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, quantum correlations and relativistic effects. Although essentially non-local, it preserves the non-signaling principle. This flexible model predicts that gravity is not quantized as well as the appearence of an arrow of time. 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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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. Wolfram [2], for instance, studied systematically the rules of one dimensional automata while G. 't Hooft and H.T. Elze studied them from a Hamiltonian perspective [5,6]. To my knowledge, my model is the first one that tries to directly model physics at the Planck scale.

Quantum field theory and general relativity are both, as we know, very accurate. One for the microcosm, the other for the macrocosm. But they do not fit well into Planck's scale, hence the search for a unifying theory. They are based on lagrangian / hamiltonian mechanics, where the masses of particles enter *ad hoc* into the equations. Many attempts were made to create this bridge, but to no avail.

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[1], and its most accepted interpretation is based on probabilities. The Special Relativity extension of QM, Quantum Field Theory (QFT), inherited the same limitations.

Recent results from experimental physics, which far surpass the precision achieved by QM predictions (but do not contradict it), require a new model of the universe in which QM and General Relativity (GR) are only limiting cases. Breaking with the *status quo* requires a completely different model, in which mass and energy are emerging quantities. My model boldly admits this possibility, though it has not reached maturity to become falsifiable yet. It's work in progress.

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.

This is an ontological model, not an epistemological model as QM. The great challenge of this line of thought is to restore the view of "gears and bolts" lost with the advent of QM. I eagerly expect that Maxwell's equations, for example, emerge from the preons patterns.

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. Whether nature in its core is granular or not is an open debate.

The cellular automaton approach is surrounded by skepticism. I invite the reader to keep his eyes wide open and set aside prejudices for a moment when analyzing this proposal. As one day Nobel laureate G. 't Hooft said: 'The cellular automaton is the only way out'.

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).

[1]Many authors treat particles in quantum mechanics as point-like structures. For Wigner, for instance, an idealized point-like event caused by a quantum particle is equally likely to occur at any one place as it is at another. Such a quantum particle might be said loosely to be nowhere in particular, insofar as we might be willing to say loosely that it's everywhere at once. This view does not compromise the uncertainty principle. Even in high energy physics, elementary particles, such as electrons and quarks are seen as points.

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	$0...SIDE-1$

Definition 3. The *cellular automaton* is a dual Euclidean lattice 4-torus of dimension SIDE[2], 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*[3] 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. They aren't acronyms but a convention used in programming languages where the names of the constants receive capitalized letters.

2.2 Auxiliary functions

These function definitions are used to clarify the axiomatic rules in the next Section:

▷ PWM mask
procedure *pwm*(n) **begin**

[2] A torus can be programatically seen as a hypercube lattice with periodic boundaries. As so, it is only necessary to specify one value, SIDE, to define it.

[3] The word preon was coined by Jogesh Pati and Abdus Salam in 1974. The theory does not predict the existence of preons. Rather they are the starting point. All fields, including the so commented lately Higgs Field itself are emergent patterns.

return $n \,\mathbf{mod}\, \sqrt{SIDE} < n/\sqrt{SIDE}$
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.

▷ 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 $light \,\mathbf{mod}\, cycle < cycle/sector$ **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.

$\triangleright$ Changes P to a kinetic P
procedure *kineticP*$(\overrightarrow{d}, P)$ **begin**
$\overrightarrow{p}^P_3 = \overrightarrow{p}^{P'}_3 = \overrightarrow{d}$; $\overrightarrow{p}^P_4 = \overrightarrow{p}^{P'}_4 = \overrightarrow{0}$; $p^P_{14} = p^{P'}_{14} = 0$;
end.

2.3 Dynamics[4]

The following axioms constitute the essence of this work:

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

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

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[5] preons interfere with each other.*

Axiom 3. *Decay of P*

$p^P_{17} = p^P_{17} \gg 1$
if $p^P_{17} = 0$ **then**
  if $p^P_{16} = BOUND$ **then**
    $p^P_{16} = FREE$ $\triangleright$ bound P is set free
  else if $p^P_8 = VIRTUAL \wedge \overrightarrow{p}^P_2 \bullet \overrightarrow{p}^P_4 = 1$ **then** $\triangleright$ the dot product singles out one brick
    $P \leftarrow P_0$; reissue P $\triangleright$ 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 $d = |\overrightarrow{p}_2| \bmod 2D$. 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: $p^1_{10} = p^2_{10} = w^1 w^2$; $\overrightarrow{p}^1_4 = -\overrightarrow{p}^2_4 = \overrightarrow{p}^1_4 \times \overrightarrow{p}^2_4$; $p^1_{18} = p^2_{18} = 0$.*

Axiom 6. *One brick of the wavefront of a real preon continues propagating as a G after the reissue, with spin $\overrightarrow{p}^G_4 = \overrightarrow{p}_2$.*

[4]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.

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

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**
  $kineticP\left(p_6^U p_6^P \left(\overrightarrow{p}_2^P - \overrightarrow{p}_2^U\right), P\right)$; $p_{14}^P = p_{14}^{P'} = 0$; ▷ 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*[6]*.*

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

3 Implementation notes

Implementation in this context means the construction of a practical computer program that will be replicated in each cell of the automaton to test its basic operations.

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 preon brick receives the value

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

Remark 2. A visit-once-tree (see Appendix) is used during preon and burst 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 Sec. 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.

[6] In the initial condition of the universe, there is a surplus of momentum directions favouring one direction (See Conjecture 1).

4 Discussion

4.1 Conjectures

Based on the axiomatic body presented above, I state now some conjectures related to the expected behavior of the automaton. To prove all these conjectures is beyond the capacity of the author. Community participation for this purpose is imperative.

Conjecture 1. *Clusters of Us and associated Ps tend to produce stable or transient patterns of HBAR/2 Us that I call* fermions *by direct analogy. 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 angular momentum (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 at the atomic scale. This conjecture was inspired by the Hofer electron [16].*

Conjecture 4. *The magnetic effects of a still charged particle over another still charged particle 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 (*10^{-12} *and* 10^{-33}*, respectively). The notion of 'Infinite' Hilbert spaces necessary for contextuality in QM is therefore supported by the automaton model.*

Conjecture 6. *Gravity is not quantized (adiabatic process). Gravitons don't carry LM or AM. They aren't spin 2 particles either. They are actually a teeny form of aggregating particles (cloud of preons).*

Conjecture 7. *Curved spacetime emerges from the combined interactions of preons in the universal canvas, the lattice.*

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 in this model leptons and hadrons are composite particles*[7]*, 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 strong 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 (See Def. 9 and 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.*

[7] It should be emphasized that in this work the only elementary objects are preons and bursts.

Conjecture 12. *When an interaction occurs, the wreak havoc caused by the reissue of preons results in the dissolution of the involved partners, reorganizing themselves immediately afterwards, probably (elastic scattering), but not necessarily (inelastic scattering), 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 in processes mediated by weak force.*

Conjecture 15. *Since the theory is strictly non-local, it dodges Bell's theorem, which applies only to local theories.*

Conjecture 16. *The graviton mechanism adopted implies an arrow of time, thus preserving the second law from the beginning.*

Conjecture 17. *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.*

Conjecture 18. *Bose-Einstein and Fermi-Dirac statistics form themselves from ensembles of preon clouds due to spin alignment.*

4.2 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. AM is conserved at the particle level. The other conservation laws are emergent features. Gravitons do not violate conservation of AM since there is no AM exchange involved. Since the model is finite, it implies the existence of a long Poincaré cycle where all patterns repeat themselves *ad infinitum*, including gravitons, so in this sense gravitons are also conserved.

4.3 The non-signaling principle

Def. 6 and Remark 3 imply that bursts propagate between each light step, so that they can be seen as superluminal, but nowhere does this open the possibility of carrying information, so the principle of non-signaling is preserved.

4.4 The uncertainty principle

Quantization of charge coupled with the way clouds of preons interact on the Planck scale are reflected in the measurements made on the subatomic scale as an uncertainty in complementary quantities such as position and momentum, always involving HBAR Us.

4.5 Quantum correlations and entanglement

The intrinsic entanglement postulated at the Planck scale reflects itself as quantum correlations and entanglement at the ensemble level.

4.6 Quantum gravity

The already extensive quest for the quantization of gravity (refs.) becomes dispensable in view of the adiabatic method presented in this paper.

4.7 Bridge to quantum and classical mechanics

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

In addition, identifying the distribution of preons within a particle with the phase waves described by Unnikrishnan in [19], may perhaps solve the bridge for QM and CM with additional simplification of the model.

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*, where preons never stop, forming fancy patterns. 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 non-signaling principle is preserved. Conservation laws are mostly emergent characteristics. Since graviton emission is not conditioned to AM transfer, gravity is not quantized. The existence of an arrow of time preserves the second law. 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 defined 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. 4.7, 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 (Ref. [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.

References

[1] K. Zuse *Rechnender Raum*, Elektronische Datenverarbeitung, 8, 336-344 (1967).

[2] S. Wolfram *A New Kind of Science*, Wolfram Media, {23-60}, 112, and 865-866 (2002).

[3] M. Gardner *The fantastic combinations of John Conway's new solitaire game "life"*, Sci. Am. 223, 120-123 (1970).

[4] T. Ostoma, M. Trushyk *Cellular automata theory and physics*, arXiv: 9907013v1 (1999).

[5] G. 't Hooft *The fate of the quantum*, arXiv: 1308.1007v1 (2013).

[6] H.T. Elze *Action principle for cellular automata and the linearity of quantum mechanics*, Phys. Rev. A **89** 012111 (2014).

[7] A. Sciarretta *A discrete spacetime model for quantum mechanics*, arXiv: 1506.00817v1 (2015).

[8] Fredkin, Edward *An Introduction to Digital Philosophy.* Int. J. Theor. Phys. 42 (2): 189–247 (2003).

[9] Y. Ozhigov *Constructive physics*, arXiv: 0805.2859 (2008).

[10] V.V. Kornyak *Discrete dynamical models: combinatorics, statistics and continuum approximations*, arXiv: 1501.07356 (2015).

[11] P. Symons *Digital waveform generation*, Cambridge University Press (2014).

[12] G.N. Mardari *What Is A Quantum Really Like?*, AIP Conf. Proc. vol **810** p 360 (2006).

[13] J.G. Richens, J.H. Selby and S.W. Al-Safi *Entanglement is necessary for emergent classicality*, arXiv: 1705.08028v1 (2017).

[14] J. Case, D. Rajan, A. Shende *Spherical wave front generation in lattice computers*, Int.J.Comput.Inf. (1994).

[15] P.A.M. Dirac *Quantized singularities in the electromagnetic field*, Proc.Royal Soc. London A 133 60-72 (1931).

[16] W.A. Hofer *Elements of physics for the 21st century*, J. Phys.: Conf. Ser. 504, 012014 (2014).

[17] D. Itô *Cohesive force of electron and Nambu's mass formula*, Prog. Theor. Phys. **47**, no. 3 (1972).

[18] C.M. Scandolo et al. *Is it possible to be objective in every physical theory?*, arXiv: 1805.12126v1 (2018).

[19] C.S. Unnikrishnan *Reconstructing quantum mechanics without foundational problems*, arXiv: 1812.06088v1, (2018).

[20] P. Arrighi, G. Di Molfetta, N. Eon *A gauge-invariant reversible cellular automaton*, arXiv: 1802.07644 (2018).

[21] V. Bagnulo *Deep Inelastic Scattering*, Thesis 38.4001/6, The University of Winnipeg (2006).

[22] D.J. Griffiths *Introduction to Quantum Mechanics*, Prentice-Hall, p. 155. (1995).

[23] F.O. Durães, F.S. Navarra, G. Wilk *The interacting gluon model: a review*, Braz. J. Phys., vol. **35**, pp. 3-23 (2005).

[24] F. Mandl and G. Shaw *Quantum Field Theory*, John Wiley and Sons (1984).

[25] G. Rajasekaran *Fermi and the theory of weak interactions*, arXiv: 1403.3309 (2014).

[26] M. Frasca, A. Farina *Parcels of universe or why Schrodinger and Fourier are so relatives*, arXiv: 1804.05204, (2018).

Appendix: Visit-once-tree

To avoid cell access conflict (see Remark 2), 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 $level \bmod 2 = 0$ **then**
        return ($dir = 4$ **and** $d_0 = 2$)
    else
        return ($dir = 2$ **and** $d_0 = 4$)
    end if
else if $x = 0$ **and** $y < 0$ **and** $z > 0$ **then**
    if $level \bmod 2 = 0$ **then**
        return ($dir = 4$ **and** $d_0 = 3$)
    else
        return ($dir = 3$ **and** $d_0 = 4$)
    end if
else if $x = 0$ **and** $y > 0$ **and** $z < 0$ **then**
    if $level \bmod 2 = 0$ **then**
        return ($dir = 5$ **and** $d_0 = 2$)
    else
        return ($dir = 2$ **and** $d_0 = 5$)
    end if
else if $x = 0$ **and** $y < 0$ **and** $z < 0$ **then**
    if $level \bmod 2 = 0$ **then**
        return ($dir = 5$ **and** $d_0 = 3$)
    else
        return ($dir = 3$ **and** $d_0 = 5$)
    end if
end if
$\triangleright$ zx plane
else if $x > 0$ **and** $y = 0$ **and** $z > 0$ **then**
    if $level \bmod 2 = 1$ **then**
        return ($dir = 4$ **and** $d_0 = 0$)
    else
        return ($dir = 0$ **and** $d_0 = 4$)
    end if
else if $x < 0$ **and** $y = 0$ **and** $z > 0$ **then**
    if $level \bmod 2 = 1$ **then**
        return ($dir = 4$ **and** $d_0 = 1$)
    else
        return ($dir = 1$ **and** $d_0 = 4$)
    end if
else if $x > 0$ **and** $y = 0$ **and** $z < 0$ **then**
    if $level \bmod 2 = 1$ **then**
        return ($dir = 5$ **and** $d_0 = 0$)
    else
        return ($dir = 0$ **and** $d_0 = 5$)
    end if
else if $x < 0$ **and** $y = 0$ **and** $z < 0$ **then**
    if $level \bmod 2 = 1$**then**
        return ($dir = 5$ **and** $d_0 = 1$)
    else
        return ($dir = 1$ **and** $d_0 = 5$)
    end if
else
$\triangleright$ spirals
    $x_0 = x + SIDE/2$
    $y_0 = y + SIDE/2$
    $z_0 = z + SIDE/2$
    switch level **mod** 3 **do**

case 0
  if $x_0 \neq SIDE/2$ **and** $y_0 \neq SIDE/2$ **then**
    return $(z_0 > SIDE/2$ **and** $dir = 4)$ **or** $(z_0 < SIDE/2$ **and** $dir = 5)$
  end if
  break
case 1
  if $y_0 \neq SIDE/2$ **and** $z_0 \neq SIDE/2$ **then**
    return $(x_0 > SIDE/2$ **and** $dir = 0)$ **or** $(x_0 < SIDE/2$ **and** $dir = 1)$
  end if
  break
case 2
  if $x_0 \neq SIDE/2$ **and** $z_0 \neq SIDE/2$ **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