DETERMINISTIC IMPULSIVE VACUUM FOUNDATIONS FOR QUANTUM-MECHANICAL WAVEFUNCTIONS

JOHN S VALENTINE

independent researcher, johnv@johnvalentine.co.uk

By assuming that a fermion de-constitutes immediately at source, that its constituents, as bosons, propagate uniformly as scalar vacuum terms with phase (radial) symmetry, and that fermions are unique solutions for specific phase conditions, we find a model that self-quantizes matter from continuous waves, unifying bosons and fermion ontologies in a single basis, in a constitution-invariant process. Vacuum energy has a wavefunction context, as a mass-energy term that enables wave collapse and increases its amplitude, with gravitational field as the gradient of the flux density. Gravitational and charge-based force effects emerge as statistics without special treatment. Confinement, entanglement, vacuum statistics, forces, and wavefunction terms emerge from the model's deterministic foundations.

Keywords: physicality, duality, vacuum, matter, fermion, constitution, quantization, boson, entanglement, wavefunction, symmetry, weak interaction, strong force, coherence, neutrino oscillation.

PACS: 02.30.Vv, 04.60.Bc, 11.10.Gh, 11.10.Jj, 12.10.-g, 12.39.-x.

1. Foundations

Minimal foundations lead to fewer free variables, and reduce assumptions. Symmetries found in these foundations may then describe wider ontologies. In this work, we explore a simple model.

Our simplest entity is a **wave** on just one basis axis, b [1, 3–7]. The waves propagate in bound pairs, as oscillators: these are fundamental **bosons**, constituting all matter and energy. All waves propagate at the same rate, both in terms of phase φ and space r traversed: $dr = d\varphi$.

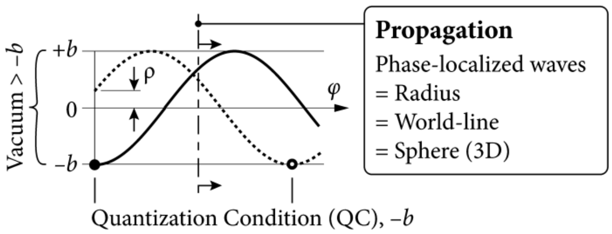

Figure 1. Boson Structure.

This structure gives properties: A boson's energy is *scalar*, and is invariant (conserved) while it propagates. In Euclidean space, these are *spherically symmetrical* expanding impulses where $d\rho/d\varphi = 0$. Intrinsic **mass-energy** ρ (fig.1) is the cosine of the phase difference between a **reference wave** having phase $\varphi_{\mathbf{A}}$ and its entangled vacuum partner having phase $\varphi_{\mathbf{B}}$:

$$-b\rho = -b\cos(\varphi_{\mathbf{B}} - \varphi_{\mathbf{A}}) = -b\, e^{-i(\varphi_{\mathbf{B}} - \varphi_{\mathbf{A}})} \qquad (1)$$

with the **field** being the gradient of the flux density of the mass-energy of all waves with respect to space (3.1.1). The wave structure allows both positive and negative **spin states** to be superimposed in the boson, and resolved on collapse; where $\varphi_{\mathbf{A}} = 0$ and $\varphi_{\mathbf{B}}$ is modulo $\pm\pi$,

$$\mathrm{sign}(spin) = \mathrm{sign}\left(b\,\frac{d\mathbf{B}}{dt}\right) \qquad (2)$$

$$\mathrm{sign}(chirality) = \mathrm{sign}(b\,\mathbf{B}) \qquad (3)$$

Spin states are merely options for presenting the same intrinsic phase difference when one of the waves is privileged as being the matter-state reference wave.

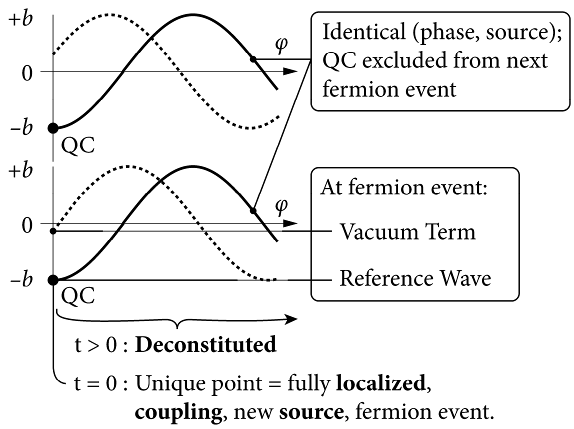

Figure 2. Phase evolution of a fermion's constituents;

Fermions (fig.2) exist as a unique solution to two bosons *each* having *one* wave at phase $-b$; the **quantization condition** ("QC"). This unique solution identifies a point on the otherwise spherically symmetric and *entangled* bosons. Because the bosons are impulsive (zero width), the fermion exists as a *point* in spacetime, i.e. the fermion state has no duration. The total **constitution** of a fermion event is as follows: (a) two waves, $b = -1$, at the QC; (b) two waves, $b \neq -1$, being **vacuum** terms; and (c) any other wave pairs at the point, also necessarily vacuum terms.

1.1.1 *Direct interactions*

Mass-energy acts as a phase operator or modulator on the waves of other bosons, as the sum of the overlapping vacuum phase potentials ρ_n:

$$\varphi_{\text{modulated}} = \varphi_{\text{carrier}} + \sum_n \rho_n \quad (4)$$

In terms of phase operators, wave **Z** is phase-modulated by ρ from vacuum bosons (eq.5, fig.3):

$$\mathbf{W} = \rho\,\mathbf{Z} \quad (5)$$

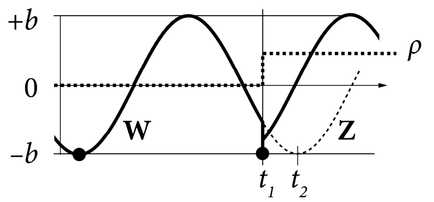

Figure 3. **W** = Phase modulation of **Z** by ρ.

It is then the *modulated* wave that qualifies for the quantization condition, with the modulation *retarding* or *advancing* the QC (fig.4), and therefore the prospective positions for the fermion, expressing **action** (3.0).

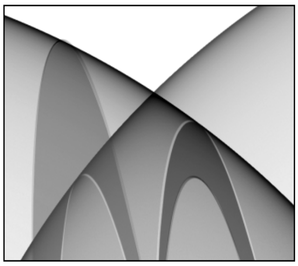

Figure 4. A volumetric plot of the propagation evolution of the *quantization conditions* of non-excluded waves from two co-modulating bosons, of known mass-energy. The right source has $\rho = 0.1\pi$ which *advances* the QC for the left wave on overlap, creating the inner ring. Conversely the left source has $\rho = -0.25\pi$ which *retards* the QC for the right source (outer ring, left). This may be viewed as a **longitudinal modulation**.

Without modulation, it would be improbable for fermions to form. We say that: (a) a deconstituted fermion requires vacuum energy to reconstitute; (b) free fundamental fermions are impossible; and (c) vacuum energy (mass-energy) prevents infinite propagation of bosons. Thus, a complete wavefunction must incorporate both the *matter* under consideration and the confining or environmental *vacuum* energy.

1.1.2 *Exclusion and symmetry breaking*

We require that states be uniquely identifiable, otherwise they cannot interact nor be resolved, and that any fermion event occurs only at unique spatial solutions to the QC. This goes further than implying the Pauli Exclusion Principle, to indicate that a boson's wave may not engage with other waves if it has the same phase and source as another wave – a condition that occurs after every fermion event.

This **exclusion symmetry** can only be broken when an excluded wave's *partner* (in the same boson) forms a QC, and *disentangles* both waves of that boson from the expanding shell (fig.5, Table 1), leaving both waves of the other boson free to interact, where one of them was previously excluded (3.2).

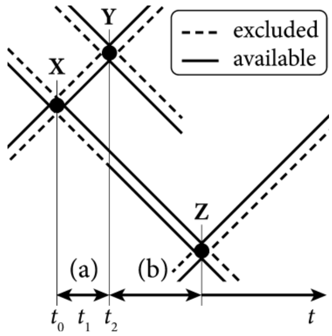

Figure 5. The identical waves from fermion event **X** will be excluded from triggering the next quantization condition **Y** (Table 1). (a) weak-excluded until **Y**; (b) weak-broken until **Z**.

	Fermion Source				
	Boson 1		Boson 2		
t	φ_A	φ_B	φ_C	φ_D	Description
t_0	$\boldsymbol{a}$	b	$\boldsymbol{a}$	d	Fermion Event **X**
t_1	$a + t_1$	$b + t_1$	$a + t_1$	$d + t_1$	Propagation
t_2	$a + t_2$	$b + t_2$	c	$\boldsymbol{d + t_2}$	Symmetry-breaking

Table 1. The corresponding sequence chart of phase values, showing the breaking of source exclusion symmetry. In $t_{0..2}$, excluded wave states are shown with shaded background, and a quantization condition is shown in bold face. At t_2, wave **D** interacts with an external boson, at fermion event **Y** (fig.5).

1.1.3 *Summary: a new picture of vacuum and fields*

Our picture presents reality as naturally-quantized, phase-localized vacuum energy. Its continuously-propagating waves are impulses with specific origin and eventual limits. Rather than assuming continuous fields, we present vacuum energy as discrete *spherical* impulses carried by bosons. This has implications for the conventional coupling and vacuum statistics: in our model, the *free parameters* of the Standard Model (and others) are derived *variables* that approximate a wavefunction's environment. Convention assumes an unchanging constitution of a fermion, and that some vacuum properties are constant, whereas our model is **constitution-invariant** because it operates on the fundamental information units: the waves of bosons, allowing fermions and the interacting elements of their environment to accountably change their constitution.

This uses deterministic classical foundations, which imply emergent quantum-mechanical processes, approximating to modern physics at sufficient scale. From the macroscopic viewpoint, fermions only appear to move or exist continuously because measurement may only occur at fermion events, similar to how a strobe effect illuminates its target. Conversely, conventional background vacuum energy density and its related statistics assume a uniform or nonlocal field value, and we question here the reliability of such statistical approximations, as having limited scope as *effective* methods that degrade at smaller scales and higher energies.

For quantum computation with these foundations, we may regard fermions as the sharp eigenstates of a wave, with their partner wave being unknown: for each boson: $[-b,\ ?]$. **Qubits** can be constructed from an individual boson's non-excluded waves (where the resolved intrinsic state is *spin*), or from the entangled wave states of all the propagating waves from a fermion event (where the resolved state is a *mass-energy* value).

2. Wavefunctions

Wavefunctions *require* a context of vacuum energy. For any boson, every *other* boson is vacuum energy.

2.1 *One-dimensional phase examples*

These following examples (figs.6–9) are introductory illustrations of the model, rather than being representative of physicality. Our first example shows two coherent *massless* sources $\{\mathbf{A}, \mathbf{B}\}$ in one spatial/phase dimension. Their bosons will not couple unless the two sources are *exactly* aligned so that their $-b$ states coincide exactly. Given that matter cannot be prepared with absolutely exact precision, the zero-width impulses make coupling impossible.

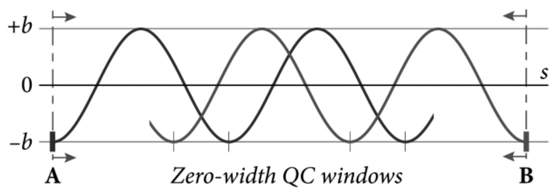

Figure 6. Two massless sources, 1-dimensional background.

Next, we change boson **B** to have *mass-energy* (fig.7). On overlap, this modulates the phase of the other boson, creating a **phase window** for coupling. Depending on the phase of both sources, a coupling will predictably either happen or not.

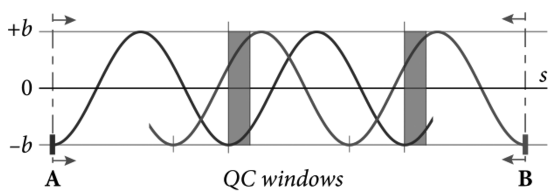

Figure 7. Wave **B** carries mass-energy (retarding **A**).

If we then add some randomness to the phase of any boson (fig.8), the edges of the window are 'blurred', the shape of fall-off depending on the profile (e.g. uniform, or normal distribution) of the randomness, in the manner of a Dirac **delta function**.

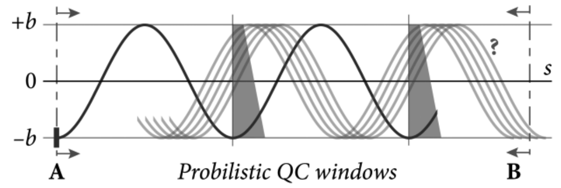

Figure 8. Randomness in the phase or source position of **B**.

Adding more sources gives a statistical **power spectrum** of the mass-energy (fig.9). To account for the environmental vacuum, we need to know its power spectrum, and model it as a flux of mass-energy. Indeed, where system confinement is not sufficient to generate a unique solution, extra statistical vacuum terms must be included.

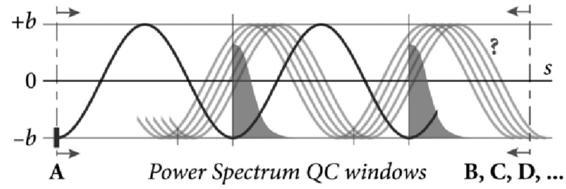

Figure 9. More than one vacuum source, random phase.

These examples illustrate how mass-energy, in the form of vacuum energy, is essential for the collapse of fermions, and that wave phase and (de)coherence can be critical to the occurrence of wave collapse.

2.1.1 *An approximation of one wave with vacuum*

Where a wave interacts with another wave of unknown random phase (say vacuum energy), the probability of interaction by phase modulation is a function of the vacuum energy. Where external bosons are considered and their phases are unknown, the phase-localized quantization condition is spread over the phase range as a probability distribution. Rather than being zero, as it was in the case of single wave, the *independent* probability of generating a quantization condition within the wave cycle is simply

$$P(x_{\mathrm{A}}) = p. \tag{6}$$

Although p is the same for each wave cycle, the probability P_n, of an event occurring in cycle n, requires that the previous event was unsuccessful. Where $p < 1$, P_n is a series converging to zero. We define the probability Q of a null interaction

$$Q_n = Q_{n-1} - P_n \tag{7}$$

and the probability of a quantization condition

$$\begin{aligned} P_n &= p\, Q_{n-1} \\ &= p\,(Q_{n-2} - P_{n-1}). \end{aligned} \tag{8}$$

With $n = 0$ for the first wave cycle, we initialize the sequence for the first test:

$$Q_{n<0} = 1 \quad (9)$$
$$P_{n<0} = 0$$

Eqs. 6-8 (fig.10) simplify to

$$P_n = p^n;\; Q_n = (1-p)^n \quad (10)$$

The probability of generating a quantization condition in the interval between source and cycle n tends to 1 with increasing n:

$$P_{0..n} = \sum_{m=0}^{n} p\,(Q_{m-2} - P_{m-1}) \quad (11)$$

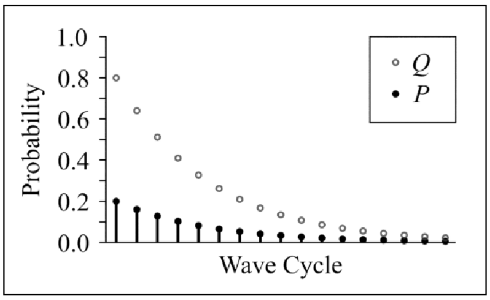

Figure 10. Probability P of a quantization condition.

The radial phase is trivial:

$$r = \varphi_{\mathrm{A}} = x_{\mathrm{A}} + 2\pi n \quad (12)$$

When *two* waves of a boson are available for the quantization condition, the solutions for $x_{\mathrm{A}}, x_{\mathbf{B}}$ are superimposed: interleaved and ordered.

2.2 *Euclidean approximation*

When one wave is considered, the nondimensional probability of achieving the quantization condition *per phase cycle* is simply p (eqs.6–11). For an *expanding sphere in vacuum*, the independent radial form for one cycle *approximates* at large integer values of r to

$$P(r) = 1 - (1-p)^{\frac{dV(r)}{dr}} \quad (13)$$

where p is the fraction of radial phase that is available for the quantization condition, depending on vacuum energy density, and $V(r)$ is the volume of space enclosed by the previous cycle at radius r:

$$\frac{dV(r)}{dr} = \frac{4\pi}{3}(r^3 - (r-1)^3) \quad (14)$$
$$= 4\pi\left(r^2 - r + \frac{1}{3}\right)$$

This approximation is not suited to changes of conditions, because it assumes a uniform probability over each successive 1-unit-thick crust of a hollow sphere. The history-dependent radial form of probability distribution P_H (incorporating the failure of previous events, eq.8, and the remaining null term available to infinity) tends to zero for infinite r:

$$P_H(r) = p^r\left(1 - (1-p)^{\frac{dV(r)}{dr}}\right) \quad (15)$$

$$\int_0^\infty P_H(r)\,dr = 1 \quad (16)$$

The total area under the curve, for $0 < r < \infty$ is 1, so it is pre-normalized, and the function increases from near-zero to a maximum value (the zone of **asymptotic freedom**), then tails off to follow P_n (eq.8), a distribution that describes a tendency to collapse fermions at a given distance (the zone of **confinement**). This kind of function provides essential clues for the distances that various types of particles tend to maintain, in given vacuum conditions. Fig.11 shows the first 400,000 terms for $p = 10^{-5}$: for $r > 64$, the series tends to zero at infinite r. For small p, approximate values of r at respective percentiles {5, 50, 95} of $\int P_H(r)$ are:

$$r = \left\{ \frac{5.129}{p}\,,\; \frac{6.931}{p}\,,\; \frac{29.96}{p} \right\} \quad (17)$$

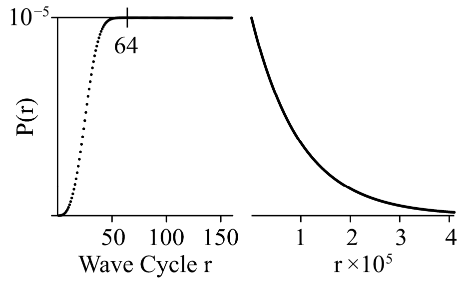

Figure 11. Plot of $P_H(r)$ for $p = 10^{-5}$, eq.15.

2.3 *Vacuum*

Approximating this process for discrete sources to statistics, we may use standard terminology for QM, and assign each modulator as an **amplitude** (factor) function in the probability distribution. Where this becomes impractical, or vacuum energy is sufficiently de-coherent or random, a power spectrum of flux (where positive and negative potentials maintain separate amplitude axes; complex) replaces individual terms, to represent a conventional field.

When applied to larger-scale dynamics, the higher the energy of a wave, the more likely a wave will collapse; the effect of mass-energy on phase modulation and wave collapse is analogous to the Higgs Mechanism for intrinsic mass, where bosons carrying large phase potentials are less likely to radiate far in a degenerate state, because they are prone to being collapsed by a wider variety of energies and phases of environmental bosons (vacuum energy).

2.3.1 *Unique solvability and derived background space*

For a wavefunction to be fully quantifiable, we must understand the role of external instances of vacuum energy on a system. These instances may have almost zero mass-energy, but their presence will create unique solutions in a degenerate wavefunction, and allow more tiers of residuals, each of which helps create a macroscopic tier of scale (physical hierarchy). We believe that the geometric structure of background space is not fundamental, but is instead derived from (and limited by) the uniqueness of fermion solutions, allowing lower-dimension spaces in the simplest of interactions where few bosons overlap. As a boson grows, there is a transition from simple one-dimensional to three-dimensional (four-boson) phase solutions, after which it is safe to assume flat Euclidean space. Each causal introduction of a boson will partition its wavefunction, or add a coupling term to the aggregated wavefunction.

This creates a sub-structure of trivial solutions at the highest energies and smallest scales, in cases where there are insufficient instances of vacuum energy flux to require a full (3, −1) metric. Although trivial, it depends heavily on phase coherence, and therefore has high deviation from the statistical expectation values when preparation conditions are unknown. We speculate that this may be a 'phase transition' where the three-dimensionality of space may emerge [but as yet this proposition lacks the required geometric working].

2.3.2 *Unique 4-boson solutions in Minkowski spacetime*

For any given boson shell, there are two active waves, whose relative phase determines a phase modulation value that is applied to the phase of all other overlapping waves. In Minkowski spacetime, two overlapping shells are not sufficient to create a unique solution; the circular solutions are not unique points. Adding a further overlapping shell implies up to two point solutions, again non-unique, so a fourth overlapping shell is needed to create a unique solution, but with each shell overlap, the probability of generating a 'hit' with a QC is diminished.

2.3.3 *Simplifying the vacuum*

We may model the simpler interactions, by assuming an exact preparation for the two main interacting bosons for which candidate solutions may be found, by applying a statistical evaluation of the vacuum energy flux. This has two effects on solutions: Firstly, the modulation of these vacuum bosons will enable more solutions for the known bosons; secondly, the vacuum bosons can enable uniqueness in existing solutions, even if the vacuum bosons have zero mass-energy. The latter is ideal for approximations, reducing the extra terms' contributions to an expectation value determined by the modulations of the known bosons (2.1). These approximations generalize the vacuum energy into anisotropic fields, to allow flux gradients (3.1) to accurately affect the wavefunctions.

3. Forces

Fundamentally, boson propagation is *scalar*; direction is not intrinsically encoded in fundamental boson, so any vector-like directional attributes are emergent geometric expressions of the positions of solutions, aggregated as momentum. We identify two possible mechanisms of force: one is a *direct modulation* effect, which is the displacement that a vacuum modulation imparts on a solution. Although this affects individual solutions, we find that it is approximately cancelled out by the fact that the modulation prevent a solution in the same wave cycle as the non-modulated case [there is detail in the exceptions, which should be explored further]. The other mechanism is a *statistical tendency* of a conserved fermion's bosons to collapse towards the sources of vacuum bosons. We place significance on the latter.

3.1 *Gravitational interactions*

We describe **gravity** as an effect of the variation of the density of vacuum energy flux over space, making it an emergent statistic of the anisotropic environmental vacuum. The effect is that waves are more likely to collapse in the direction of boson sources, especially where many fermions interact with unconfined (radiated) vacuum currents. There are two considerations that affect what we might regard as a stable gravitational 'field' near a body: (a) the interaction of other vacuum energy, (b) the self-interaction of the field.

3.1.1 *The flux gradient created by vacuum*

We calculate the change of flux density, not directly from the geometry of an expanding sphere (which would yield no change in the density of impulses), but by the interaction of the flux with other environmental vacuum energy, which collapses quanta of the flux in proportion to the increase in volume per unit radius, from (eq.15),

$$\frac{dV(r)}{dr} = 4\pi\left(r^2 - r + \frac{1}{3}\right) \tag{18}$$

which can be rewritten as "the expected probability of a test particle interacting with the body's field",

$$\frac{P(r,b)}{dr} = \frac{4\pi\, p_b}{r^2 - r + 1/3} \tag{19}$$

where p_b is the radiated mass-energy of the body. The mean deflection ∇ is the probability that the test particle will interact with the body's flux p_b, rather than with the environmental vacuum flux p_v, scaled by the mean expected vector ∇_b between particle events where the particle interacts with the body's bosons:

$$\nabla(r,b,v) \ = \nabla_b \frac{4\pi\, p_v p_b}{r^2 - r + 1/3} \tag{20}$$

The resulting force is comparable with other classical formulations; we have encoded the gravitational constant G into the mass-energy terms. Extra terms $-r + 1/3$ are within the approximation of eq.18 (and a better approximation is likely to result from working this backwards). Classical momentum is realised on particles by assuming they have internal kinematics that is emergent in the model without special consideration, as a regular system of waves.

Interestingly, the scaling of probability, resulting from this gradient of collapse, is not affected by the mass of the satellite body, unless it is incorporated into ∇_b, though we may calculate the reciprocal force by switching the roles of the bodies in the approximation. It also scales well to the collapse interval, making it almost independent of the constitution of the satellite. This means we can regard items of interest as 'test particles' in the 'field'.

We believe the usefulness of this approximation is limited to illustrating a possible origin of gravity, and to be less useful than running the model itself, where the gravitational effects are inherently present in the process, rather than computed separately. We lose fidelity from the physical model by approximating the actual bosons as a power spectrum of vacuum energy, and we lose even more fidelity by assuming the power spectrum as a scalar flux term. We also lose the phase coherence of any radiation, and the quantum detail for individual wave collapses.

3.1.2 *Self-interaction (macroscopic)*

We can assume that, in a massive body, a proportion of radiated bosons will interact with other quanta of radiation from the same body, dissipating the field with increasing radius, and generating higher-order fields in a chaotic system that requires approximation. This field is likely to comprise bosons of low mass-energy; the lighter of the fermion constituents, because they are most likely to propagate large distances. Near to the body, gravitation is likely to be indistinguishable from the interactions that conserve the body's constitution. Far from the body, self-interaction quickly loses relevance, as the increasing surface area of the boson quickly exposes it to a more significant probability of collapse from vacuum energy. We will leave this aspect for further study, e.g. the detail of cosmological extremes like black holes.

3.1.3 *Summary of gravitational interactions*

These deflections give a directional element to what is otherwise just a 'field' comprising scalar waves. Its aggregated magnitude, expressed as classical particle momentum, is small compared to an equivalent effect from the phase modulation from the interacting parts of the flux. The nature of the resulting force is different from the direct interactions of the bosons themselves. This means we will not find a gravity-carrying boson; instead we must look to environmental vacuum statistics to quantify the effect of gravity.

3.2 *Charges and their forces*

Charge is the interaction of a boson's positive or negative phase modulation with the environmental vacuum energy. Where one of a fermion's waves has already interacted with vacuum and been taken off-shell (1.1.2), the remaining on-shell waves are guaranteed to have only one sign of modulation $\{++,\ --\}$ present, in contrast to a shell that has not yet interacted which has one of $\{++,\ +-,\ -+,\ --\}$ modulations present. Shells having mixed sign are neutrally charged; those with one sign carry charge.

Each fermion therefore has two charge values: the **initial charge** on two bosons, and the **residual charge** on the boson that remains after its first interaction. We map the initial charge to the **weak interaction**, and the residual charge to the **electric interaction**. The radiation of a fermion source therefore has two wavefunctions, partitioned by source and interaction events. The residual wavefunction is a choice between two possible wavefunctions, depending on which boson interacts first as a result of the initial wavefunction. This choice is generally unobserved because it is *part of the process* that preserves the constitution of conserved fermions. However, we can detect weak interactions when they *change the constitution* of an otherwise conserved fermion: a change in momentum, effects from the change in constitution of future fermions, or the sign of wave properties like chirality. The strong force has different a origin, being a result of the double-linking confinement structures [6,7] found in QCD (5.2).

3.2.1 *Attraction and repulsion*

This requires that interchangeable 'lighter' bosons are available from vacuum, to supply the persistent heavy boson with a partner. Field line vectors are a sum of the source radial vectors, scaled by their probabilities. In future works, we intend to reconcile charge structures with established literature.

3.3 *Summary of forces*

In this model, the forces of the Standard Model are an effect of flux gradients on the probability of wave collapse. Rather than being separate and specific forces acting independently on classical bodies, the forces are intrinsically present in the model, without any need for specific mathematical treatment to generate or isolate them. Indeed, to rediscover these forces, we have explored the observable displacement effects of organised structured sources (classical bodies) on test particles and micro-systems, in comparison with the same systems in background vacuum. We stress here that these forces are emergent expressions of the fundamental propagation and collapse, and are Lorentzinvariant, whereas the separated fields are not translation-symmetric.

4. Physical Structures

Author's Note: It is customary for foundational works to attempt to explain grand unification and every aspect of the Standard Model. Although these remain our aims, we believe it is too soon to declare success in this regard, as our researches are not yet sufficiently exhaustive, nor are they quantitatively calibrated to experimental physics. We provide this section as guidance for further work.

4.1 *Particles*

Conserved fermions are those that are similarly re-constituted over time: their constituent bosons 'bounce' off vacuum energy at virtual anti-fermions, and return to create a mutual coupling point for the next fermion event. Such fermions have **classical momentum** as an aggregation of displacements. When this cycle is interrupted (rather than simply nudged) by other bosons, fermions change their constitution or are annihilated.

A truly *free* fundamental fermion, i.e. the sole occupant of a universe without vacuum energy, can never collapse, for two reasons: (a) a single source can only contribute *one* term, of the *two* required to constitute a further fermion event, because of exclusion (1.1.2); and (b) there is no vacuum energy, to provide the second term. However, we can model a free fermion with the addition of environmental vacuum energy.

A **composite** structure is one where its fermions depend on each others' constituents to remain conserved. This means that some of the fermions' energy is **confined** rather than emitted anonymously into vacuum.

4.1.1 *Fundamental fermions*

Our model defines a minimum constitution for fermions, essentially two bosons, with as many supplemental bosons as required to create a unique solution for a quantization condition. When we examine the particles identified by the Standard Model in this context, we find opportunity to define quarks and leptons (both electron and neutrino-type) in these new terms, rather than just assume they are fundamentally indivisible. This necessarily admits instances of discrete vacuum energy as part of the constitution, whether coherent and confined in a composite, or incidental to the system. For example, neutrinos might be a combination of very light bosons, quarks a combination of heavy bosons, and electron-type leptons are a mix of the two boson types.

4.1.2 *Neutrinos*

Our neutrinos, being fermions, are the combination of two very light bosons, which needn't be massless. The tiny mass of the boson constituents allows them to propagate great distances, and their part in interactions is generally limited to providing a unique solution for heavier bosons, rather than the behavior of massive bosons which tend to perpetuate the conserved particles that collapse near their source. The mechanism for oscillations is a vacuum interaction.

4.2 *Antimatter*

As with Dirac images of the fermion, the *vacuum constituents* of a fermion would form anti-matter if they later couple as fermions. The cyclic process of matter conservation involves a fermion's bosons each finding a fermionic solution with vacuum, before returning for re-constitution. As a process, this creates a 'polarized vacuum' where idempotent conserved $\pm$fermions (matter, or antimatter, whichever has more mass-energy), with their corresponding one-off separated $\mp$half-fermion instances as the reflection points.

5. Predictions and Applications

5.1 *Description of a black hole*

Our model can be applied to the scenario of a black hole, without any special treatment: the same process of fermion reconstitution is at work in a black hole, as is at work in the low energy environments that we are more familiar with. The Schwarzschild radius is not privileged, but the classical effects are achieved by quantum means; our event horizon is a fuzzy probabilistic boundary. From the outside of a black hole, as we approach the event horizon, the vacuum energy density increases, making bosons collapse more readily into fermions (1.1.1, 2.1, 3.1), with a greater proportion of fermions failing to reconstitute in a conserved manner from one instance to the next.

5.1.1 *Evaporation, probabilistic boundary*

The event horizon itself does not have any special properties. The event horizon can be assigned to be a radius from which there is a significant confidence that matter cannot escape. Indeed, it is the large-scale result of many interactions within a zone where two relevant variables (both being classical generalizations) are high: *vacuum energy density* is large enough to prevent bosons propagating far, and a *gradient of vacuum energy density* implies a directional preference for collapse. There are no limits to the vacuum energy density; many boson shells may occupy a length or volume that is less than a fundamental wavelength in size, but interaction opportunities per boson are limited.

Although our model was not designed around solutions to problems related to black holes, we find it presents a good model for some currently-favored ideas, such as black hole evaporation[Bekenstein–Hawking], without the problems of classical gravitation. Our constitution for a fermion requires that at least two bosons leave each fermion event. In low-energy environments, fermions might typically re-constitute after their bosons 'bounce' off the vacuum. This is in contrast with the dense environment of a black hole, where higher energy densities will increase the probability that fermions will not reconstitute themselves because their bosons pair up with other vacuum waves, never to return to their original encoding. If this occurs near the event horizon zone, then some energy may probabilistically escape.

This model does not suffer 'information paradox' problems, because our matter is encoded as separate bosons, and even within the dense body of a black hole, these bosons interact as normal. However, the encoding of fermions entering a black hole is likely to be significantly scrambled by the interactions within.

5.2 *Mass variation of quarks and gluons*

Gluons are the confined energy of hadrons: these bosons, having significant mass-energy, collapse readily at short distances, each quark coupling to both other members of the hadron (6 bosons), with residuals providing larger-scale currents at significantly lower mass-energies. There are nine components in total, for the six bosons. For each pair of the bosons leaving a quark, one of the bosons (say, the anti-color) has two wavefunctions, partitioned by the symmetry-breaking interaction of the other boson, which makes both its waves available for interaction. Where two wavefunctions are concurrent for any two bosons on their sphere shell, the probability of interaction depends on the phase coherence of their respective interaction windows. Where the boson energies are near-equal, the maximum probability (where windows are non-overlapping) is twice that of the minimum probability (where windows overlap), and where boson energies are unequal, the range of probability is narrower, with the smaller mass-energy value seeming to be an error on the larger value. For a wavefunction having only a single boson with both waves active, their interaction windows are non-overlapping, and conversely, the windows of a pair of bosons *before* the symmetry break may overlap. Aggregating such distributions from masses or initial phase values should yield typical ranges found in experiment, and vice versa. The phase coherence of the wavefunctions gives directionality to the probabilities, particularly when sources are close.

5.3 *Radial occlusion effect; EPR variants*

Consider a large body at radius r from a radiating source: the large body should collapse some of the waves that would otherwise have radiated beyond the system. Given that we think that all mass-energy values are very small relative to the highest possible value of mass-energy that a boson may carry, it is likely that the occlusion effect is significantly smaller than the direct exchanges of bosons that occur between the two bodies; a squared order smaller than the direct modulation interaction (3.1). However, it should be testable.

5.4 *Confinement energy and momentum*

The model allows composite particles to gain or lose their confined energy, but this is not necessarily in proportion to their classical momentum; it is possible for a system to lose confinement energy while gaining momentum, though strictly speaking, this also implies a change in the constitution of the composite particle.

5.5 *Example exotic particle structures**

A three-fermion singlet may be constructed, where each fermion couples to both the other fermions (5.2) within $1r$ wavelength, and is equivalent to a very compact hadron. This composite travels at light speed without residuals, and without external vacuum interaction; indeed it must avoid vacuum energy (within $2\pi r/3$ of its axis) to remain conserved, given that its $p = 0.5$.

5.6 *Fast guided information transport**

It should be possible to transport information towards a recipient at a density (several orders of magnitude) greater than the fundamental density, if the receiver prepares the vacuum with phase-coherent periodic emissions. If the source is able to generate a boson having a wave phase slightly de-synchronised from the target, but within the mass-energy modulation window of the target's coherent signal, then the information will propagate to the target. An analogy for this mechanism is a 'domino run on a conveyor belt', where a target periodically drops dominos onto a conveyor belt that is moving away from it, and a downstream source tips a domino to send a signal. Many such signals could be sent in parallel, using non-overlapping phase windows, provided there is no interference (which would cause cross-talk).

Although this signalling method could work at near-fundamental scale if the machinery could be built, at a scale significantly smaller than typical electron interactions, it has been mentioned only as a curiosity, because it has many problems that prevent it being practical: (a) It is inefficient over distance; (b) Information propagation collapses the carrier signal; (c) The sender of the information has no way of knowing if a carrier signal is available for the complete propagation path, so this is suited only to short distances, and must be implemented with a full protocol; (d) It is prone to interference from oppositely-modulated bosons having higher energy than the information, shifting the signal phase out of the modulation window of the carrier signal, and losing the information to vacuum.

6. Further Work

6.1 *Disproof and viable alternatives*

Reasonable alternatives weaken the model, so we have identified these to open it to challenge.

6.1.1.1 We assume the quantization condition (1.0) occurs only at $-b$, because we use it as an absolute phase position in the algebra that has special privileged physical meaning [1, 3–7]. Viable alternatives may be: (a) at any point where phases are equal, or (b) $+b$.

6.1.1.2 We assume that at the point at which two boson shells overlap, phase modulation spontaneously sweeps over the phase range, to include any swept quantization conditions. The alternative view, of not including the phase range, severely reduces amplitudes.

6.2 *Problems*

Here we list aspects of the model that are weak, poorly understood, or worthy of further work:

6.2.1.1 What is the fundamental scale of this model, which is not yet calibrated to standard length. We expect a scale to emerge from the solutions to composite configurations.

6.2.1.2 A description of harmonic oscillators and black bodies (QED). We expect 'sparse sampling' to provide the mechanism.

6.2.1.3 Is there a process that creates bosons of a given mass-energy, without assuming a big-bang?

6.2.1.4 Verify that different vacuum environments exist in the universe, and investigate the possibility that an increase in vacuum flux for an observer may cause their own confinement and vacuum interactions to increase in frequency, red-shifting the surroundings.

6.2.1.5 (a) Verify that 3D background space emerges from scalar phases (2.3.1), where four or more bosons have common geometric solutions.
(b) When less than four sources overlap, unique QC solutions may exist in lower-dimension space (2.1). Examine the resulting ontologies.

6.2.1.6 Do 'flavors/generations' correspond to the number of bosons required to create a unique solution for a fermion?

6.2.1.7 Is energy conserved or mixed for all bosons passing through a fermion event?

6.2.1.8 Investigate the modulation properties of matter and anti-matter (4.2), for any imbalance or cascade effect.

6.2.1.9 Investigate whether non-persistent fermions (4.2) are an adequate description of 'dark matter'.

6.2.1.10 Computability of the deterministic aspects of the model, and sufficient approximation in statistics.

6.2.1.11 Operational calculus on approximations of vacuum interactions (2.2), into e^n format.

Afterword

We are hopeful that the model outlined in this work describes useful symmetries. First is the symmetry of matter and vacuum states (1.0) on a common axis [3–7], with simple physical rules that encapsulate important entity and exclusion principles. Our model's intrinsic inclusion of forces (3.3), and their emergence without special treatment, strongly suggests that our model has a force-unifying symmetry in its basic process. Further, we feel that the constitution-invariance of the process (1.1.3), free of renormalization and singularity problems and effective energy limits, is worthy of further study.

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