Toward unification

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Abstract

A universe based on a fully deterministic, Euclidean, 4-torus cellular automaton is presented using a constructive approach. Each cell contains one integer number forming bubble-like patterns propagating at the speed of light, interacting and being reissued constantly. The collective behavior of these integers is conjectured to form patterns similar to classical and quantum physics, including the mass spectrum. Although essentially non-local, it preserves the non-signaling principle. This flexible model predicts that gravity is not quantized. Being a causal theory, it can potentially explain the emergence of the classical world and macroscopic observers.

Keywords: unification, cellular automaton, graviton, nonlocality, beyond Standard Model

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Table 1: Brick fields

Field	Name	Type	Values
p_1	Clock	UI	Incremented in unison after each T seconds
$\overrightarrow{p}_2$	Origin	SV	*null* or N_D possible directions. $\lvert\overrightarrow{p}_2\rvert$ =preon radius
$\overrightarrow{p}_3$	Momentum direction (LM)	SV	*null* or N_D possible directions
$\overrightarrow{p}_4$	Spin	SV	*null* or N_D possible directions
p_5	Helicity	SI2	± 1
p_6	Charge	SI2	± 1
p_7	Chirality	SI2	± 1
p_8	Gravity	SI2	± 1
p_9	Color and conjugation	UI6	R G B R' G' B'
p_{10}	Entanglement	2 UI	$0...(SIDE-1)^2$
p_{11}	Sinusoidal phase	SI	$-SIDE/2...+SIDE/2$
p_{12}	Frequency	UI	$1...SIDE-1$
p_{13}	Interference	SI	$-SIDE/2...+SIDE/2$
p_{14}	Charge messenger	SI2	$0, \pm 1$
p_{15}	Gravity messenger	UI1	0-OFF, 1-ON
p_{16}	Cohesion	UI1	0-FREE, 1-BOUND
p_{17}	P decay counter	UI	$0...2 \cdot SIDE - 1$
p_{18}	Directionality	UI	$0...SIDE-1$

1 Introduction

Cellular automata are mathematical idealizations of physical systems in which space and time are discrete. The idea of modeling our universe using cellular automata is not new, discreteness is seen by many authors (Refs. [1–8] form a small list) as a solution for the divergences of the Standard Model (SM), and is supported by the existence of a fundamental Planck volume, suggesting that structures smaller than this tiny volume should not be relevant to the theory.

Quantum mechanics (QM), despite its resounding success, gives us a somewhat blurred image of the universe because of its base on the uncertainty principle, point particles, and its most accepted interpretation is based on probabilities. Recent results from experimental physics, which far surpass the precision achieved by QM predictions, require a new model of the universe in which QM is only a limiting case.

Can nature be modeled as a cellular automaton? The model described here is designed to investigate this possibility. The emergence of a unified theory of physics is the ultimate goal of a final version based on this approach. Here the automaton is a couple of simple cubic grids closed on themselves as a 4-torus where one *brick* (formatted integer number) is attached to each cell. The cell has a processor, or logical circuit, and interacts with its eight nearest neighbors only (von Neumann convention). Preons are modified under the tick of a central clock. The Planck length is the natural candidate to be used as the distance between the automaton cells.

The approach adopted in this work is a constructive one [9, 10]. Whenever possible, I try to emulate directly the laws of physics, probing the adequate heuristics. On the other hand, I'm not saying that the Universe is a vast computer, in fact, I'm attempting to model Planck scale physics using a cellular automaton.

2 Theory

2.1 Ontology

Definition 1. Property *formats*: SI, signed integer; UI, unsigned integer; SV, signed 3d-vector, with $N_D = \pi\,({}^{SIDE}/_2)^2$ possible directions. The default length is $SIDE$.

Definition 2. *Brick* is a formatted (p_1, p_2, ...) N-integer (see Table 1).

Definition 3. The *cellular automaton* is a dual Euclidean lattice 4-torus of dimension SIDE, where a single brick is attached to each cell. The distance between cells is L and the clock period (p_1) is T. Each lattice is alternatively principal (read-only) or dual (draft). D is the main diagonal of the lattice. Three dimensions are spatial and the fourth corresponds to internal degrees of freedom.

Definition 4. A *preon*[1] is a spherical wavefront of bricks occupying the same w address, expanding at the speed of light $c = {}^{L}/_{LIGHT}$ (one light step is $LIGHT = 2D$ clock ticks). It is considered *real* or *virtual* ($p_8 = \pm 1$).

Definition 5. *Graviton* (G) is a brick that propagates in a straight line at the speed of light. It vanishes after traveling the distance of $SIDE/2$ units in the direction of its spin vector.

Definition 6. A *burst* is a cubic wavefront occupying the same w address, expanding at the maximum speed $s = {}^{L}/_{T}$. The burst duration is $BURST = {}^{3\,SIDE}/_{2}$.

Definition 7. *Unpaired* (U) is a non-overlapping preon. It works like a charge fragment.

Definition 8. *Pair* (P) are two overlapping preons. The components of the pair are identified by the upper indices P and P', respectively.

Definition 9. A vacuum P (P_0) has trivial net properties $\overrightarrow{p}_3$, $\overrightarrow{p}_4$, p_6, p_7, p_9, p_{15}, p_{17}, and $p_8 = -1$.

Definition 10. The *input parameters* are $SIDE = 2^{208}$, $L =$ *one Planck length*, $T =$ *Planck time*$/3 \cdot SIDE$, and $EXCESS$. They are used for mapping to the real world.

2.2 Auxiliary functions

▷ PWM mask
procedure $pwm(n)$ **begin**
  return $n \bmod \sqrt{SIDE} < n/\sqrt{SIDE}$
end.

▷ Charge conjugation test
procedure $conj(p)$ **begin**
  if $p_9 \& 38_H \neq 0$ **then return** $+1$ ▷ matter
  if $p_9 \& 07_H \neq 0$ **then return** -1 ▷ antimatter
  return 0 ▷ neutral
end.

▷ Variable f is a 3-bit field, n={1,2}
procedure $rot(f, n)$ **begin**
  rotate f by n bits to the right
end.

▷ Color bits exchange
procedure $exchange()$ **begin**
  if $p_9^{P1} = p_9^{P2} \neq 3f_H$ **then**
    if $p_9^{P1} = p_9^{P2} = 0$ **then**
      $p_9^{P1} = 20_H$; $p_9^{P2} = 04_H$
    end if
    $rot(p_{9L}^{U}, p_1^{U} \& 01_H + 1)$; $rot(p_{9H}^{U}, p_1^{U} \& 01_H + 1)$
    $rot(p_{9L}^{P1}, p_1^{P1} \gg 1) \& 01_H + 1)$; $rot(p_{9H}^{P1}, (p_1^{P1} \gg 1) \& 01_H + 1)$
    $rot(p_{9L}^{P2}, p_1^{P2} \gg 2) \& 01_H + 1)$; $rot(p_{9H}^{P2}, (p_1^{P2} \gg 2) \& 01_H + 1)$
    if $p_9^{P1} \& p_9^{P2} \neq 0$ **then**
      undo changes
    end if
  end if
end.

[1] *The word* preon *was coined by Jogesh Pati and Abdus Salam in 1974.*

▷ The brick signature value
procedure *signature*(p) **begin**
  return $(SIDE+1)^2\, p.x + (SIDE+1)\, p.y + p.z + 1$
end.

▷ Alignment / anti-alignment test $(a = \pm 1)$
procedure *align*(a) **begin**
  if $a = -1 \wedge \overrightarrow{p}_3^{P1} \bullet \overrightarrow{p}_3^{P2} < 0$ **then**
    return $pwm\left(-\overrightarrow{p}_3^{P1} \bullet \overrightarrow{p}_3^{P2} / |\overrightarrow{p}_3^{P1}||\overrightarrow{p}_3^{P2}|\right)$ ▷ $\overrightarrow{p}_3^{P1} \bullet \overrightarrow{p}_3^{P2} \sim -1$
  else if $a = +1$ **then**
    return $pwm\left(\overrightarrow{p}_3^{P1} \bullet \overrightarrow{p}_3^{P2} / |\overrightarrow{p}_3^{P1}||\overrightarrow{p}_3^{P2}|\right)$ ▷ $\overrightarrow{p}_3^{P1} \bullet \overrightarrow{p}_3^{P2} \sim +1$
  end if
  return 0
end.

▷ Polarization mask
procedure *pol*$(sector)$ **begin**
  $light = |\overrightarrow{p}_2|$; $cycle = SIDE/p_{12}$
  if $light \bmod cycle < cycle/sector$ **then**
    return $\mathrm{pwm}\left([p_{11}]^2\right)$
  end if
  return 0
end.

▷ Hash value used for vacuum symmetry breaking
procedure *hash*(n) **begin**
  return $((n+1) \cdot prime) \gg (ORDER/2)(SIDE-1)$ ▷ 'prime' is a prime number
end.

▷ Changes P to a kinetic P
procedure *kineticP*$(\overrightarrow{d}, P)$ **begin**
  $\overrightarrow{p}_3^P = \overrightarrow{p}_3^{P'} = \overrightarrow{d}$; $\overrightarrow{p}_4^P = \overrightarrow{p}_4^{P'} = \overrightarrow{0}$; $p_{14}^P = p_{14}^{P'} = 0$;
end.

2.3 Dynamics[2]

Axiom 1. *The sinusoidal phase of preons is given by the p_{11} field, calculated by means of a* Direct Form Oscillator cf. *[11]. When preons are overlapped, the generator is fired multiple times, and the p_{12} updated accordingly.*

Define the constants

$$\begin{aligned} k &= 2\cos(\omega T), \\ U_1 &= SIDE \sin(-2\omega T), \\ U_2 &= SIDE \sin(-\omega T). \end{aligned}$$

At the beginning of each wave do

$$u_0 = 1;\ u_1 = U_1;\ u_2 = U_2.$$

The evolution law is

$$\begin{aligned} u_3 &= k\, u_2 - u_1, \\ u_1 &= u_2, \\ u_2 &= u_3. \end{aligned}$$

[2]A proof-of-concept C program is under development where very basic operations can be visualized. Its latest version can be accessed on github https://github.com/automaton3d/automaton.git.

Axiom 2. *Interference derives from a track left by the preons on the visited cells (p_{13} field), inspired by work of Sciarretta [7]. The value algebraically added by the sinusoidal phase on the cell decays absolutely and exponentially after each light step [12]. Only entangled*[3] *preons interfere with each other.*

Axiom 3. *Decay of P*

$p_{17}^P = p_{17}^P \gg 1$
if $p_{17}^P = 0$ **then**
  if $p_{16}^P = BOUND$ **then**
    $p_{16}^P = FREE$ ▷ bound P is set free
  else if $p_8^P = VIRTUAL \wedge \overrightarrow{p}_2^P \bullet \overrightarrow{p}_4^P = 1$ **then** ▷ the dot product singles out one brick
    $P \leftarrow P_0$; reissue P ▷ virtual P is returned to the vacuum
  end if
end if.

Axiom 4. *Preon interaction is detected by mutual comparisons in the* w *dimension at the last tick of a time frame. The interaction type (UxG, PxG, UxU, UxP or PxP) is then calculated. The preons are reissued at the contact point by default. If the preon never interacts, it is reissued by wrapping.*

Axiom 5. *A preon launches a burst every time it is reissued. The burst erases the wavefront of the preon, except a brick seed. Then, its spin ($\overrightarrow{p}_4$) is rotated by the angle $2\pi d\, p_5/D$, where $d = |\overrightarrow{p}_2| \,\mathbf{mod}\, 2D$. If it is entangled, then the burst will cause its partner to assume the opposite spin direction. Then, it gets entangled with the preon it is interacting with: $p_{10}^1 = p_{10}^2 = w^1 w^2$; $\overrightarrow{p}_4^1 = -\overrightarrow{p}_4^2 = \overrightarrow{p}_4^1 \times \overrightarrow{p}_4^2$; $p_{18}^1 = p_{18}^2 = 0$.*

Axiom 6. *The wavefront of a real preon continues propagating as a G after the reissue, with spin $\overrightarrow{p}_4^G = \overrightarrow{p}_2$.*

Axiom 7. *Let $C = \{\, 3f_H, 01_H, 02_H, 04_H, 20_H, 10_H, 08_H, 3f_H \,\}$. When a vacuum P is reissued, then $p_9^P = C[p_1 \& 07_H]$ and $p_9^{P'} = C[8 - (p_1 \& 07_H)]$.*

Axiom 8. *UxG interaction*

if $p_8^U = +1$ **then**
  $p_{15}^U = ON$; $\overrightarrow{p}_3^U = -\overrightarrow{p}_2^G$ ▷ graviton detection
end if.

Axiom 9. *PxG interaction*

Move p_{18}^P value in the direction $-\left(1.5 - |\overrightarrow{p}_2^G \bullet \overrightarrow{p}_2^P / |\overrightarrow{p}_2^G||\overrightarrow{p}_2^P||\right) \hat{p}_2^G$. ▷ light bending

Axiom 10. *UxU interaction*

if $p_9^{U1} \neq p_9^{U2}$ **then**
  if $p_6^{U1} = -p_6^{U2} \wedge p_7^{U1} = -p_7^{U2} \wedge p_8^{U1} = p_8^{U2} \wedge p_9^{U1} =\sim p_9^{U2}$ **then**
    U_1 and U_2 merge into a P ▷ annihilation
    $\overrightarrow{p}_4^{U1} = -\overrightarrow{p}_4^{U2} = \overrightarrow{p}_4^{U1} \times \overrightarrow{p}_4^{U2}$ ▷ spin realignment
  end if
else
  $\overrightarrow{p}_4^{U1} = -\overrightarrow{p}_4^{U2} = \overrightarrow{p}_4^{U1} \times \overrightarrow{p}_4^{U2}$ ▷ spin realignment
end if.

Axiom 11. *UxP interaction*

$p_{18}^P = p_{18}^P + 1$ ▷ update directionality
if $p_{15}^U = ON \wedge P \equiv P_0$ **then** ▷ recruit vacuum P
  $kineticP(\overrightarrow{p}_4^U, P)$; $p_{16}^P = BOUND$; $p_{15}^U = OFF$ ▷ grav. acceleration
else if $pwm\,(p_{13}) \wedge P \equiv P_0$ **then**
  $p_{14}^P = p_{14}^{P'} = p_6^U$; $\overrightarrow{p}_4^P = \overrightarrow{p}_4^{P'} = \overrightarrow{p}_4^U$ ▷ static EM interaction
else if $p_{14}^P = \pm 1 \wedge pwm(p_{18}^P) \wedge pwm(p_{13}^P) \wedge pol\,(8)$ **then**

[3] Entanglement must be included in the theory to avoid that it is reduced to the classical theory, cf. [13].

$kineticP\left(p_6^U p_6^P\left(\overrightarrow{p}_2^P - \overrightarrow{p}_2^U\right), P\right)$; $p_{14}^P = p_{14}^{P'} = 0$; ▷ Coulomb interaction
else if $p_{14}^P = \pm 1 \wedge \overrightarrow{p}_4^P = \overrightarrow{p}_4^{P'} \neq \overrightarrow{0} \wedge pwm(p_{18}^P) \wedge pwm(p_{13}^P) \wedge$
$pol\,(4) \wedge pwm\left(|\overrightarrow{p}_4^{P1} \bullet \overrightarrow{p}_4^{P2}/|\overrightarrow{p}_4^{P1}||\overrightarrow{p}_4^{P2}||\right) = ON$ **then**
$kineticP\left(\overrightarrow{p}_4^P \times \left(\overrightarrow{p}_2^P - \overrightarrow{p}_2^U\right), P\right)$; $p_{14}^P = p_{14}^{P'} = 0$; ▷ magnetic force
else if $p_6^P = -p_6^{P'} \wedge p_{16}^P = FREE \wedge p_{16}^{P'} = FREE \wedge pwm(p_{18}^P)$ **then**
reissue all overlapping preons from the contact point ▷ absorption interaction
else if $(p_9^U \,\&\, p_9^P) \neq 0$ **then**
$kineticP\left(\overrightarrow{p}_2^P - \overrightarrow{p}_2^U, P\right)$; $exchange()$ ▷ strong force
else if $p_7^U \neq 0 \wedge p_7^P \neq 0 \wedge p_7^U = -conj(U) \wedge$
$p_7^P = -conj(P) \wedge pwm\left(p_{13}^U\right) \wedge pwm\left(p_{13}^P\right) \wedge pwm(p_{18}^P)$ **then**
$kineticP\left(\overrightarrow{p}_2^P - \overrightarrow{p}_2^U, P\right)$ ▷ weak force
if $P \equiv P_0$ **then**
$p_{17}^P = p_{17}^{P'} = 2 \cdot SIDE - 1$; $p_{16}^P = p_{16}^{P'} = BOUND$ ▷ weak harvesting
end if
else if $p_{16}^P = p_{16}^{P'} = BOUND \wedge \overrightarrow{p}_3^P = \overrightarrow{p}_3^{P'} \neq \overrightarrow{0} \wedge p_6^P \neq p_6^{P'}$ **then** ▷ P is not free
reissue P from $\overrightarrow{p}_0^P - \overrightarrow{p}_2^P + |\overrightarrow{p}_2^P|\,\hat{p}_3^P$
reissue U from $\overrightarrow{p}_0^U - \overrightarrow{p}_2^U + |\overrightarrow{p}_2^P|\,\hat{p}_3^P$ ▷ inertia
end if.

Axiom 12. *PxP interaction*

if $P_1 \equiv P_2 \equiv P_0$ **then**
if $p_2^{P1} = p_2^{P2} \wedge hash\left(w^{P1}\right)$ **xor** $hash(p_1^{P1}) = hash(w^{P2})$ **xor** $hash(p_1^{P2})$ **then**
reissue P_1 and P_2 ▷ vacuum symmetry breaking
else if $hash\left(w^{P1}\right)$ **xor** $hash(p_1^{P1})$ **xor** $signature(P_1) = hash(w^{P2})$ **xor**
$hash(p_1^{P2})$ **xor** $signature(P_2)$ **then**
reissue P_1 and P_2 ▷ quantum fluctuation
end if
else if $p_9^{P1} = (38_H, 07_H) \wedge P_2 \equiv P_0 \wedge pwm(p_{18}^{P1}) \wedge pwm(p_{18}^{P2})$ **then**
$p_9^{P2} = 38_H$; $p_9^{P2'} = 07_H$ ▷ leptonic synthesis
else if $p_4^{P1} = p_4^{P2} = \overrightarrow{0} \wedge p_2^{P1} \neq p_2^{P2}$ **then** ▷ kinetic P x kinetic P?
if $align(-1)$ **then**
$P_1 \leftarrow P_0$; $P_2 \leftarrow P_0$ ▷ cancellation
else if not $align(+1)$ **then**
$p_{17} = 2 \cdot SIDE - 1$ ▷ communicated via burst
end if
else if $p_9^{P1} \neq LEPT \wedge p_9^{P2} \neq LEPT \wedge p_9^{P1} \neq ANTILEPT \wedge p_9^{P2} \neq ANTILEPT$ **then**
$exchange()$ ▷ gluon-gluon interaction
else if $p_{16}^{P1} = p_{16}^{P1'} = BOUND \wedge p_7^{P2} = p_7^{P2'}$ **then**
reissue P_1 from $\overrightarrow{p}_0^{P1} - \overrightarrow{p}_2^{P1} + |\overrightarrow{p}_2^{P1}|\,\hat{p}_3^{P1}$
reissue P_2 from $\overrightarrow{p}_0^{P2} - \overrightarrow{p}_2^{P2} + |\overrightarrow{p}_2^{P1}|\,\hat{p}_3^{P1}$ ▷ neutrino inertia
end if.

Axiom 13. *The symmetry of LM is broken in one single direction by the value EXCESS.*

Axiom 14. *All preons occupy the same 3d address in the initial state of the universe. The charges are evenly distributed between the preons.*

3 Implementation notes

Remark 1. Isotropy and spherical wavefront generation are achieved applying the method described in Ref. [14]. The novel feature of that work is that, to obtain the isotropy, is required for each expansion step, executing n steps of the basic algorithm of the automaton, where n is two times the diameter of the universe D (space diagonal). The lattice speed is s and light speed c. Then we have the relation

$$s = 2\,D\,c.$$

In order to synchronize the preons forming a wavefront, each receives the value

$$t = \lceil 2D\,|p_2|\, + 0.5 \rceil.$$

Remark 2. A visit-once-tree (see Appendix) is used during preon expansion to avoid cell access conflicts. Burst conflict in the same layer due to multiple detection is solved by a look-ahead algorithm.

Remark 3. The time frame is segmented into two steps: one, when the bursts are active, has a duration of BURST time units. The other, when preons and gravitons are active, has a duration of 2D time units. The entire frame is termed SYNCH. This is to avoid undesired superposition of a preon wavefront with a burst or gravitons on a common layer (w address).

Remark 4. Some properties, e.g. sine wave and polarization, cannot be used directly, but must first be compared against a standard PWM sequence (see Definition 2.2), ruling out the need for an interaction detection mechanism based on an explicit pseudorandom number generator.

Remark 5. Additional numerical fields, besides those in Table 1, are necessary to implement the above mechanisms.

4 Discussion

4.1 Conservation laws

Preons are never created or destroyed—their number remains always SIDE. Electric, weak and strong charges are conserved. Spin and helicity are conserved as well. Angular momentum is conserved at the particle level. The other conservation laws are emergent features.

4.2 Conjectures

Based on the axiomatic body presented above, I state now some conjectures related to the expected behavior of the automaton.

Conjecture 1. *Clusters of Us and associated Ps tend to produce stable or transient patterns of HBAR/2 Us that I call* fermions. *This quantization effect is supported by Axiom 13 (equivalent to a Dirac monopole [15]) and by the closure of the universe.*

Conjecture 2. *The neutrino is a special fermion made of weakly charged Ps, carrying HBAR/2 units of orbital AM. Also,* $p_5^{\nu} = -1$, $p_5^{\overline{\nu}} = +1$, $\nu_e \equiv \nu_\mu \equiv \nu_\tau$.

Conjecture 3. *In a fermion, the spins tend to align either outward or inward, forming a spherically symmetric pattern. These states correspond to either spin up or spin down. This conjecture was inspired by the Hofer electron [16]. Coherence inhibits this tendency.*

Conjecture 4. *The magnetic effects of a still charge over another still charge cancels out due to spherical symmetry. Kinetic Ps can break the symmetry of the cloud, which passes into an oval configuration and consequently induces a magnetic dipole.*

Conjecture 5. *A fermion is in a superposition state when one part of the spins of its Us points inward while the other part points outward. The singlet correlations verified at the ensemble level are byproducts of superposition. Remember that a fermion is formed by a huge number of preons considering the distance between the atomic and Planck scales. 'Infinite' Hilbert spaces necessary for contextuality in QM are though supported by the automaton model.*

Conjecture 6. *Gravity is not quantized (adiabatic process).*

Conjecture 7. *Curved spacetime emerges from the combined action of preons.*

Conjecture 8. *If the alignment predicted in Axiom 11 happens in all Us of a particle, then the Ps merge into a vector boson and escape the influence of the charges, propagating away.*

Conjecture 9. *Quarks are emergent patterns formed inside hadrons, so are confined. These patterns tend to shrink to a point at higher LM.*

Conjecture 10. *Since leptons and hadrons are composite particles, they can possess radial vibration, like a pulsating sphere [17]. The muon is the first excited state of the electromagnetic radial vibrational state of the electron, the tauon is the second, so there is just one stable kind of charged lepton: the electron. For quarks, the charm is the first excited state of the strong radial vibrational state of the up. The top is the second radial vibrational state of the up. The strange is the first radial vibrational state of the down. The bottom is the second radial vibrational state of the down. The down is formed when the up captures a charged lepton. We, therefore, are led to conclude that there is just one kind of stable quark, the up. The W and Z bosons are weak analogous to the single (fundamental) mode. Therefore, the amount of Ps trapped in these resonance modes gives rise to the* rest mass *of the particles when they emit duo-gravitons in addition to the gravitons emitted by their Us.*

Conjecture 11. *Weak charged Us are always harvesting vacuum pairs (Axiom 11), causing radial vibration about the weak charges, in the form of virtual weak Ps, therefore, the vibrational patterns do not contribute to the particle's mass (virtual particle). This harvesting process results in collected Ps (radial vibration) which remain stable up to a threshold around 80 GeV. Unlike in the electromagnetic case, the only observable radial vibration mode is the fundamental one. This process can be hindered by other processes as well, that's why a neutron in the deuteron and in many other nuclei is stable. If there is enough AM available, the newly formed weak boson starts to propagate, escaping the influence of electric/weak charges ($p_{16}^{P} = p_{16}^{P'} = FREE$) of the Us (inverse or direct beta decay). This boson (whether real or virtual) is inherently unstable, so, a short time afterward, all weak Ps associated with this vibrational mode revert automatically to vacuum Ps.*

Conjecture 12. *When an interaction occurs, the wreak havoc caused by the reissue of preons results in the dissolution of the involved partners, organizing themselves immediately, probably, but not necessarily, in the same particles. This would explain, for example, spin flipping.*

Conjecture 13. *Preons are reissued at the contact point when the W particle interacts, settling into other combinations of particles. This helps to explain direct/inverse beta decay, for example.*

Conjecture 14. *Neutrino emission/absorption helps maintain the balance of AM.*

Conjecture 15. *The Us distribution is in the ratio of 3 quarks to 1 charged lepton. More precisely, 50% up quarks, 25% electrons and 25% down quarks.*

4.3 Bridge to quantum and classical mechanics

Can this theory attain classical mechanics in some suitable limit? The answer seems to be affirmative if it satisfies the three axioms presented by Scandolo et al. (see [18]).

Also, identifying the preons distribution within a particle with the phase-waves described by Unnikrishnan in [19], may solve the bridge to QM and CM in one stroke with further simplification of the model, mainly ruling out the enforced nonlocality.

5 Conclusion

The construction of a cellular automaton describing the basic laws of nature is a long-term goal, requiring the synergy of many researchers. In this contribution, I presented a tentative solution to the unification problem using a constructive approach, a framework for further investigation toward a full-fledged unification theory. The scenario is the *Planck World*. Can it be adjusted to enforce all natural symmetries (see [20]) and relativistic effects? The preliminary results obtained, already suggest a certain resemblance to QM, the SM and experimental data [16, 21–25]. The no-signaling principle is preserved. Conservation laws are mostly emergent characteristics. Since graviton emission is not conditioned to AM transfer, gravity is, in this sense, not quantized. The graviton mechanism adopted implies an arrow of time, thus preserving the second law from the beginning. The main result is that the mass spectrum can be calculated from first principles (see Conjecture 10).

Note that the term energy has not been used anywhere in the text. Far from being heresy, it simply means that it was not necessary to invoke it at this stage of the model's development, even though energy is an ill-defined concept in Physics. Clearly, this is a causal theory and therefore, according to Sec. 4.3, SBS states must be sought or enforced, in order to enable it to reach classical theory and account for macroscopic observers.

Except for assisting in the development of the basic mechanisms, the construction of such an automaton for directly solving cosmological problems, or even complex molecules, is inconceivable. Its complete usefulness will come through mathematical analysis in the approximation of large numbers ([26] being a possible starting point).

6 Compliance with ethical standards

The author declares that he has no conflict of interest.

7 Summary

This study received no funds.

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Appendix: Visit-once-tree

To avoid cell access conflict, the path of the expanding preon or burst must be tested using the pseudocode below:

```
▷ Tests whether the direction dir is a valid path in the visit-once-tree.
procedure isAllowed (dir, p, d0) begin
    x = p.x + dirs[dir].x
    y = p.y + dirs[dir].y
    z = p.z + dirs[dir].z
    level = abs(x) + abs(y) + abs(z)
    ▷ x-axis
    if x > 0 and y = 0 and z = 0 and dir = 0 then
        return true
    else if x < 0 and y = 0 and z = 0 and dir = 1 then
        return true
    end if
    ▷ y-axis
    else if x = 0 and y > 0 and z = 0 and dir = 2 then
        return true
    else if x = 0 and y < 0 and z = 0 and dir = 3 then
        return true
    end if
    ▷ z-axis
    else if x = 0 and y = 0 and z > 0 and dir = 4 then
        return true
    else if x = 0 and y = 0 and z < 0 and dir = 5 then
        return true
    end if
    ▷ xy plane
    else if x > 0 and y > 0 and z = 0 then
        if level mod 2 = 1 then
            return (dir = 0 and d0 = 2)
        else
            return (dir = 2 and d0 = 0)
        end if
    else if x < 0 and y > 0 and z = 0 then
        if level mod 2 = 1 then
            return (dir = 1 and d0 = 2)
        else
            return (dir = 2 and d0 = 1)
        end if
    else if x > 0 and y < 0 and z = 0 then
        if level mod 2 = 1 then
            return (dir = 0 and d0 = 3)
        else
            return (dir = 3 and d0 = 0)
        end if
    else if x < 0 and y < 0 and z = 0 then
        if level mod 2 = 1then
            return (dir = 1 and d0 = 3)
        else
            return (dir = 3 and d0 = 1)
        end if
    end if
    ▷ yz plane
```

```
else if x = 0 and y > 0 and z > 0 then
    if level mod 2 = 0 then
        return (dir = 4 and d0 = 2)
    else
        return (dir = 2 and d0 = 4)
    end if
else if x = 0 and y < 0 and z > 0 then
    if level mod 2 = 0 then
        return (dir = 4 and d0 = 3)
    else
        return (dir = 3 and d0 = 4)
    end if
else if x = 0 and y > 0 and z < 0 then
    if level mod 2 = 0 then
        return (dir = 5 and d0 = 2)
    else
        return (dir = 2 and d0 = 5)
    end if
else if x = 0 and y < 0 and z < 0 then
    if level mod 2 = 0 then
        return (dir = 5 and d0 = 3)
    else
        return (dir = 3 and d0 = 5)
    end if
end if
▷ zx plane
else if x > 0 and y = 0 and z > 0 then
    if level mod 2 = 1 then
        return (dir = 4 and d0 = 0)
    else
        return (dir = 0 and d0 = 4)
    end if
else if x < 0 and y = 0 and z > 0 then
    if level mod 2 = 1 then
        return (dir = 4 and d0 = 1)
    else
        return (dir = 1 and d0 = 4)
    end if
else if x > 0 and y = 0 and z < 0 then
    if level mod 2 = 1 then
        return (dir = 5 and d0 = 0)
    else
        return (dir = 0 and d0 = 5)
    end if
else if x < 0 and y = 0 and z < 0 then
    if level mod 2 = 1then
        return (dir = 5 and d0 = 1)
    else
        return (dir = 1 and d0 = 5)
    end if
else
▷ spirals
    x0 = x + SIDE/2
    y0 = y + SIDE/2
    z0 = z + SIDE/2
    switch level mod 3 do
```

```
        case 0
            if x_0 ≠ SIDE/2 and y_0 ≠ SIDE/2 then
                return (z_0 > SIDE/2 and dir = 4) or (z_0 < SIDE/2 and dir = 5)
            end if
            break
        case 1
            if y_0 ≠ SIDE/2 and z_0 ≠ SIDE/2 then
                return (x_0 > SIDE/2 and dir = 0) or (x_0 < SIDE/2 and dir = 1)
            end if
            break
        case 2
            if x_0 ≠ SIDE/2 and z_0 ≠ SIDE/2 then
                return (y_0 > SIDE/2 and dir = 2) or (y_0 < SIDE/2 and dir = 3)
            end if
            break
    end switch
  end if
  return false
end
```