1, and which we have associated with the creation and expansion of ordinary space (see section 4.3.3). By eliminating contributions to Λ from quantum fluctuations, the present model thereby averts the "cosmological constant problem" [11], and may thus explain the observed small value of that constant.
>
> Note that, although quantum fluctuations do not produce $\mathbf{p}_0$ energy (which is native to level 1), and thus are not a source of gravity, our earlier results indicated that such fluctuations *can* produce $\mathbf{p}_k$-energy forms (and corresponding virtual particles) that are native to level 2 and above; i.e., $\mathbf{p}_1$ energy (virtual leptons), $\mathbf{p}_2$ energy (virtual baryons), etc. These $\mathbf{p}_k$-energy forms can then be nonforwardly projected, yielding (for $\mathbf{p}_1$ energy) the electromagnetic and weak interactions, and (for $\mathbf{p}_2$ energy) the strong interaction. The electromagnetic interaction, due to the backward projection of $\mathbf{p}_1$ energy for such virtual particles, can presumably then yield, e.g., the Casimir effect and the Lamb shift.
>
> In summary, we might say that quantum vacuum energy (and thus virtual particles) can emitate[10], weakitate, and strongitate --- but cannot gravitate.
>
> **Nonquantization** (or, why gravity seems to defy attempts at quantization): Since the source of gravity is $\mathbf{p}_0$ energy (which is native to level 1), and since the quantum of action h is native to level 2, then the basis for the gravitational interaction is *prior* to, and thus independent of, h; and so gravity is not

10 Where "emitate" might also have been written as EMitate, with obvious meaning in this context.

fundamentally quantum mechanical.[11] Or, in more figurative language, we might say: The basic ingredient for gravity ($\mathbf{p}_0$ energy) is "up and running" at level 1, before quantum mechanics (i.e., *h*) "gets its boots on" at level 2.

Furthermore, given our result that quantum fluctuations cannot contribute to Λ, then Λ appears also to be independent of *h*, and thus independent of quantum mechanics. So, as far as we can tell from the present model, gravity is *completely* independent of *h* and quantum mechanics --- perhaps obviating the need for a "quantum theory of gravity".[12]

Universality (almost): Recall that, in constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for system P, *all* of the energy that is involved --- in whatever form it might take ($\mathbf{p}_0$ energy, $\mathbf{p}_1$ energy, $\mathbf{p}_2$ energy, etc.) --- shares the provenance of entering the system via the $\mathbf{p}_0$ portal, and is therefore (essentially, at least) "$\mathbf{p}_0$ energy". Consequently, the "lateral/intralevel projection of $\mathbf{p}_0$ energy within level 1" is a *universal* characteristic of all these energy forms and their associated objects/particles (e.g. real leptons, real baryons, etc). In other words, *all* of the energy associated with these things will laterally project onto level 1, thereby making them sources of gravity. This would seem to account for the "universal" nature of the gravitational interaction.

Of course, this "universality" of gravity comes with the one exception, described above, that quantum vacuum energy, due to its provenance of entering the system at level 2 or above, and thereby *bypassing* the $\mathbf{p}_0$ process, is not $\mathbf{p}_0$ energy, and is therefore *excluded* as a source of gravity. So provenance matters.

4.7.5 Other possible fundamental interactions

Given our characterization of fundamental interactions as being the result of "nonforward projection of $\mathbf{p}_k$ energy", then the case for which $k = 3$ presents the possibility for new interaction types, via (a) backward projection of $\mathbf{p}_3$ energy, and (b) lateral/intralevel projection of $\mathbf{p}_3$ energy (onto level 4). Likewise, for $k = 2$, there might be an interaction type that is due to lateral/intralevel projection of $\mathbf{p}_2$ energy (onto level 3). However, due to the confinement that occurs for $\mathbf{p}_2$ energy, $\mathbf{p}_3$ energy, etc., it is possible that such interactions would not manifest outside of the compacted spaces of level 3 and above, which could explain why such novel interactions (if they actually exist) have not yet been identified. And, for the supposed interaction resulting from lateral projection of $\mathbf{p}_2$ energy, it is possible that any of its effects that *do* manifest have been confused/conflated with aspects of the strong interaction.

Finally, there is the question of "backward projection onto *level 0*": might this, too, produce a new type of interaction? This question will be taken up in section 4.14.

11 It should thus be apparent that use of the term "graviton" in this paper does not imply any bias towards a *quantized* conception of gravity.

12 Some articles that question the need for quantum gravity are [12] and [13].

4.8 Interaction examples

In our descriptions of fundamental interactions above we actually only provided an account of the first *half* of some interactions: *emission* of the mediating particle from its source, by either backward or lateral projection. In the examples below, we give more complete descriptions by also including (where appropriate) the *absorption* of the mediating object.

4.8.1 Electromagnetic

Consider the electromagnetic interaction between an electron and a proton, in which the electron emits a photon, and the proton absorbs it. Our description of the electromagnetic interaction in section 4.7.1 accounted only for the first half of that interaction: emission of the photon by the electron, which we described as the backward projection, onto level 1, of $\mathbf{p}_1$ energy. The second half of the interaction --- absorption of the photon by the proton --- can be accounted for as follows: the photon energy, at level 1, is *forward* projected[13] from level 1 (i.e., along the line of $\mathbf{p}_1$), thereby becoming associated with the *proton's* $\mathbf{p}_1$ component. (Of course, this means that *only* objects *having* a $\mathbf{p}_1$ component in their genome can participate in the electromagnetic interaction; which, again, indicates that electric charge is associated with $\mathbf{p}_1$.) The *converse* interaction, in which the *proton* emits the photon, and the electron absorbs it, is described by exactly the same language above, except we replace the word "electron" with the word "proton", and vice versa.

4.8.2 Weak

Consider the decay of a neutron into a proton via the weak interaction, mediated by emission of a W^- particle (so-called beta decay). Since the neutron is a *level-3* object, and the W^- is a *level-2* object, doesn't this process involve *backward* projection onto level 2 (i.e., not *intralevel* projection, *within* level 2 --- the modus operandi that we determined above for the weak interaction)? No; as with the leptons at level 2, we interpret that the neutron's participation in the weak interaction is due to *intralevel/lateral* projection of $\mathbf{p}_1$ energy. But, to understand this, we must recall that $\mathbf{p}_1$ is *native* to level 2, so that a lateral projection of $\mathbf{p}_1$ energy associated with the neutron will be placed onto *level 2* --- not level 3 (the level of the neutron itself).

Beta decay is thus described as follows: $\mathbf{p}_1$ energy associated with the neutron is *laterally* projected onto/within level 2, as the W^- particle --- thereby transforming the neutron into a proton.

As another example, the weak interaction of a proton (emitter) and electron (absorber), mediated by exchange of a Z particle, is described as follows: $\mathbf{p}_1$ energy associated with the proton is laterally projected onto level 2 (as the Z particle), which

13 This kind of "forward" projection is different from the forward projections that *create* the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for system P. This will be clarified as we go along, and then summarized/formalized in postulate 5.

then becomes associated with the *electron's* $\mathbf{p}_1$ component. And vice versa for an electron emitter and proton absorber.

4.8.3 Strong

The strong interaction between *nucleons A* (emitter) and *B* (absorber), mediated by exchange of a meson, can be described in the following way: $\mathbf{p}_2$ energy associated with *A* is backward projected onto level 2, as a meson. This meson energy is then forward projected along the line of $\mathbf{p}_2$, thereby becoming associated with *B's* $\mathbf{p}_2$ component.

The strong interaction between *quarks A* and *B*, mediated by exchange of a gluon, can be described as follows: $\mathbf{p}_2$ energy associated with *A* is backward projected onto level 1 (as a gluon), via the sequence ($-\mathbf{p}_2$, $-\mathbf{p}_1$). This gluon energy is then forward projected along the lines of $\mathbf{p}_1$ and $\mathbf{p}_2$ --- i.e., via the sequence ($\mathbf{p}_1$, $\mathbf{p}_2$) --- thereby becoming associated with *B's* $\mathbf{p}_2$ component.

4.8.4 Gravitational

Consider the *gravitational* interaction between *A* and *B*, which are two objects/particles/entities at level 1 or above (so that each has a $\mathbf{p}_0$ component), and where *A* is the emitter, and *B* is the absorber. First, $\mathbf{p}_0$ energy associated with *A* is laterally projected onto level 1 (as the graviton), which then becomes associated with *B's* $\mathbf{p}_0$ component.

Note that, as worded above, the criterion for *emitting* a graviton (the presence of $\mathbf{p}_0$ energy), and thereby being a *source* of gravity, seems to be stricter than the criterion for *absorbing* a graviton (the mere presence of the $\mathbf{p}_0$ component in an object's genome). It might be the case that we need to increase the criteria on the absorber; i.e., we might insist that it has not just a $\mathbf{p}_0$ component in its genome, but that it meet the stricter requirement of having $\mathbf{p}_0$ energy, as defined earlier. This stricter requirement would not only prevent virtual particles (born out of quantum vacuum energy) from being *emitters* of gravitons (and thus sources of gravity), but would also prevent them from being *absorbers* of gravitons --- with the result that virtual particles would not participate at all in the gravitational interaction.

On the other hand, if we *keep* the looser requirement for absorbing gravitons, then we would have a situation where the virtual particles of quantum fluctuations cannot be a source of gravity, but *can* absorb gravitons, and thus be a gravitational *sink*. Could such a gravitational-sink effect be an explanation for the weakness of gravity with respect to the other forces? That is, with virtual particles acting as a gravitational sink, could the tens-of-orders-of-magnitude difference in the energy densities between virtual particles and ordinary particles account for the tens-of-orders-of-magnitude difference in strength between gravity and the other forces?

4.9 Matter-antimatter asymmetry

In constructing the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for world P, we have found that the $\mathbf{p}_0$ process inputs (dark) energy into level 1, and also acts as a portal for inputting energy into subsequent levels. Likewise, the projection $\mathbf{p}_1$ can input electric charge at level 2, and also at subsequent levels; and $\mathbf{p}_2$ can produce baryon charge at level 3 and above. For $\mathbf{p}_1$ and $\mathbf{p}_2$, let us now assume the following, more specific, pattern of electric and baryon charge production:

> At the *first* level for which a given of these projections ($\mathbf{p}_1$ or $\mathbf{p}_2$) is in effect (i.e., its native level), its associated charge (electric or baryon, respectively) takes on a particular sign, either positive or negative (+/-). At the *second* level for which a given of those projections is in effect, its associated charge takes on the *opposite* sign that it had at the first level. And, at the third level or above there are *equal* amounts of positive and negative, so the net charge is *zero*. Or, in short: The charge associated with a given of these projections ($\mathbf{p}_1$ or $\mathbf{p}_2$) alternates in sign for the first two levels that the projection is in effect, and is net zero at later levels. Note that this charge-production scheme is *non*conservative at each of the first two steps (but might be conservative overall).

Thus, the electric charge (associated with $\mathbf{p}_1$) that is produced at level 2 has, let us say, *negative* sign; the electric charge produced at level 3 has *positive* sign; and the electric charge produced at level 4 and above has a net value of zero. Likewise, the baryon charge (associated with $\mathbf{p}_2$) that is produced at level 3 has, let us say, positive sign; the baryon charge produced at level 4 has negative sign; and is net zero at level 5 and above.

The result of this pattern of charge production is leptons with negative electric charge at level 2 (which yields electrons); baryons with positive electric charge and positive baryon charge at level 3 (which yields protons); and objects at level 4 that have *zero* electric charge and *negative* baryon charge. And let us suppose that the level-4 objects do not participate in the strong interaction --- perhaps because the extra internal structure of those objects (i.e. the spaces S^3_{x3p} that are internal to, or nested within, S^3_{12p}; see section 3.2) interferes with the pathway for that interaction. Such level-4 objects, having zero electric charge, and not interacting strongly, are thus candidates for *dark matter*.[14] These results are shown in Fig. 5.

Levels 1 through 4 in Fig. 5 constitute a world of dark energy and "matter", with a conspicuous absence of *anti*matter (i.e. matter-antimatter asymmetry), which comports with the world that we find ourselves in right now. And if, as shown in Fig. 5, the projection sequence for system P *ends* with $\mathbf{p}_3$ placing energy E_{4p} into level 4 (i.e. that

---

14 Having *negative* baryon charge, one could think that these dark matter candidates --- call them *trans*baryons --- might annihilate on contact with baryons. However, following the paradigm that we have described, the transbaryons would likely have a *new* type of charge --- call it *transbaryon charge* --- of a certain sign, say positive, associated with their $\mathbf{p}_3$ component. So their annihilation might require contact with an *anti*transbaryon (having negative transbaryon charge), which might only rarely exist, if at all. Some of the transbaryons could then exist as stable particles within galaxies, mingling with baryons without annihilating, and thereby play the role of dark matter.

$E_{tp} = E_{1p} + E_{2p} + E_{3p} + E_{4p}$), and if we assume that $E_{4p} \approx 5(E_{2p} + E_{3p})$, then we would have the situation that we observe today in which the dark matter has about five times the mass of ordinary matter (i.e., matter at levels 2 and 3).

In conclusion, our model for constructing the physical universe *via a sequence of discrete, ordered, steps* that may be nonconservative of charge --- in contrast to the *non*discrete standard big bang model (where charge conservation seems to always hold) --- enables us to generate the observed pattern of matter-antimatter asymmetry, while also yielding a new candidate for dark matter.

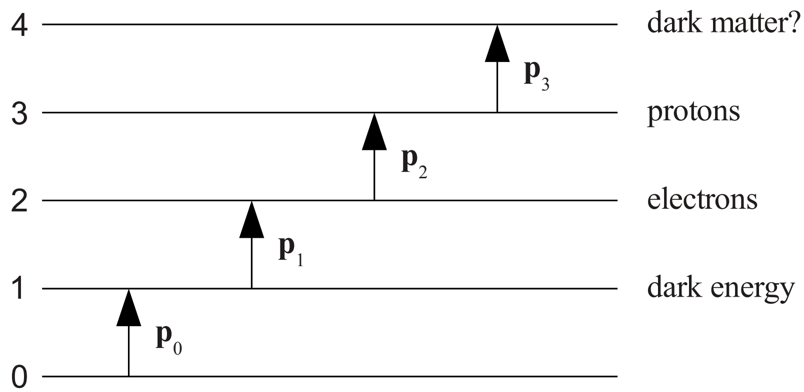

Fig. 5 The spectrum of particle types that the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) for system P would yield, given the pattern of alternating-sign-then-zero charge production that we have assumed for the first three steps/levels at which a projection is operant (excepting $\mathbf{p}_0$). This particle spectrum comports with observed matter-antimatter asymmetry, and level 4 yields a new candidate for dark matter.

4.9.1 Primary and secondary projections

In contrast to the charge-production scheme described above, which yields matter-antimatter asymmetry, our present-day experience is that *all* electric- and baryon-charge production is *fully* conservative. Consideration of this, as well as our model of the fundamental interactions developed above, in which some projections propagate "along the lines of" other, *already-existing* projections, suggests the existence of two different projection types. These projection types will be called *primary* and *secondary* --- defined as follows:

> The *primary projections* are the ones that *construct* the *infrastructure* of system/world P, the sequence for which we have denoted as ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$). That is, starting at level 0, they construct the subsequent levels (1, 2, 3, etc.) and the connections/projections between them; and relations between these projections construct the different spaces of the system. In addition, the primary projections input energy into the levels that they construct, which is partitioned among (and within) the spaces, thereby constructing what may be called the (initial population

of) *primary entities/particles* of the system (i.e., dark energy at level 1, leptons at level 2, baryons at level 3, and --- possibly --- dark matter at level 4). In our scheme of matter-antimatter asymmetry for world P, the *primary* projections $\mathbf{p}_1$ and $\mathbf{p}_2$ (at least) are *nonconservative* of charge in each of their first two steps. The primary projections are all *forward* projections.

The *secondary projections* may be forward, backward, or lateral/intralevel. These are the projections that happen in world P once the infrastructure of that world has been constructed/established by the sequence of primary projections. Among these secondary projections are the ones that we have described as being responsible for the fundamental interactions, the processes of which construct --- let us say --- *secondary entities/particles* of the system (i.e., photons, mesons, gluons, gravitons, and W/Z particles). In essence, the secondary projections utilize the *existing* infrastructure (of levels, and the primary projections which connect the levels) as a kind of interaction *network* --- moving energy (and information) in all directions (forward, backward, and lateral). In this respect, the levels and primary projections of system P act as *nodes* and *edges*, respectively, in a *communication network*. In world P, the secondary projections (unlike the primary projections) are, evidently, *fully conservative* of charge.

To denote the secondary *forward* projections, we will utilize the same notation that is used for the primary projections; i.e. $\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, etc. When using these symbols, either the context or explicit statements will tell us whether they represent the primary or secondary type. Likewise, for the *backward* projections (which are *always* secondary), we may use the notation $-\mathbf{p}_0$, $-\mathbf{p}_1$, $-\mathbf{p}_2$, etc. (as we have already done above); or we may state it in words, e.g. "the backward projection of $\mathbf{p}_k$ energy onto level k" (as we have also done above). And for lateral/intralevel projections (which, too, are *always* secondary), there is no special notation yet developed --- so we simply state it in words, e.g. "the lateral/intralevel projection of $\mathbf{p}_k$ energy within level $k + 1$" (as we have done above).

In summary, primary projections are about *constructing* the infrastructure of a *new* system or world, and priming it with energy; secondary projections are about what happens within that *already-existing* infrastructure. Both primary and secondary projections are forms of communication, since they both communicate energy and information among levels. However, the primary projections only communicate in *one* direction --- *forward*; whereas the secondary projections may communicate in *all* directions: forward, backward, and lateral. So, to be clear, the primary projections do not just disappear after their initial creation; rather, they remain operant, and form a system of communication *channels* along which the secondary projections can propagate.

We said above that the *secondary* projections include those that are responsible for the fundamental interactions. An example of a secondary projection that is *not* a fundamental interaction per se would be the creation of an electron-positron pair from a photon --- which can be described as the (conservative) secondary forward projection of the photon energy, along the line of $\mathbf{p}_1$, from level 1 to level 2. Similarly, the creation of a proton-antiproton pair from a photon can be described as the (conservative) secondary forward projection of the photon energy, along the sequence ($\mathbf{p}_1$, $\mathbf{p}_2$), from level 1 to level 3.

4.10 Postulates 5 and 6

Recent developments in the model suggest the need for two more postulates:

> **Postulate 5:**
>
> Within the infrastructure of "nodes and edges" that is constructed by a sequence of *primary* projections, *secondary* projections may be propagated in all directions (backward, forward, and lateral/intralevel).
>
> **Postulate 6:**
>
> A projection of any type, to a given level, involves the input/communication of energy onto that level, which constitutes an object/entity (e.g. a "particle", real or virtual) at that level.

4.11 Constructing position, velocity, acceleration, and spin properties for objects/particles in system P

We have already described how the projection $\mathbf{p}_0$ "looks" from the perspective of $\mathbf{p}_1$: as an isotropic, homogeneous three-dimensional space (i.e. ordinary space, or S^3_{01p}). We also found that the process of constructing ordinary space cannot leave $\mathbf{p}_0$ (or $\mathbf{p}_1$) manifesting as a vector, or having a favored position, within that space. So, in the latter sense, $\mathbf{p}_0$ ($\mathbf{p}_1$) is located *everywhere* in ordinary space.

We now ask, how does $\mathbf{p}_0$ look from the perspective of (an observer at) *level 0*? The answer (by postulate 3) is simply that $\mathbf{p}_0$ *is a one-dimensional vector*. Furthermore, by the scope rule, this interpretation/meaning of $\mathbf{p}_0$ (from the perspective of level 0) is available/operant *everywhere* within system/world P (whereas the *three*-dimensional meaning from the perspective of $\mathbf{p}_1$ is only operant at level 2 and above, since $\mathbf{p}_1$ itself is only operant at those levels).

Consider now an object/particle, A, of world P; in particular, let A be an object at *level 2* or above (e.g. an electron or proton), which thus has, at minimum, $\mathbf{p}_0$ and $\mathbf{p}_1$ in its sequence/genome. Consider also an object, B, of *level 1* or above; i.e., an object that has, at minimum, $\mathbf{p}_0$ in its genome. In general, A's $\mathbf{p}_1$ component sees $\mathbf{p}_0$ as ordinary, isotropic, homogeneous three-dimensional space; and, specifically, it sees B's $\mathbf{p}_0$ component (and thus B itself) as being uniformly distributed throughout this space --- and thus, in this sense, having every possible position, but no particular position within ordinary space. By the scope rule, however, the meaning of B's $\mathbf{p}_0$ component from the perspective of *level 0* is also available to object A; to wit, from this perspective, A sees B's $\mathbf{p}_0$ component as a *one-dimensional vector*. We interpret that this meaning of $\mathbf{p}_0$ is just the *position* *vector* of B with respect to A. Since A is *any* object at level 2 or above, then *every* object at level 2 or above generates a position vector for B in the same way. And since B is *any* object at level 1 or above, then position vectors are generated in this way for *every* object at level 1 or above. In general, a position vector so constructed may be denoted by the symbol $\mathbf{r}_{p0}$, where the "p0" in the subscript indicates that its construction depends on the presence of the projection $\mathbf{p}_0$ in the object B.

We note the following about the position vector, $\mathbf{r}_{p0}$, described above:

- Since it is the position vector of "B with respect to A", then $\mathbf{r}_{p0}$ is a *relative* position vector.
- The process of constructing an object's position in ordinary space involves *two* different perspectives of the $\mathbf{p}_0$ projection: (1) The perspective of $\mathbf{p}_0$ as seen from $\mathbf{p}_1$, which creates the ordinary space itself, and sees objects as being "smeared out" over all of this space; and (2) the perspective of $\mathbf{p}_0$ as seen from level 0, which creates the object's $\mathbf{r}_{p0}$ position vectors with respect to other objects. It is the *combination* of these dual perspectives, I propose, that yields the "wave-particle duality" of objects. And we might further say that the "wave" aspects of an object come mainly from (1), and the "particle" aspects come mainly from (2).
- Since $\mathbf{p}_0$ is independent of ordinary space (as established earlier), then an object within system P is not inherently associated with (or bound to) any particular position within that space. So the magnitude and direction of an $\mathbf{r}_{p0}$ have no inherent values, and therefore have a *range* of possible values; that is, the magnitude and direction of an $\mathbf{r}_{p0}$ are *variables*. Combining this with the first bullet point above, we conclude that *the magnitude and direction* of an $\mathbf{r}_{p0}$ position vector are *relative variables*.
- The process of constructing a relative position vector ($\mathbf{r}_{p0}$) is dependent on the perspective of the "observer" at level 0. Consequently, an object in system/world P (the physical universe) *has no* $\mathbf{r}_{p0}$ position vectors independent of this observer.
- The construction of an $\mathbf{r}_{p0}$ position vector for an object depends on that object having a $\mathbf{p}_0$ component; thus, for objects that *lack* a $\mathbf{p}_0$ component (i.e., objects at level 0), construction of $\mathbf{r}_{p0}$ relative position vectors does not occur. That is, the relative position vector, $\mathbf{r}_{p0}$, is only supported for objects *at level 1 or above* (where $\mathbf{p}_0$ is operant).

It follows from the last bullet point that an object *at level 0* either has no position property at all, or it has a position property that is *different* from $\mathbf{r}_{p0}$. We will now see that the latter is the case.

Let us use the symbol $\mathbf{r}_0$ to refer to the hypothetical position vector for an object at level 0. To sort out the nature of $\mathbf{r}_0$, we first note that, due to the scope rule, an object at level 0 is operant *throughout* system/world P; so the "position" of such an object is *everywhere* within world P. Thus, from the perspective of an object at level 2 or above, the direction of $\mathbf{r}_0$ is *every* direction within ordinary space. So, in that sense, the *direction* of $\mathbf{r}_0$ is (like that of $\mathbf{r}_{p0}$) a *relative variable*. On the other hand, since an object at level 0 is operant everywhere within world P, then the "distance" to that object is always exactly *zero*. So, in that sense, the *magnitude/length* of $\mathbf{r}_0$, being always zero, is an *absolute constant*. Thus we might say that $\mathbf{r}_0$ is the *zero* vector, i.e. $\mathbf{r}_0 = \mathbf{0}$.

In summary: In terms of their *directions*, both $\mathbf{r}_{p0}$ and $\mathbf{r}_0$ are relative variables. In terms of their *magnitudes*, however, $\mathbf{r}_{p0}$ is a relative variable, but $\mathbf{r}_0$ is an absolute constant (with a value of zero).

In the above analysis, the relative position vector (i.e., the position vector of *B* with respect to *A*) is constructed when *A* references the (perspective of the) observer at level 0 to interpret the meaning of *B*'s $\mathbf{p}_0$ component. Likewise, object *B* can (without help from *A*) reference the observer at level 0 to interpret the meaning of its *own* $\mathbf{p}_0$ component. The result, again, is that $\mathbf{p}_0$ is a one-dimensional vector. However, since this interpretation of $\mathbf{p}_0$ (as a one-dimensional vector) is *not* relative to another object (*A*) within system P, then it will yield a property that appears to be *intrinsic* to *B*. To wit, it should yield an intrinsic or internal axis (or orientation) for object *B*. Since *B* is *any* object at level 1 or above, then *every* object at level 1 or above will have such an internal axis. We interpret this internal axis to be the property known as *spin*. I have not as yet worked out why, according to the present model, some objects/particles should have half-integral spin (i.e. fermions), and others should have integral spin (i.e. bosons), but the following is likely to be an important clue: In the present model, all of the fundamental fermions are created by *forward* projection, and all of the fundamental bosons are created by *non*-forward projection.

Let us now proceed to the succeeding projection, $\mathbf{p}_1$, and ask: what is the meaning of that projection from the perspective of (an observer at) level 0? The answer is that (like $\mathbf{p}_0$) it is a one-dimensional vector, and (due to the scope rule) this meaning of $\mathbf{p}_1$ is available/operant throughout system/world P.

Now consider two objects, *A* and *B*, *both at level 2 or above*, which thus have (at minimum) $\mathbf{p}_0$ and $\mathbf{p}_1$ components in their genomes. By the scope rule, the meaning of *B*'s $\mathbf{p}_1$ component from the perspective of *level 0* is available to object *A*; to wit, from this perspective, *A* sees *B*'s $\mathbf{p}_1$ component as *a one-dimensional vector*. But what property should be associated with this $\mathbf{p}_1$ vector? Since $\mathbf{p}_1$ is subsequent to $\mathbf{p}_0$, then, in this sense, the observer at level 0 (and thus also object *A*) may see $\mathbf{p}_1$ as being "attached" to the end of the position vector associated with $\mathbf{p}_0$ (i.e. $\mathbf{r}_{p0}$) --- which evokes the image from classical mechanics of the *velocity vector* of an object being attached to the end of its position vector, thereby suggesting that the property of *velocity* might be associated with $\mathbf{p}_1$. This association is further supported by the following argument.

Recall that we earlier associated $\mathbf{p}_0$ with *energy*, and $\mathbf{p}_1$ with *time*, the product of the two being *action*. Since we have just associated $\mathbf{p}_0$ also with the *position* variable, then (in order for the product of the properties associated with $\mathbf{p}_0$ and $\mathbf{p}_1$ to be action) $\mathbf{p}_1$ must be associated with *momentum*, and thus with *velocity*.

We therefore interpret that the meaning of *B*'s $\mathbf{p}_1$ component, as seen by *A* (applying the perspective of level 0), is just the *velocity vector* of *B* with respect to *A* --- to be denoted as $\mathbf{v}_{p1}$, where the "p1" in the subscript indicates that the construction of this velocity vector depends on the presence of the projection $\mathbf{p}_1$ in the object *B*. Since *A* is *any* object at level 2 or above, then *every* object at level 2 or above generates a velocity vector ($\mathbf{v}_{p1}$) for *B* in the same way. And since *B* is *any* object at level 2 or above, then velocity vectors/$\mathbf{v}_{p1}$s are generated in this way for *every* object that is at level 2 or above (where $\mathbf{p}_1$ is operant).

We note the following about the velocity vector, $\mathbf{v}_{p1}$, described above:

- Since it is the velocity vector of "*B* with respect to *A*", then $\mathbf{v}_{p1}$ is a *relative* velocity vector.
- By applying the pattern that was established by our interpretation of $\mathbf{r}_{p0}$, we interpret that both the direction *and* magnitude/speed of the velocity vector $\mathbf{v}_{p1}$ are *relative variables*. And we note that this is indeed the case for objects that have $\mathbf{p}_1$ in their genomes (e.g. leptons and baryons).
- The process of constructing a $\mathbf{v}_{p1}$ velocity vector is dependent on the perspective of the "observer" at level 0. Consequently, an object in system/world P (the physical universe) *has no* $\mathbf{v}_{p1}$ velocity vectors (nor corresponding *momentum* vectors) independent of this observer.
- The construction of a $\mathbf{v}_{p1}$ velocity vector for an object depends on that object having a $\mathbf{p}_1$ component; thus, for objects that *lack* a $\mathbf{p}_1$ component (i.e. objects at levels 1 or 0), construction of a $\mathbf{v}_{p1}$ relative velocity vector does not occur. That is, the relative velocity vector, $\mathbf{v}_{p1}$, is only supported for objects *at level 2 or above* (where $\mathbf{p}_1$ is operant).

It follows from the last bullet point that an object *at level 1* either (a) has no velocity property at all, or (b) it has a velocity property that is *different* from $\mathbf{v}_{p1}$. But an object at level 1 has the *position* vector $\mathbf{r}_{p0}$, which is a *variable*; and variable position implies a velocity property. So we rule out (a), and conclude that (b) must be the case.

Let us use the symbol $\mathbf{v}_{p0}$ to refer to the hypothetical velocity vector for an object at level 1. If we now apply the pattern that was established by our interpretation of $\mathbf{r}_0$, we get the following result: for objects at level 1 (e.g. photons, gluons, and gravitons) the *direction* of the velocity vector $\mathbf{v}_{p0}$ should be a *relative variable*, but the *magnitude/speed* should be an *absolute constant*. Of course, we know that this is actually the case for photons, and is supposed to be the case for gluons and gravitons, for all of which the constant speed is just the speed of light, *c*. However, for dark energy (a level 1 entity created by *forward* projection) this constant speed is likely zero.[15]

15 That is, since dark energy is a *single* entity spanning all of ordinary space, then it cannot really move *within* that space; and so its velocity is zero. But even if we divide the dark energy into "elements", then an element of it that might be moving at velocity $\mathbf{v}$ with respect to a given point in space is always matched by an element of it that is moving with velocity $-\mathbf{v}$; the sum of the velocities of all such elements thereby being zero.

Let us now use the symbol $\mathbf{v}_0$ to refer to the velocity vector for an object at *level 0*. If we apply the patterns above, we get the following result: for an object at level 0, the *magnitude* of its velocity (i.e. its speed, $|\mathbf{v}_0|$) should be an *absolute constant*. Indeed, this is supported by the following analysis: Due to the scope rule, an object at level 0 is in effect/operant/available at *all* locations/positions within ordinary space. So, in this sense, the *position* of an object at level 0 is *all of space*. Since its position is *everywhere* in space, and this position is a constant, then such an object does not "travel" or propagate from one point in space to another --- for, *it is already there*. In this sense, its speed is *zero*. Yet, because an object that is created (at a *particular* point in ordinary space) by *backward projection* onto level 0 becomes instantly operant/available *everywhere* in space, then, in this sense, its speed is *infinite*. Thus, an object *at* level 0 has an absolute constant speed of zero, but an object that is backward projected *onto* level 0 has an absolute "constant" speed of infinity.[16]

We can summarize the basic kinematic results above in the following statement:

> From the perspective of an observing object *A* that has $\mathbf{p}_1$ in its genome, for $k = 0$, 1: Wherever $\mathbf{p}_k$ is present/operant (e.g. in an observed object *B*), the magnitude of the kinematic property associated with it is a *relative variable*; conversely, wherever $\mathbf{p}_k$ is *not* present/operant, the magnitude of the kinematic property associated with it is an *absolute constant*. (Where the kinematic property associated with $\mathbf{p}_0$ is *position*, whose magnitude is distance; and the kinematic property associated with $\mathbf{p}_1$ is *velocity*, whose magnitude is speed.)

At this point we recall that projections can be either forward or non-forward, and that the latter type is the source of fundamental interactions or forces, with accompanying accelerations. Since the indented statement above deals only with the presence or nonpresence of *forward* projections ($\mathbf{p}_0$ or $\mathbf{p}_1$), it tacitly assumes the *absence* of nonforward projections and/or their effects, which means that it assumes *the absence of their resultant forces or accelerations*. Making this assumption more explicit, for the case of $k = 1$ ($\mathbf{p}_1$) we could rewrite the indented statement above as follows:

> In the absence of any acceleration of the observing object *A* (having $\mathbf{p}_1$ in its genome), an observed object *B* at level 1 (thereby *lacking* $\mathbf{p}_1$ in its genome) has an absolute constant speed.

Since *photons* are level-1 objects, and a nonaccelerating observer is an *inertial* observer, this statement yields the second postulate of special relativity.

Now, for the succeeding projection, $\mathbf{p}_2$, we ask: what is the meaning of that projection from the perspective of (an observer at) level 0? As usual, from that perspective, $\mathbf{p}_2$ is a one-dimensional vector; and, following the pattern above, it is suggested that we associate this meaning of $\mathbf{p}_2$ with an *acceleration* vector, for which both the direction and magnitude are *relative variables*. Apparently, then, an object can have a (physical)

16 Note that backward projection onto level 0 may yield an exception to the following statement from section 2: "...nothing that comes into being with the construction of the physical universe exists at level 0".

relative acceleration property simply by virtue of having a $\mathbf{p}_2$ component, i.e. *without* the involvement of nonforward projections.

Consider now an object *A* at level 2, and an object *B* at level 3. Object *A*, applying the perspective of level 0, will then see object *B*'s $\mathbf{p}_2$ component as a relative acceleration vector/variable. However, as indicated earlier, $\mathbf{p}_2$ is *confined* within the *internal* spaces of objects at level 3 and above (e.g. baryons), or within the residual/internal spaces of mesons at level 2. It follows that, *outside* of those internal spaces, i.e. *within the ordinary space of our experience*, where $\mathbf{p}_2$ is not operant, *such a relative acceleration variable is not supported*, and so physical acceleration is an *absolute constant* there.[17] As before, since this result deals only with the presence or nonpresence of the *forward* projection $\mathbf{p}_2$, it tacitly assumes the *absence* of *nonforward* projections and/or their effects, which means that it assumes *the absence of (net) forces caused by those nonforward projections*. This allows us to make the following statement:

> In the absence of (net) forces, an object within the ordinary space of our experience has an *absolute constant acceleration*.

If we then assume the *value* of that constant to be *zero*, this statement becomes simply the *law of inertia*, also known as *Newton's first law of motion*.

In summary, *physical* relative acceleration is confined to the *internal* spaces of objects such as baryons and mesons; *outside* of those internal spaces, i.e. within the ordinary space of our experience, acceleration is *absolute*. This result comports with the fact that the physical acceleration of an object within ordinary space (as measured by an accelerometer) is independent of external observers, and is thus absolute (not relative). (In contrast, the *position* and *velocity* of an object in ordinary space can, as described above, be absolute *or* relative, depending on the absence or presence of the projections $\mathbf{p}_0$ and $\mathbf{p}_1$ in its genome.)

4.12 Revisiting mass

Suppose we define mass as "energy that has relative position *and* relative velocity". Since we have associated the former kinematic property with $\mathbf{p}_0$, and the latter with $\mathbf{p}_1$, then it seems appropriate to associate mass with the *conjunction* of $\mathbf{p}_0$ and $\mathbf{p}_1$ --- as we also did earlier (in section 4.4.1), denoting it as $\mathbf{p}_1\mathbf{p}_0$.

4.13 Revisiting gravity

Recall our earlier result that (the emission phase of) gravity should be attributed to a *nonforward* projection of $\mathbf{p}_0$ energy --- either backward projection onto level 0, or lateral/intralevel projection onto level 1. However, if gravity were attributed to *backward* projection of $\mathbf{p}_0$ energy (onto level 0), then (as concluded in section 4.11) the graviton

17 The indented statement above for the cases $k = 0$ and 1 can then be extended to the case $k = 2$, where the kinematic property associated with $\mathbf{p}_2$ is *acceleration*.

would have a speed of *infinity*. But, of course, gravity actually has a *finite* speed --- indeed, all indications are that it propagates at the speed of light, c [14]. Apparently, then, gravity cannot be the result of backward projection onto level 0; and so it should be the result of *lateral/intralevel* projection of $\mathbf{p}_0$ energy onto level 1. This means that the graviton is a *level-1* object, with only a $\mathbf{p}_0$ component, thereby making its position a relative variable, and its speed an absolute constant.

Accordingly, we ascribe the following aspects/properties to the graviton:

- It has *only* a $\mathbf{p}_0$ projection, which may be denoted as $\mathbf{p}_{0,g}$. Since it comes from $\mathbf{p}_0$ energy, and retains its $\mathbf{p}_0$ component in the lateral (i.e. nonbackward) projection, then it (the graviton/$\mathbf{p}_{0,g}$) also consists of $\mathbf{p}_0$ energy.
- It (i.e. its $\mathbf{p}_{0,g}$ projection) is *subsequent* to, and thus dependent on, $\mathbf{p}_0$ --- since it is a *secondary* projection of $\mathbf{p}_0$ energy, which is subsequent to $\mathbf{p}_0$ itself.
- It (i.e. its $\mathbf{p}_{0,g}$ projection) is *prior to*, and thus *independent of*, $\mathbf{p}_1$ (since it springs from *intralevel* projection onto level 1 --- *not* backward projection from level 2 or above, as with the photon and gluon). Note that, even if $\mathbf{p}_1$ and level 2 did not exist, intralevel projection of $\mathbf{p}_0$ energy onto level 1 (as the graviton/$\mathbf{p}_{0,g}$) would *still* occur at level 1 (obviously without any help from, or dependence upon, $\mathbf{p}_1$).
- We thus have the following order of priority: $\mathbf{p}_0$, $\mathbf{p}_{0,g}$, $\mathbf{p}_1$.

The first, third, and fourth bullet points indicate that, from the perspective of $\mathbf{p}_1$, the graviton's $\mathbf{p}_{0,g}$ projection will "look" much like the $\mathbf{p}_0$ projection; i.e., the graviton/$\mathbf{p}_{0,g}$ will manifest to $\mathbf{p}_1$ as a form of $\mathbf{p}_0$, albeit with less priority (as indicated in the last bullet point). And we have already determined that $\mathbf{p}_0$, from the perspective of $\mathbf{p}_1$, manifests as ordinary, three-dimensional space, S^3_{01p}. Thus, due to its likeness with $\mathbf{p}_0$, it is proposed that the presence of a $\mathbf{p}_{0,g}$ projection (i.e., the presence of a graviton) will also make a contribution to the construction of ordinary space. That is, the $\mathbf{p}_1$ projection will *combine* the inputs of $\mathbf{p}_0$ and (if present) $\mathbf{p}_{0,g}$ to construct a *hybrid* space, to be denoted as $S^3_{01p,g}$, which may be considered as just the regular S^3_{01p} space modified by the presence of the $\mathbf{p}_{0,g}$ projection (i.e. the graviton).

In what way does the presence of the graviton/$\mathbf{p}_{0,g}$ modify the regular S^3_{01p} space? Recall from section 3.4 that the basic construction of ordinary space leaves $\mathbf{p}_0$ and $\mathbf{p}_1$ without position, orientation, and direction properties within that space, which thereby leaves no way to establish any special/preferred position or direction --- with the result that (as basically constructed) ordinary space is perfectly isotropic and homogeneous. In contrast, a graviton/$\mathbf{p}_{0,g}$ *does* have position, direction, and orientation within ordinary space: its *initial* position is the same as the position of the object (e.g. proton or electron) that emits it; upon emission, the graviton travels in some direction within ordinary space; and it also has spin. So, from the perspective of $\mathbf{p}_1$, the graviton/$\mathbf{p}_{0,g}$ is a form of $\mathbf{p}_0$ that *has* position, direction and orientation within ordinary space, and thus *does* establish a special position, direction, and orientation; that is, the presence of a graviton/$\mathbf{p}_{0,g}$ has the effect of modifying space from isotropic and homogeneous S^3_{01p} into *an*isotropic and *in*homogeneous $S^3_{01p,g}$. Moreover, recall that the $\mathbf{p}_1$ projection, as seen from the perspective of $\mathbf{p}_0$, yields S^1_{10p}, or *time*. Since the $\mathbf{p}_{0,g}$ projection of the graviton will have its *own* perspective of $\mathbf{p}_1$, then it is proposed that the combination of this perspective with that of $\mathbf{p}_0$ will produce a time, $S^1_{10p,g}$, that is *different* from S^1_{10p}. The present model thereby complements general relativity by explaining *why* energy (with its emission of gravitons) affects the properties of space, time, and spacetime.

The results above allow the following description of a gravitational interaction (which may be taken as an update of, or alternative to, the one given in section 4.8.4).

Consider an observer *A* at level 2 or above, i.e. an observer for which the projections $\mathbf{p}_0$ and $\mathbf{p}_1$ are operant. As usual, $\mathbf{p}_1$ sees $\mathbf{p}_0$ as regular, isotropic, homogeneous, three-dimensional space, S^3_{01p}. Consider also an object/particle *B* at level 1 or above, having $\mathbf{p}_0$ energy, which emits a graviton in the direction of *A*. When this graviton arrives at *A*, it will be processed as follows: from the perspective of $\mathbf{p}_1$, *A* will combine the $\mathbf{p}_0$ projection with the graviton's $\mathbf{p}_{0,g}$ projection to construct a resultant, hybrid three-dimensional space $S^3_{01p,g}$. In contrast to S^3_{01p}, the directional/positional aspects of the graviton's $\mathbf{p}_{0,g}$ projection within that regular space will cause the resultant $S^3_{01p,g}$ space to be anisotropic and inhomogeneous. In addition, *A* will combine the views of $\mathbf{p}_1$ from the perspectives of both $\mathbf{p}_0$ and $\mathbf{p}_{0,g}$, thereby transforming from the regular time S^1_{10p} to the *altered* time $S^1_{10p,g}$.

4.14 Backward projection onto level 0

From the results above, it appears that the gravitational interaction does not utilize backward projection onto level 0. What, then, might that form of projection produce?

In sections 4.7 and 4.9.1 we found that backward projection is about interaction/communication between existing entities/particles. Thus we should expect backward projection onto level 0 to yield a *new* type of interaction or communication. What can be said about this new kind of interaction?

In section 4.11, we concluded that an object created (at a point within ordinary space) by *backward projection* onto level 0 becomes *instantly* operant/available *everywhere* in space; so, in this sense, its speed is *infinite*. It is proposed, therefore, that backward projection onto level 0 produces *instantaneous* interaction/communication within system/world P, i.e. the physical universe.

Recalling our previous result that the observer *at* level 0 plays a key role in constructing properties such as position, velocity/momentum, and spin, it is suggested that backward projection *onto* level 0 is a means by which this observer can also act as a mediator for performing instantaneous, system-wide "bookkeeping" in regard to the *values* of those properties --- as exhibited in, e.g., EPR/entanglement-type experiments.

Indeed, the object that is backward projected onto level 0 *is* an observer at level 0, which might thus *by itself* play the role of mediator in this respect. Stating all of this in an alternative way, we might say that, since level 0 is the *origin and boundary* of system/world P, then backward projection onto level 0 might be a way of setting boundary conditions that are instantaneously operant throughout that world. Such boundary conditions might then instantaneously "collapse" a family of possibilities/solutions into a particular outcome. Of course, it is just something like this that appears to be happening in the "quantum measurement phenomena".

Just as all energy forms that are native to level 2 or above (i.e., $\mathbf{p}_1$ energy, $\mathbf{p}_2$ energy, etc.) may backward project onto level 1, so also we might expect that all energy forms that are native to *level 1* or above (which is to say, *all* energy forms within system P --- i.e., $\mathbf{p}_0$ energy, $\mathbf{p}_1$ energy, $\mathbf{p}_2$ energy, etc.) backward project onto level 0. In this respect, instantaneous communication via backward projection onto level 0 might be a *truly* universal mode of interaction, performed by *all* energy types within system P, including quantum vacuum energy (in contrast to gravity, which, as we found, *excludes* quantum vacuum energy as a source).

Backward projection of $\mathbf{p}_0$ energy, $\mathbf{p}_1$ energy, and $\mathbf{p}_2$ energy *onto level 0* may be denoted by $-\mathbf{p}_0$, $(-\mathbf{p}_1, -\mathbf{p}_0)$, and $(-\mathbf{p}_2, -\mathbf{p}_1, -\mathbf{p}_0)$, respectively.

A complete interaction via backward projection onto level 0 may thus be described as follows: Energy associated with object *A* backward projects onto level 0, producing an object at that level. Due to the scope rule, this object is then forward projected throughout all of ordinary space, to every object *B*. All of this happens instantaneously. Since level 0, and the object at level 0, likely do not (or cannot) distinguish between objects *A* and *B*, then the object at level 0 is also forward projected to *A*, producing a kind of echo or feedback effect. However, because the whole interaction is instantaneous, there is no time delay between emission of the object by *A*, and feedback to *A*.

5 The physical universe is a meaning circuit

The construction of meaning in system P seems to always involve some application of the postulates, including (as derived from postulate 4) the scope, nesting, and inheritance rules. Recall, for example, that $\mathbf{p}_1$ constructs the meaning "$\mathbf{p}_0$ is a three-dimensional space" by first applying postulate 3, which says that "$\mathbf{p}_0$ is a one-dimensional vector", and then applying postulate 4, which says that "$\mathbf{p}_0$ is independent of $\mathbf{p}_1$". Moreover, it was shown that the isotropy and homogeneity of that same space are properties/meanings that come from the application of postulate 4. To delve deeper into the semantic process for system P we therefore ask: where do the postulates themselves come from?

Given their overarching scope in the construction of system P, the postulates must be *prior* to the sequence $(\mathbf{p}_0, \mathbf{p}_1, \mathbf{p}_2, \mathbf{p}_3)$, and so must be operant/present at level 0 itself. The postulates thus come into system/world P *via level 0*.

So, application of the postulates to construct meaning in system P is an indirect *reference to level 0*. And recall that the position, velocity, and spin properties of objects (*and* their values) are meanings that are constructed through *direct* reference to (the perspective of) level 0, or the observer at level 0. For the construction of meaning in system P, therefore, all roads apparently lead to level 0.

We can thus summarize the basic construction process for system P as follows:

a) The projection sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$) springs *from* level 0.

b) Each entity/observer which is constructed by that sequence --- e.g., each projection, composite of projections, or object/particle --- *refers back* to level 0 (directly, or indirectly via the postulates) to construct meaning.

System/world P (the physical universe) thereby constitutes a Wheelerian *meaning circuit* [15], which *begins* at level 0 and then, within the system, via the meaning-producing operations of each entity/observer constructed by the sequence ($\mathbf{p}_0$, $\mathbf{p}_1$, $\mathbf{p}_2$, $\mathbf{p}_3$), *loops back* to level 0.

Clearly, then, there are *many* "observers" in the system-P meaning circuit: every object/particle/entity, and each of its component projections, is an observer that plays a role in constructing world P, and is thereby *in the loop* of its meaning circuit. But the *central* role (or linchpin, if you will) in the system-P meaning circuit is played by *level 0*, or the observer at level 0, since every *subsequent* entity in system P has in common that it refers back to that level to construct meaning. (The nature of "the observer at level 0 of system P" is developed further in Part II [5].)

Since level 0 is also the *origin and boundary* of system P, then to reference level 0 (directly or indirectly) may be tantamount to applying/invoking *initial* and *boundary conditions* on the system to construct meaning.

6 The construction of the physical universe is a type of logical derivation

Consider a derivation in the logical system known as *natural deduction* (ND)[18], containing a sequence of several steps. The derivation begins with a state that may be called *level 0*, at which the inference rules of the system are operant and a set of zero or more initial propositions/assumptions/*premises* are stated. The first logical step of the derivation then generates level 1; the second step generates level 2; and so on. Each successive step in the sequence contains propositions that are inferred (via the inference rules) from those that are prior. A proposition at a given level can be asserted at (i.e., has within its scope) *all* subsequent levels. So, the initial premises (if any) can be asserted at level 1 and above; a proposition at level 1 can be asserted at level 2 and above; and so on. In this way, subsequent levels *inherit* everything from, and *are nested within the scope of*,

18 Natural deduction is (since the 1950s) the type of logic most often taught in introductory logic books, where the modifier "natural" is said to indicate that it follows the method/pattern/paradigm by which our minds perform deductive reasoning [16, pp. 2-3], [17], [18].

prior levels. The scopes of the premises and derived propositions can thus be pictured as a matryoshka-doll-like set of concentric spheres, with each successive scope embedded/contained within the scopes of its priors. Thus the scope, inheritance, and nesting rules that are properties of system P are also properties of system ND. In other words, systems P and ND have many similarities in structure and function, with *projections* in system P corresponding to logical *steps* in ND. For this reason, we say that *the construction of system/world P (i.e. the physical universe) is a type of logical derivation*.

6.1 Systems without postulate 3

Our development of system P included the use of postulate 3, whereby the projections are considered to be *vectors*. In section 4.11, it was shown that the characterization of $\mathbf{p}_0$ as a vector was crucial for establishing the property of *relative position* (i.e., the position of one object with respect to another). Since the relative-position property is presumably necessary for there to be *geometry*, then we might say that the incorporation of postulate 3 endows the projections, and their corresponding world, with a *geometric* character. Given the results above regarding the *logical* character of system P, we can say that a system created *with* postulate 3 is both logical *and* geometric in character.

Conversely, in a system that *omits* postulate 3, or at least omits the requirement that the projections be vectors, objects will have no relative position vectors, and so the system will presumably be lacking in geometry. Consequently, such *nonvectorial* projections, and the systems or "worlds" that they generate, may be described as *nongeometric*. Notwithstanding this lack of geometry, the nonvectorial projections in a sequence still obey the scope, nesting and inheritance rules (which, after all, stem from postulate *4*, not postulate 3). If we then include the rules of inference for propositional and predicate calculus, and identify some projections as "hypotheses/suppositions"[19], then such a system will be formally similar to, or possibly the same as, the system of natural deduction (ND). We therefore say that such nonvectorial/nongeometric systems, formed by the omission (or stated modification) of postulate 3, have a *purely-logical* character.

As with their vectorial counterparts, we assume that the nonvectorial projections come in primary and secondary versions, and that the former type (primary-nonvectorial) produces *new* infrastructure (of levels, and connections between them), whereas the latter type (secondary-nonvectorial) utilizes *existing* infrastructure as "nodes and edges" on which to propagate --- in the backward, forward, and lateral/intralevel directions.

A sequence of *primary*-nonvectorial projections may be denoted as e.g. (u_0, u_1, ..., u_m), where the *nonbolding* of the component projections indicates that they are not vectors. We can think of this sequence as creating the system U, consisting of m+1 levels, where the nonvectorial projection u_0 creates level 1 of the system, the projection u_1 creates level 2, and so on. Similar to their vectorial counterparts, *secondary-forward*-nonvectorial projections (within system U) may be denoted as u_0, u_1, u_2, etc.; and *secondary-*

19 The nature of projections that we identify as "hypotheses/suppositions" is specified in Part II [5].

backward-nonvectorial projections may be denoted as $-u_0$, $-u_1$, $-u_2$, etc.

Such nonvectorial/nongeometric/purely-logical projections show their relevance in Part II of this paper [5].

7 Making sense of the projection types

A projection type in system P can be designated by selecting *one* term from each of the following three groups of projection characteristics (with some restrictions, noted below):

1. Primary; secondary.
2. Forward; backward; lateral/intralevel. (Called the *direction*.)
3. Vectorial; nonvectorial.

Thus, the designation of a specific projection type is given by a *triplet* of these terms, such as: primary-forward-vectorial (which is the type that constructs the infrastructure of world P); or secondary-backward-vectorial (which is the type that the present model holds to be responsible for the *emission* processes in the strong and electromagnetic interactions, and the emission process of instantaneous entanglement interactions); or secondary-forward-vectorial (which is the type that is responsible for the *absorption* processes in the same interactions); or secondary-lateral-vectorial, which is the type that is responsible for both emission *and* absorption in the weak and gravitational interactions.

Note, however, that the type designation "primary-forward-vectorial" is actually redundant, since, as stated above, all primary projections *are* forward (i.e., there is no such thing as a *backward* primary projection); so this designation can be stated equivalently as "primary-vectorial". Likewise, all backward projections are necessarily *secondary* projections (since backward projections *do not* create new infrastructure of edges/lines and nodes; rather, they propagate along *existing* lines, and onto *existing* levels/nodes); so, e.g., the designation "secondary-backward-vectorial" is equivalent to "backward-vectorial". And all lateral projections are secondary; so, e.g., the designation "secondary-lateral-vectorial" is equivalent to "lateral-vectorial". Lastly, we may omit the hyphens when writing these designations, and change the order of their components.

8 Conclusion

From six very simple postulates, we have managed to provide basic explanations for many hitherto unexplained physical phenomena: the (3+1)-dimensional structure of space and time; inflation (its beginning and ending); the quantum of action; dark energy; the small value of the cosmological constant; quark construction and confinement; the construction of position, velocity, and spin properties; etc. In addition, as quantum physics seems to demand, the model elevates observers to key roles in constructing the world, and provides a means for instantaneous communication/influence across all of space, by which the values of particle properties might be regulated.

In the sequel to this paper, titled "A Model for Creation: Part II" [5], the present model is generalized and applied to the construction of a hypothetical system that is *prior* to system P, the physical universe. Once the form of this prior system is worked out (its structure is essentially identical with that of system P), an extensive interpretation of it, and its entities, then follows.

Acknowledgments

I would like to acknowledge the following people for enabling the research for this paper to take place: My late mother and late father, Margean A. White and Phillip B. White; my brother, Jeffrey C. White; John P. A. Higgins; and the late Louise L. Hay (The Hay Foundation).

References

[1] J. A. Wheeler, "It From Bit", in his *At Home in the Universe* (AIP Press, 1994).

[2] J. A. Wheeler, "The Computer and the Universe", *Int. J. Theor. Phys.* **21**, Nos. 6/7, (1982).

[3] P. Davies, N. H. Gregersen (eds.), *Information and the Nature of Reality* (Cambridge University Press, 2010).

[4] J. Van Cleve, "Dependence", in *The Cambridge Dictionary of Philosophy*, R. Audi (ed.), (Cambridge University Press, 1995), p. 191.

[5] P. B. White, "A Model for Creation: Part II" (2019), http://www.paulbwhite.org/papers/A-Model-for-Creation-part-2.pdf

[6] P. Schwarz, "How many string theories are there?", http://superstringtheory.com/basics/basic5.html (retrieved Oct. 22, 2017).

[7] A. Guth, *The Inflationary Universe* (Reading, MA: Perseus Books, 1997).

[8] K. Land, J. Magueijo, "Examination of Evidence for a Preferred Axis in the Cosmic Radiation Anisotropy", *Physical Review Letters* **95** (2005). Preprint available at https://arxiv.org/abs/astro-ph/0502237

[9] C. J. Copi, D. Huterer, D. J. Schwarz, and G. D. Starkman, "Large-angle anomalies in the CMB", *Advances in Astronomy* vol. 2010, Article ID 847541 (2010). http://www-personal.umich.edu/~huterer/Papers/cmb_review.pdf

[10] S. M. Carroll, "Dark Energy and the Preposterous Universe" (2001), arXiv:astro-ph/0107571v2

[11] S. E. Rugh, H. Zinkernagel, "The Quantum Vacuum and the Cosmological Constant Problem", *Studies in History and Philosophy of Modern Physics*, vol. 33 (2002), 663-705. Preprint available at https://arxiv.org/abs/hep-th/0012253

[12] J. Mattingly, "Is Quantum Gravity Necessary?", in *The Universe of General Relativity: Einstein Studies*, volume 11 (Boston: Birkhauser, 2006). Available at http://jmattingly.org/papers/IsGravityNecessarilyQuantized.proofs.pdf

[13] S. Carlip, "Is Quantum Gravity Necessary?", Class.Quant.Grav.25:154010 (2008). https://arxiv.org/abs/0803.3456

[14] E. Siegel, "What is the Speed of Gravity?", https://medium.com/starts-with-a-bang/what-is-the-speed-of-gravity-8ada2eb08430 (retrieved Nov. 7, 2017).

[15] J. A. Wheeler, "Bits, Quanta, Meaning", in A. Giovanni, F. Mancini, and M. Marinaro (eds.), *Problems in Theoretical Physics*, pp. 121-141. University of Salerno Press, Salerno (1984).

[16] F. J. Pelletier, "A Brief History of Natural Deduction", *History and Philosophy of Logic* **20** (1999). Preprint available at https://sites.ualberta.ca/~francisp/papers/NDHistory.pdf

[17] A. Indrzejczak, "Natural Deduction", *Internet Encyclopedia of Philosophy*, ISSN 2161-0002, http://www.iep.utm.edu/nat-ded/ (retrieved Oct. 23, 2017).

[18] J. Nolt, D. Rohatyn, *Schaum's Outline of Theory and Problems of Logic* (McGraw-Hill; 1988).