Programming relativity and gravity via a discrete pixel space in Planck level Simulation Hypothesis models

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Outlined here is a programming approach for use in Planck level simulation hypothesis models. It is based around an expanding (the simulation clock-rate measured in units of Planck time) 4-axis hyper-sphere and mathematical particles that oscillate between an electric wave-state and a mass (unit of Planck mass per unit of Planck time) point-state. Particles are assigned a spin axis which determines the direction in which they are pulled by this (hyper-sphere pilot wave) expansion, thus all particles travel at, and only at, the velocity of expansion (the origin of c), however only the particle point-state has definable co-ordinates within the hyper-sphere. Photons are the mechanism of information exchange, as they lack a mass state they can only travel laterally (in hypersphere co-ordinate terms) between particles and so this hypersphere expansion cannot be directly observed, relativity then becomes the mathematics of perspective translating between the absolute (hypersphere) and the relative motion (3D space) co-ordinate systems. A discrete 'pixel' lattice geometry is assigned as the gravitational space. Units of $\hbar c$ 'physically' link particles into orbital pairs. As these are direct particle to particle links, a gravitational force between macro objects is not required, the gravitational orbit as the sum of these individual orbiting pairs. A 14.6 billion year old hyper-sphere (the sum of Planck black-hole units) has similar parameters to the cosmic microwave background. The Casimir force is a measure of the background radiation density.

1 Introduction

It was proposed in an article on the mathematical electron [1] that the Planck units for mass, length, time and charge could be constructed as geometrical objects (notes, fig.24) as per mathematical universe hypothesis, yet these objects would arguably be indistinguishable from the mass, length, time and charge of the physical universe, thus laying a theoretical basis for the universe as a simulation where the Planck units are mathematical structures at the Planck level. In this article, part II, the mathematical particle is embedded within an expanding hyper-sphere black-hole 'universe' whereby relativity and gravity are introduced as naturally emerging properties of underlying particle geometries.

The sum universe is a 4-axis hyper-sphere expanding in incremental discrete Planck units, this expansion as the origin of Planck-time (the simulation clock-rate), the arrow of time, velocity c (the velocity of expansion) and particle motion.

The mathematical particle oscillates between an electric wave-state and a (unit of Planck mass per unit of Planck time) mass point-state.

In section 2, the particles are pulled along by this (pilot-wave) hyper-sphere expansion according to their spin axis. In hypersphere co-ordinates all particles travel at, and only at, the speed of expansion c, however information between them is exchanged via electro-magnetic waves, these, being mass-less are restricted to lateral motion within this hyper-sphere resulting in an observable 3-D space of relativistic motion, relativity as the mathematics of perspective translating between these 2 co-ordinate systems.

In section 3, all particles that are simultaneously in the mass point-state for any given unit of (Planck) time are linked to each other to form orbital pairs (analogous to atomic orbitals) as units of $\hbar c$ within a discrete pixel lattice gravitational space.

The gravitational orbit is the sum of these underlying orbital pairs.

In section 4, the simulation clock-rate is measured in discrete points (comprising the Planck units). Although measured in constant increments, a 14.6 billion year old Planck black-hole has similar parameters to the cosmic micro-wave background.The Casimir force equates to the background radiation energy density.

2 Relativity

2.1. Wave-mass duality

In an article on a mathematical electron [1], localized Planck units may emerge from a unit-less mathematical electron (see notes) oscillating between an electric wave-state (duration = electron frequency in units of Planck time) and a unit of Planck-mass (per 1 unit of Planck-time) point-state. This oscillation is driven by the expansion of the hyper-sphere pilot-wave.

2.2. Space-time

Particle A is mapped onto a space-time graph (fig.1). A does not move in space ($v = 0$), but it does move in time.

Particle B, $v = 0.866c$ is added (fig.2). After 1s B

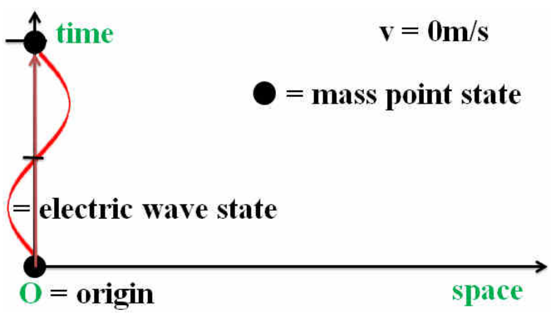

Fig. 1: particle A, v = 0

will have traveled 0.866 x 299792458 = 259620km from A along the horizontal space axis.

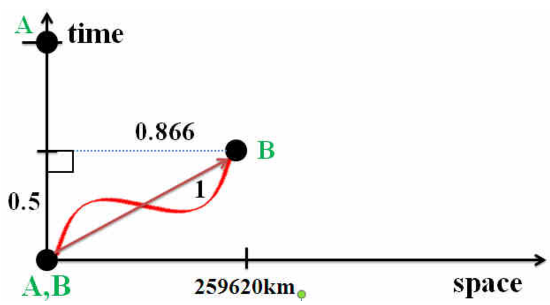

Fig. 2: particle B, v = 0.886c

Particles A and B both have a frequency = 6; $5t_p$ in the electric wave-state then $1t_p$ in the Planck mass point-state. As the A point-state occurs once every $6t_p$, mass of A $m_A = m_P/6$, however the point-state of B occurs after $3t_p$ along the A time-line and so $m_B = m_P/3$ (fig.3).

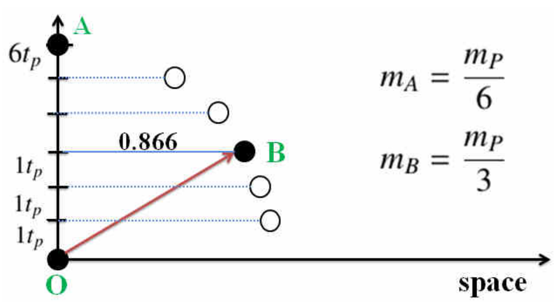

Fig. 3: particle B, relative mass

As each step on the time axis involves a $1t_p$ step, there are 6 possible velocity solutions, this also means that m_B can attain m_P, but B ($v = v_{max}$, $m_B = m_P$, fig.4) can never attain the (horizontal axis) velocity c.

The vertical axis would be measured as $1/\gamma$. For a particle that has only 6 divisions (6 steps from point to

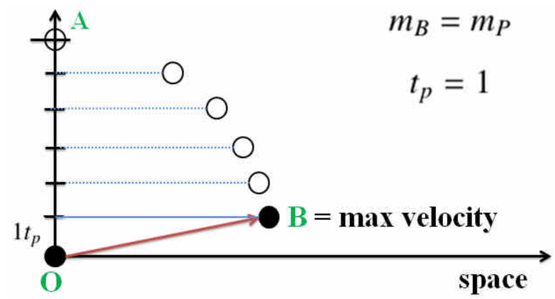

Fig. 4: particle B, maximum velocity

point), the maximum $\gamma = 6$. To determine the maximum velocity that a particle can attain (y-axis = v/c) we simply calculate when that particle will have reached Planck mass, because from there it can go no faster. A small particle such as an electron has more divisions and so a higher γ and so can go faster in 3-D space than a larger particle such as a proton with a smaller γ (a smaller number of divisions).

$$\frac{1}{\gamma} = \sqrt{1 - \frac{v^2}{c^2}} \tag{1}$$

$$\gamma_{electron} = m_P/m_e, \gamma_{proton} = m_P/m_p$$

2.3. Hyper-sphere

2.3.1. Replacing the above with a 4-axis co-ordinate system, to illustrate are shown (h, x) axis with particles represented as semi-circles (cross-section). Depicted is particle B at some arbitrary universe time t. B begins at origin O and is pulled along by the hyper-sphere pilot wave expansion (fig.5, 6, 7).

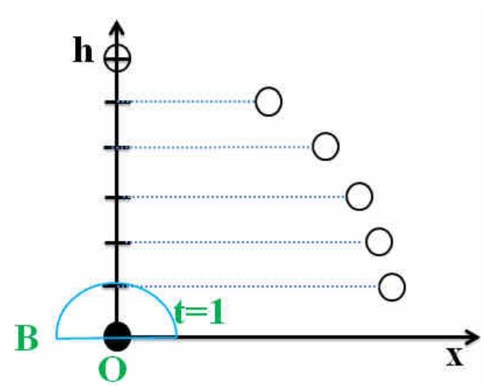

Fig. 5: $t = 1$

At $t = 6$, B collapses into the mass point state and has defined co-ordinates within the hypersphere (fig.8) which

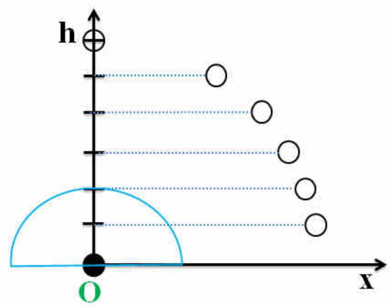

Fig. 6: t = 2

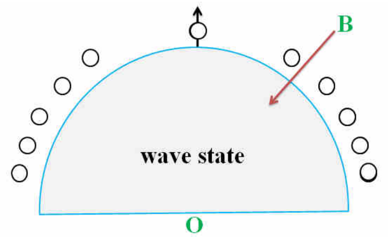

Fig. 7: t = 5

then becomes the new origin O', the above repeating ad infinitum t = 7, 8, ... (fig.9, 10).

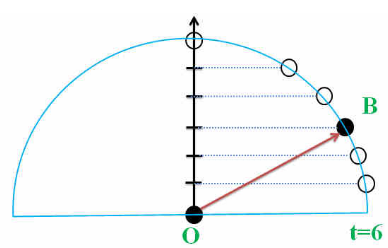

Fig. 8: t = 6, point-state

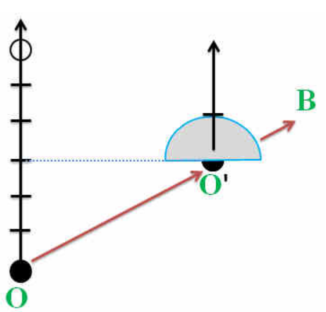

Fig. 9: t = 6+1

The process also repeats for A (fig.11). The universe hypersphere itself is then analogous to a particle presently in the wave-state whose origin O was the big bang.

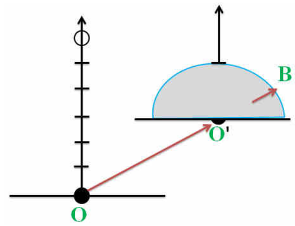

Fig. 10: t = 6+2

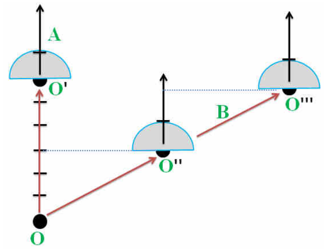

Fig. 11: Origin points; A, B

2.3.2. In the space-time diagram (fig.3) was depicted for A; $v = 0$, $m_A = m_P/6$ and for B; $v = 0.866c, m_B = m_P/3$. However in the (h, x) graphs we find that as A and B have the same frequency, $f = 6$, the lengths OA = OB = 6, this is because the hyper-sphere expands radially. As a consequence B can rightly claim that it is A whose velocity is at $v = 0.866c$ and for B velocity $v = 0$ (fig.12).

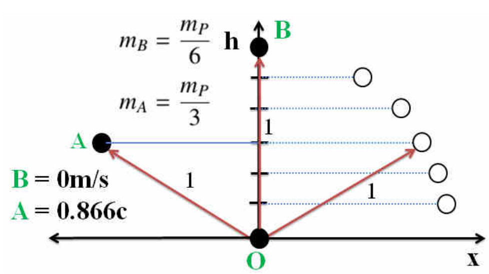

Fig. 12: relative mass B to A

Both A and B are traveling at the speed of expansion (which translates to c) from the origin O. In the virtual coordinate system everything travels at, and only at, the speed of expansion as this is the origin of all motion, particles and planets do not have any inherent motion of their own, they are simply pulled along by this expansion.

After 1 second both A and B will therefore have traveled the equivalent of 299792458m in virtual co-ordinates from origin O (fig.13). Each of the 11 depicted solutions are equally valid as the radii are the same.

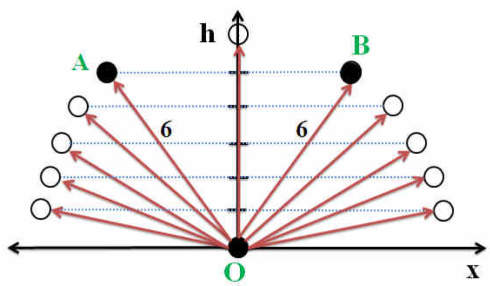

Fig. 13: radial expansion

2.3.3. Particles are assigned an N-S spin axis (fig.14). As the universe expands, it stretches particle A (position and motion of the wave-state are undefined). When $t = 6$, the wave-state collapses to the defined point-state, as determined by the N. This means that of all the possible solutions, it is the particle N-S axis which determines where the point-state will actually occur, with the hyper-sphere acting as a pilot-wave.

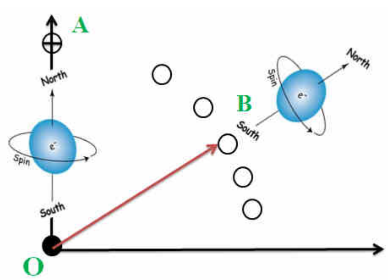

Fig. 14: N-S axis; A v = 0, B v = 0.886c

Thus if we can change the N-S axis angle of B compared to A, then as the universe expands the B wave-state will be stretched as with A. But the point of collapse will now reflect the new N-S axis angle. B does not need to have an independent motion; B is simply being dragged by the universe in a different direction as the universe expands. We can thus simulate a transfer of physical momentum to B by simply changing the N-S axis. The radial universe expansion does the rest.

2.3.4. Information between particles is exchanged by photons. Photons do not have a mass point-state, only a wave-state and so have no means to travel the time-line axis (they are 'time-stamped', i.e.: a photon reaching us from the sun is 8 mins old). Instead they travel horizontally (and thus at the speed of light in 3-D space). The period required for particles to emit and to absorb photons is proportional to wavelength. In the following diagram (fig.15) A emits a photon. B travels towards A, as such it will take B less time to absorb that photon than if B was parallel to or moving away from A. If the x-axis length $x = v/c$, then the h-axis length $h = \sqrt{1^2 - x^2}$ and the common relativistic Doppler equation can be written;

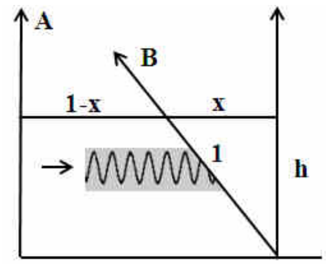

Fig. 15: Doppler shift

$$v_{observed} = v_{source} . \frac{\sqrt{1 - \frac{v^2}{c^2}}}{1 - \frac{v}{c}} = v_{source} . \frac{h}{1 - x} \quad (2)$$

$E_{wave} = hv$ applies to both particle and photon wave states but E_{mass} applies only to the particle mass point-state. For each particle oscillation there is 1 Planck-energy wave-state followed by 1 Planck-mass point-state; and thus $E_{wave} = E_{mass}$, however as particle mass is the average frequency of occurrence of units of Planck mass then the formula $E = mc^2$ in the context of this model cannot be used as $E = mc^2$ requires particles to have a constant property defined as mass [2].

2.3.5. Returning to our ABC particles, if photons (information) can only be exchanged along the horizontal axis which are the (x, y, z) axis, ABC will only 'see' this horizontal information if ABC relies on the electromagnetic spectrum. Instead of virtual co-ordinates OA, OB and OC and a constant time and velocity, the (x, y, z) axis will be able to measure only the horizontal AB, BC and AC (fig.16) as a 3-D space.

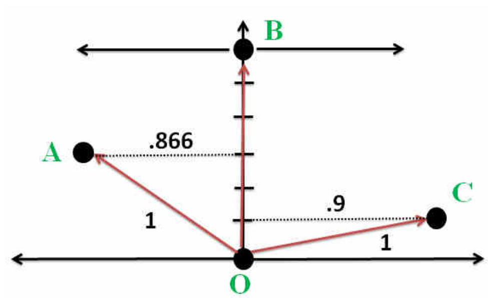

Fig. 16: 3-axis hyper-sphere surface

As for ABC there is no 'depth' (time-line axis) perception, particle space will appear as a 3D surface phenomena of a hyper-sphere that has a dimension-less interior leading to the singularity paradox.

Furthermore time for ABC translates as motion, if there is no motion in the (x, y, z) axis there will be no means to measure time, thus although the dimension of time for the 3-D space ABC world derives from the expansion of the universe (the universe clock-rate, as measured in units of Planck time) and may equate to universe time, it is actually a measure of particle motion (a change of information states).

3 Gravitational Orbitals

As particles are treated as oscillations between an electric wave-state (the particle frequency) to a discrete unit of Planck-mass (at unit Planck-time) mass point-state, mass is not treated as a constant property of the particle, consequently for objects whose mass is less than Planck mass there will be units of Planck time when the object has no particles in the point-state and so no mass.

Gravity is treated as a (unit of) Planck-mass to (unit of) Planck-mass (particle to particle) interaction and so is also not a constant property but rather a discrete event, the magnitude of the gravitational interaction per unit time approximating the magnitude of the strong force, the gravitational coupling constant representing a measure of the frequency of these interactions and not the magnitude of the gravitational force itself.

Each particle that is in the mass point-state per unit of Planck time is linked to every other particle simultaneously in the mass point-state by a unit of $\hbar c$ (defined here as a gravitational orbital) forming a complex of discrete particle-particle orbital pairs. The velocity of a gravitational orbit is summed from these individual orbital velocities. Gravitational potential and kinetic energies are a measure of the alignment of these orbitals..

Orbital angular momentum of the planetary orbits derives from the sum of the planet-sun particle-particle orbital angular momentum irrespective of the angular momentum of the sun itself and the rotational angular momentum of a planet includes particle-particle rotational angular momentum.

As orbits are the result of summed particle-particle orbital pairs, information regarding macro orbiting objects is not required.

3.1 Gravitational coupling constant

The gravitational coupling constant α_G characterizes the gravitational attraction between a given pair of elementary particles in terms of the electron mass to Planck mass ratio;

$$\alpha_G = \frac{Gm_e^2}{\hbar c} = \frac{m_e^2}{m_P^2} = 1.75...x10^{-45} \tag{3}$$

If particles oscillate between an electric wave-state to Planck-mass (for 1 unit of Planck-time) point-state then at any discrete unit of Planck time a number of particles in the universe will simultaneously be in the mass point-state. For example a 1kg satellite orbits the earth, for any t, satellite (A) will have $1kg/m_P = 45.9\ x10^6$ particles in the point-state. The earth (B) will have 5.97 $x10^{24}kg/m_P = 0.274\ x10^{33}$ particles in the point-state. For any given unit of Planck time the number of links between the earth and the satellite will sum to;

$$N_{links} = \frac{m_A m_B}{m_P^2} = 0.126\ x10^{41} \tag{4}$$

If A and B are respectively Planck mass particles then $N = 1$. If A and B are respectively electrons then the probability that any 2 electrons are simultaneously in the mass point-state for any chosen unit of Planck time becomes $N = \alpha_G$ and so a gravitational interaction between these 2 electrons will occur only once every 10^{45} units of Planck time.

3.2 Planck unit formulas

(inverse) fine structure constant $\alpha = 137.03599...$
n_p = pixel number (fig. 17, 18)
m_P = Planck mass
λ_{object} = Schwarzschild radius

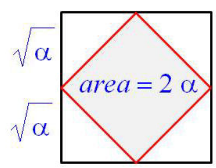

Fig. 17: alpha pixel, $n_p = 1$

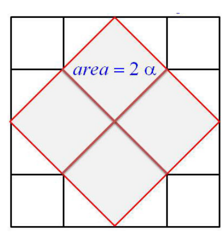

Fig. 18: lattice geometry, $n_p = 2$

Between 2 rotating point mass
orbital radius

$$r = 2\alpha {n_p}^2 l_p \tag{5}$$

orbital velocity

$$v = \frac{c}{\sqrt{2\alpha} n_p} \tag{6}$$

Between objects A and B (mass $M_A >> M_B$)
${n_p}^*$ = average n_p (average of all particle to particle links between A and B)

N_{points} = number of particles in the Planck mass point-state per unit of Planck time

$$N_{points} = \frac{M_A}{m_P} \tag{7}$$

n_g = analogous to the principal quantum number n

$$n_g = \frac{{n_p}^*}{\sqrt{N_{points}}} \tag{8}$$

pixel aggregate

$$d = \frac{(\sqrt{2\alpha})n_p^*}{\sqrt{N_{points}}} = (\sqrt{2\alpha})n_g \tag{9}$$

We can now define a set of base Planck orbital units (where $\sqrt{d^2-1}$ is the relativistic term, 3.4.1) from which we derive $\hbar$;

$$M_o L_o V_o = \hbar$$

$$M_o = \frac{m_P\sqrt{d^2-1}}{Nd^2}, (mass) \tag{10}$$

$$L_o = d^2 N l_p, (length) \tag{11}$$

$$V_o = \frac{c}{\sqrt{d^2-1}}, (velocity) \tag{12}$$

For any given distance $L_o = r_g$, the pixel number n_p can support multiple units of Planck mass and so r_g can be treated as analogous to atomic energy levels. When n_g = 1 that n_p level is full and additional units of Planck mass will go to the next n_p level (fig. 19).

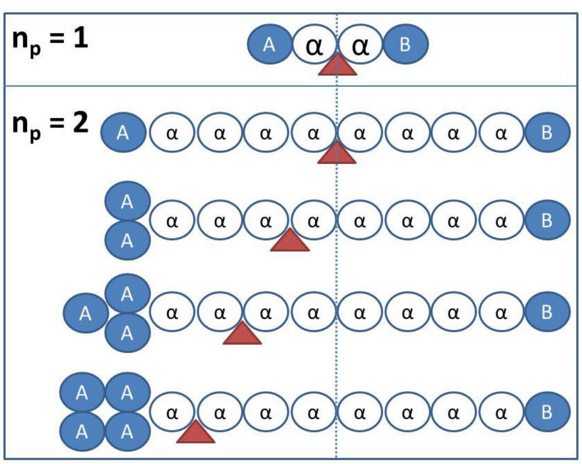

Fig. 19: orbital levels with barycenter

converting to Schwarzschild radius

$$r_g = d^2 N_{points} l_p = \alpha n_g^2 \lambda_M \tag{13}$$

gravitational orbit velocity from summed point velocities

$$v_g = \sqrt{N_{points}} v = \frac{c}{d} = \frac{c}{\sqrt{2\alpha} n_g} \tag{14}$$

gravitational acceleration

$$a_g = \frac{v_g^2}{r_g} \tag{15}$$

gravitational orbital period

$$T_g = \frac{2\pi r_g}{v_g} \tag{16}$$

orbital angular momentum

$$L_{oam} = N_{links} n_g \frac{h}{2\pi}\sqrt{2\alpha} \tag{17}$$

rotational angular momentum

$$L_{ram} = (\frac{2}{5}) N_{links}\ n_{rot} \frac{h}{2\pi} \tag{18}$$

3.2.1 Example - Earth orbits

$$N_{points} = \frac{M_{earth}}{m_P} \tag{19}$$

Earth surface orbits
- $r_g = 6371.0\ km$
- $a_g = 9.820\ m/s^2$
- $T_g = 5060.837\ s$
- $v_g = 7909.792\ m/s$

Geosynchronous orbit
- $r_g = 42164.0\ km$
- $a_g = 0.2242\ m/s^2$
- $T_g = 86163.6\ s$
- $v_g = 3074.666\ m/s$

Moon orbit (d = 84600s)
- $r_g = 384400\ km$
- $a_g = .0026976\ m/s^2$
- $T_g = 27.4519\ d$
- $v_g = 1.0183\ km/s$

3.2.2. Example - Planetary orbits

$$N_{points} = \frac{M_{sun}}{m_P} \tag{20}$$

mercury $r_g = 57\ (10^9)m, T_g = 87.969d, v_g = 47.87$km/s
venus $r_g = 108\ (10^9m, T_g = 224.698d, v_g = 35.02$km/s
earth $r_g = 149\ (10^9)m, T_g = 365.26d, v_g = 29.78$km/s
mars $r_g = 227\ (10^9)m, T_g = 686.97d, v_g = 24.13$km/s
jupiter $r_g = 778\ (10^9)m, T_g = 4336.7d, v_g = 13.06$km/s
pluto $r_g = 5.9\ (10^{12})m, T_g = 90613.4d, v_g = 4.74$km/s

The energy required to lift a 1kg satellite into a geosynchronous orbit is the difference between the energy of each of the 2 orbits (geosynchronous and earth).

$$E_{orbital} = \frac{hc}{2\pi r_{6371}} - \frac{hc}{2\pi r_{42164}} \tag{21}$$

$$N_{links} = (M_{earth}m_{satellite})/m_P^2 = 0.126x10^{41}$$
$$E_{total} = E_{orbital}N_{links} = 53MJ/kg$$

3.3. Angular momentum

$$N_{sun} = \frac{M_{sun}}{m_P} \quad (22)$$

$$N_{planet} = \frac{M_{planet}}{m_P} \quad (23)$$

$$N_{links} = N_{sun}N_{planet} \quad (24)$$

3.3.1 Orbital angular momentum L_{oam}

$$L_{oam} = 2\pi\frac{Mr^2}{T} = N_{sun}N_{planet}\frac{h}{2\pi}\sqrt{\frac{2\alpha}{N_{sun}}}n_p$$
$$= N_{links}\ n_g\frac{h}{2\pi}\sqrt{2\alpha},\ \frac{kgm^2}{s} \quad (25)$$

The orbital angular momentum of the planets is independent of the orbital angular momentum of the sun.

mercury = .9153 x10^{39}
venus = .1844 x10^{41}
earth = .2662 x10^{41}
mars = .3530 x10^{40}
jupiter = .1929 x10^{44}
pluto = .365 x10^{39}

Orbital angular momentum combined with orbit velocity cancels n giving an orbit constant. Adding momentum to an orbit will therefore result in a greater distance of separation and a corresponding reduction in orbit velocity accordingly.

$$L_{oam}v_g = N_{links}\frac{hc}{2\pi},\ \frac{kgm^3}{s^2} \quad (26)$$

3.3.2 Rotational angular momentum L_{ram}

$$N_{links} = (N_{planet})^2 \quad (27)$$

Rotational angular momentum contribution to planet rotation.

$$v_{rot} = \sqrt{N_{points}}\frac{c}{2\alpha n_p} = \frac{c}{2\alpha n_{rot}} \quad (28)$$

$$T_{rot} = \frac{2\pi r}{v_{rot}} \quad (29)$$

$$L_{ram} = (\frac{2}{5})\frac{2\pi Mr^2}{T} = (\frac{2}{5})N_{links}\ n_{rot}\frac{h}{2\pi},\ \frac{kgm^2}{s} \quad (30)$$

Earth (r = 6371km, n = 2289.4)
$T_{rot} = 83847.7s$ (86400 *observed*)
$v_{rot} = 477.8m/s$ (463.3)
$L_{ram} = .727\ x10^{34}\ \frac{kgm^2}{s}$ (.705)
Mars (r = 3390km, n = 5094.7)
$T_{rot} = 99208s$ (88643)
$v_{rot} = 214.7m/s$ (240.29)
$L_{ram} = .187\ x10^{33}\frac{kgm^2}{s}$ (.209)

Rotational angular momentum combined with v_{rot}

$$L_{ram}v_{rot} = (\frac{2}{5})N_{links}\ \frac{hc}{2\pi 2\alpha},\ \frac{kgm^3}{s^2} \quad (31)$$

3.4. Orbital plane rotation

3.4.1 Relativistic orbits In section 2., objects are pulled along by the expansion of the hyper-sphere irrespective of any motion in 3-D space. As such, while B (satellite) has a circular orbit in 3-D space co-ordinates, it follows a cylindrical orbit (from B' to B'') around the A (planet) time-line axis in hyper-sphere co-ordinates. If A is moving with the universe expansion (albeit stationary in 3-D space) then t_d naturally emerges along the A time-line axis (fig. 20). B is traveling at the speed of light in this cylindrical orbit in incremental steps, but this is obscured when measured along a circular plane.

$$t_o = \frac{2\pi r_g}{c} \quad (32)$$

$$t_d = T_g\sqrt{1-\frac{v_g^2}{c^2}} = \sqrt{T_g^2 - t_o^2} = t_o\sqrt{d^2-1} \quad (33)$$

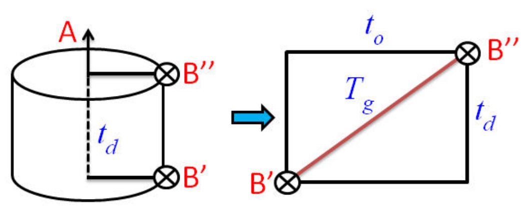

Fig. 20: B's orbit relative to A's time-line axis

For the orbital angular momentum example where $d = d_{sun}$;

$$M_oL_oV_o = \hbar \quad (34)$$

$$L_{oam} = N_{links}\hbar\sqrt{d^2-1},\ \frac{kgm^2}{s} \quad (35)$$

3.4.2 Precession

We can account for the discrepancy between t_d and T_g by combining the velocities of B (v_g) with the A-B cylindrical orbital plane (v_{plane}).

$$v_{plane} = \frac{c}{2(\sqrt{2\alpha})^3n_g^3} \quad (36)$$

$$t_d = \frac{2\pi r_g}{(v_g + v_{plane})} = T_g - \frac{\pi\sqrt{2\alpha}n_gNl_p}{c} \quad (37)$$

The ellipticity of the B orbit around A
semi-minor axis: $b = \alpha l^2\lambda_{sun}$

semi-major axis: $a = \alpha n^2 \lambda_{sun}$
radius of curvature L:

$$L = \frac{b^2}{a} = \frac{al^4 \lambda_A}{n^2} \tag{38}$$

$$\frac{3\lambda_A}{2L} = \frac{3n^2}{2\alpha l^4} \tag{39}$$

Combining L with v_{plane} gives the precession :

$$T_{precession} = \frac{4\pi\sqrt{2\alpha}\alpha^2 n l^4 \lambda_{sun}}{3c} \tag{40}$$

1296000 arc secs:
Mercury $T_{precession}$ = 3 015 373 yrs
Earth $T_{precession}$ = 33 763 000 yrs
arc secs per 100 years:
Mercury = 42.9814
Venus = 8.6248
Earth = 3.8388
Mars = 1.3510
Jupiter = 0.0623

3.5. F_p = Planck force;

$$F_p = \frac{m_P c^2}{l_p}$$

$$M_a = \frac{m_P \lambda_a}{2l_p},\ m_b = \frac{m_P \lambda_b}{2l_p} \tag{41}$$

$$F_g = \frac{M_a m_b G}{R^2} = \frac{\lambda_a \lambda_b F_p}{4R_g^2} = \frac{\lambda_a \lambda_b F_p}{4\alpha^2 n^4 (\lambda_a + \lambda_b)^2} \tag{42}$$

a) $M_a = m_b$

$$F_g = \frac{F_p}{(4\alpha n^2)^2} \tag{43}$$

b) $M_a >> m_b$

$$F_g = \frac{\lambda_b F_p}{(2\alpha n^2)^2 \lambda_a} = \frac{m_b c^2}{2\alpha^2 n^4 \lambda_a} = m_b a_g \tag{44}$$

3.6 Orbital transition

Atomic electron transition is the change of an electron from one energy level to another. The following redefines the Rydberg formula in terms of 'physical' orbitals, where transition is an orbital replacement, the electron plays no role.

Consider the Hydrogen Rydberg formula for transition between and initial i and a final f orbit. The incoming photon λ_R causes the electron to 'jump' from the $n = i$ to $n = f$ orbit.

$$\lambda_R = R.(\frac{1}{n_i^2} - \frac{1}{n_f^2}) = \frac{R}{n_i^2} - \frac{R}{n_f^2} \tag{45}$$

The above can be interpreted as referring to 2 photons;

$$\lambda_R = (+\lambda_i) - (+\lambda_f)$$

Let us suppose a region of space between a free proton p^+ and a free electron e^- which we may define as zero. This region then divides into 2 waves of inverse phase which we may designate as photon $(+\lambda)$ and anti-photon $(-\lambda)$ whereby

$$(+\lambda) + (-\lambda) = zero$$

The photon $(+\lambda)$ leaves (at the speed of light), the anti-photon $(-\lambda)$ however is trapped between the electron and proton and forms a standing wave orbital. Due to the loss of the photon, the energy of $(p^+ + e^- + -\lambda) < (p^+ + e^- + 0)$ and so is stable.

Let us define an $(n = i)$ orbital as $(-\lambda_i)$. The incoming Rydberg photon $\lambda_R = (+\lambda_i) - (+\lambda_f)$ arrives in a 2-step process. First the $(+\lambda_i)$ adds to the existing $(-\lambda_i)$ orbital.

$$(-\lambda_i) + (+\lambda_i) = zero$$

The $(-\lambda_i)$ orbital is canceled and we revert to the free electron and free proton; $p^+ + e^- + 0$ (ionization). However we still have the remaining $-(+\lambda_f)$ from the Rydberg formula.

$$0 - (+\lambda_f) = (-\lambda_f)$$

From this wave addition followed by subtraction we have replaced the $n = i$ orbital with an $n = f$ orbital. The electron has not moved (there was no transition from an n_i to n_f orbital), however the electron region (boundary) is now determined by the new $n = f$ orbital $(-\lambda_f)$.

4 Planck unit black-hole

A micro black-hole 'Planck unit point' (fig. 23) is defined here as a discrete entity that embodies the Planck units. For a discussion of these units as geometrical objects refer 6.2, 6.3.

The simulation begins with a single point, time t_{age} = 1. A second point is added, t_{age} = 2 and so on ... t_{age} as the clock rate of the simulation and measured in units of Planck time t_p, the sum black-hole (the sum of these points) growing in these Planck steps accordingly. The only variable required is t_{age}. Table 1., gives the parameters for a black-hole universe; age = 14.6 billion years (the peak frequency 160.200 GHz was used as reference to obtain the value for t_{age}).

The velocity of the universe expansion is constant and is the origin of the speed of light. It is also this expansion that gives the omni-directional (forward) arrow of time. When the black-hole has reached the limit of its expansion (when it is 1 Planck step above absolute zero), the simulation clock will stop. If the clock

Table 1:

Age (billions of years)	14.624
Age (units of Planck time)	0.4281 x $10^{61} t_p$
Cold dark matter density	0.21 x $10^{-26} kg.m^{-3}$
Radiation density	0.417 x $10^{-13} kg.m^{-3}$
Hubble constant	66.86 km/s/Mpc
CMB temperature	2.7269K
CMB peak frequency	160.2GHz
Cosmological constant	1.0137 x 10^{123}

reverses, the above will reverse, the black-hole universe shrinking point by point accordingly.

4.1. Mass density

Assume that for each expansion step, to the sum black-hole is added a Planck unit point = unit of Planck time t_p, Planck mass m_P and Planck (spherical) volume (Planck length = l_p), such that we can calculate the mass, volume and so density of this black-hole for any chosen time by setting t_{age}; the age of the black-hole as measured in units of Planck time and t_{sec} the age of the black-hole as measured in seconds.

$$t_p = \frac{2l_p}{c} \; (s)$$

$$mass : m_{bh} = 2t_{age} m_P \; (kg)$$

$$volume : v_{bh} = 4\pi r^3/3, \;\; r = 4l_p t_{age} = 2ct_{sec} \; (m)$$

$$\frac{m_{bh}}{v_{bh}} = 2t_{age} m_P . \frac{3}{4\pi(4l_p t_{age})^3} = \frac{3m_P}{2^7 \pi t_{age}^2 l_p^3} \; (\frac{kg}{m^3}) \quad (46)$$

Via the Friedman equation, replacing p with the above mass density formula, $\sqrt{\lambda} = r = 2ct_{sec}$ reduces to the black-hole radius ($G = c^2 l_p/m_P$);

$$\lambda = \frac{3c^2}{8\pi Gp} = 4c^2 t_{sec}^2 \quad (47)$$

4.2. Temperature

Measured in terms of Planck temperature = T_P;

$$T_{bh} = \frac{T_P}{8\pi\sqrt{t_{age}}} \quad (48)$$

The *mass/volume* formula uses t_{age}^2, the *temperature* formula uses $\sqrt{t_{age}}$. We may therefore eliminate the age variable t_{age} and combine both formulas into a single constant of proportionality that resembles the radiation density constant.

$$T_p = \frac{m_P c^2}{k_B} = \sqrt{\frac{hc^5}{2\pi G {k_B}^2}} \quad (49)$$

$$\frac{m_{bh}}{v_{bh} T_{bh}^4} = \frac{2^5 3\pi^3 m_P}{l_p^3 T_P^4} = \frac{2^8 3\pi^6 k_B^4}{h^3 c^5} \quad (50)$$

4.3. Radiation density

From Stefan Boltzmann constant σ_{SB}

$$\sigma_{SB} = \frac{2\pi^5 k_B^4}{15h^3 c^2} \quad (51)$$

$$\frac{4\sigma_{SB}}{c}.T_{bh}^4 = \frac{c^2}{1440\pi}.\frac{m_{bh}}{v_{bh}} \quad (52)$$

4.4. Casimir

The Casimir force per unit area for idealized, perfectly conducting plates with vacuum between them, where $d_c 2l_p$ = distance between plates in units of Planck length;

$$\frac{-F_c}{A} = \frac{\pi hc}{480(d_c 2l_p)^4} \quad (53)$$

if $d_c = 2\pi\sqrt{t_{age}}$ then eq.52 = eq.53, equating the Casimir force with the background radiation energy density.

$$\frac{-F_c}{A} = \frac{c^2}{1440\pi}.\frac{m_{bh}}{v_{bh}} \quad (54)$$

fig.21 plots Casimir length $d_c 2l_p$ against radiation energy density pressure measured in mPa for different t_{age} with a vertex around 1Pa, fig.22 plots temperature T_{bh}.

A radiation energy density pressure of 1Pa gives $t_{age} \sim$ 0.8743 $10^{54} t_p$ (2987 years), length = 189.89nm and temperature T_{bh} = 6034 K .

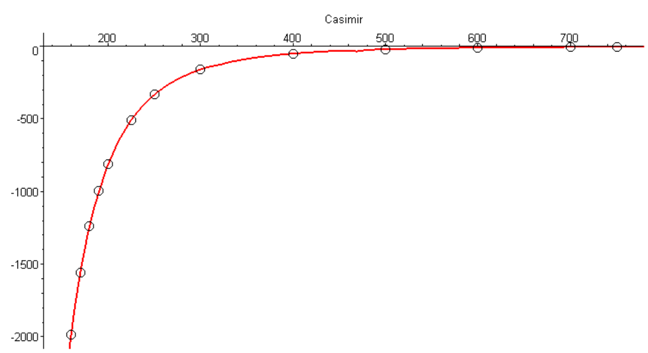

Fig. 21: y-axis = mPa, x-axis = $d_c 2l_p$ (nm)

4.5. Hubble constant

1 Mpc = 3.08567758 x 10^{22}m.

$$H = \frac{1Mpc}{t_{age} t_p} \quad (55)$$

4.6. Black body peak frequency

$$\frac{xe^x}{e^x - 1} - 3 = 0, x = 2.821439... \quad (56)$$

$$f_{peak} = \frac{k_B T_{bh} x}{h} = \frac{x}{8\pi^2\sqrt{t_{age}} t_p} \quad (57)$$

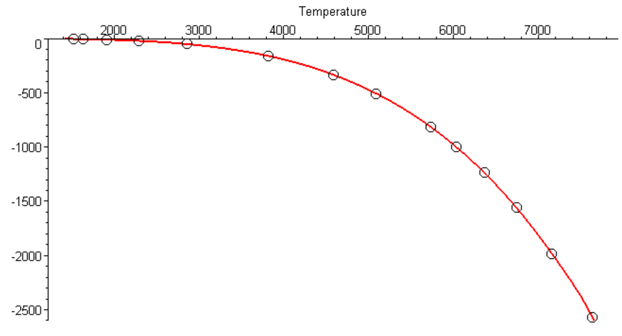

Fig. 22: y-axis = mPa, x-axis = T_{bh} (K)

4.6. Entropy

$$S_{BH} = 4\pi {t_{age}}^2 k_B \tag{58}$$

4.7. Cosmological constant

Riess and Perlmutter (notes) using Type 1a supernovae calculated the end of the universe $t_{end} \sim 1.7$ x $10^{-121} \sim 0.588$ x 10^{121} units of Planck time;

$$t_{end} \sim 0.588x10^{121} \tag{59}$$

The maximum temperature T_{max} would be when $t_{age} = 1$. What is of equal importance is the minimum possible temperature T_{min} - that temperature 1 Planck unit above absolute zero, for in the context of this model, this temperature would signify the limit of expansion (the black-hole could expand no further). For example, if we simply set the minimum temperature as the inverse of the maximum temperature;

$$T_{min} \sim \frac{1}{T_{max}} \sim \frac{8\pi}{T_P} \sim 0.177\ 10^{-30}\ K \tag{60}$$

This would then give us a value 'the end' in units of Planck time ($\sim 0.35\ 10^{73}$ yrs) which is close to Riess and Perlmutter;

$$t_{end} = T_{max}^4 \sim 1.014\ 10^{123} \tag{61}$$

The mid way point ($T_{mid} = 1K$) becomes
$T_{max}^2 \sim 3.18\ 10^{61} \sim 108.77$ billion years.

4.8. Spiral

By expanding according to a Theodorus spiral pattern (fig. 23) the universe can rotate with respect to itself differentiating between an L and R universe without recourse to an external reference. The integer dimensions (mass, volume) follow a linear progression (spiral circumference), the radiation components a sqrt progression (spiral arm).

t_{age} = number of points (see also fig.18).

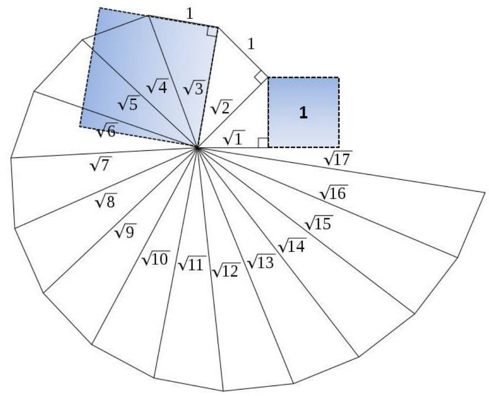

Fig. 23: spiral lattice geometry

5 Comments

The Mathematical Universe Hypothesis states that our physical world is a mathematical structure [3]. In this paper and the paper on the mathematical electron [1] I have described a simulation hypothesis method that may reconcile the mathematical universe with the physical universe. The principal assumption being that our universe operates at the Planck level and at this level mass, space and time are mathematical structures.

All events occur at the Planck level, the quantum level is an averaging of these events as the macro world is a statistical averaging of the quantum world. The physical world has definable co-ordinates.

It is the geometries of the particles that naturally result in orbits, half-life (see notes) etc. ..., the universe guided by geometrical imperatives rather than abstract laws, and as these motions follow repeating patterns they can be described using mathematical formulas (the laws of Physics).

Notes:

6.1 Half-life: We drop coffee cups, they break only when landing on the handle (the fracture point), an event which occurs on average every 16 drops. If we start with 16 cups and drop them simultaneously, pick up the remaining unbroken cups, drop and repeat until all cups are broken, then we will derive the half-life formula. If particles have a geometrical structure and this structure has 1 or more fracture points then a half-life will emerge naturally from that geometry. Conversely the electron formula (eq. 62) suggests the electron is perfectly symmetrical and so has no fracture points and so it could have a quark substructure [1] but this would not be detected as the quarks would be identical and the electron structure immutable.

6.2 The Planck units as geometrical objects and the relationships between them [1], fig.24.

Geometrical units

Unit	Geometrical object	Scalar
mass	$M = 1$	$k,\ unit = u^{15}$
time	$T = 2\pi$	$t,\ unit = u^{-30}$
momentum (sqrt of)	$P = \Omega$	$p,\ unit = u^{16}$
velocity	$V = 2\pi\Omega^2$	$v,\ unit = u^{17}$
length	$L = 2\pi^2\Omega^2$	$l,\ unit = u^{-13}$
ampere	$A = \dfrac{2^6\pi^3\Omega^3}{\alpha}$	$a,\ unit = u^3$

Fig. 24: Planck units as geometrical objects

6.3 The formula for the mathematical electron f_e (α = inverse fine structure constant);

$$f_e = 4\pi^2 r^3 \ (r = 2^6 3\pi^2 \alpha\Omega^5),\ units = \frac{(AL)^3}{T} = 1 \quad (62)$$

6.4 Hypersphere: The wavelength (oscillation cycle) derives from $f_e l_p$ (in Planck units along the universe expansion time-line). For example, the wavelength of a sin wave from the circumference of a circle $2\pi r$ (fig.25).

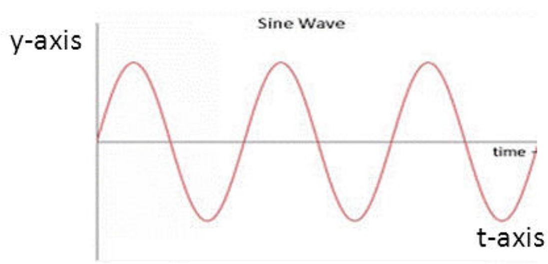

Fig. 25: sine wave

A (2D) sin wave from the (dimensionless) surface area of a sphere $4\pi r^2$ (fig.26).

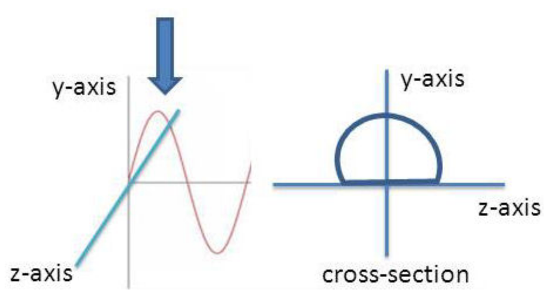

Fig. 26: 2D sine wave

A (3D) sin wave from the (dimensionless) surface area of a 4-axis hyper-sphere $2\pi^2 r^3$ (fig.27).

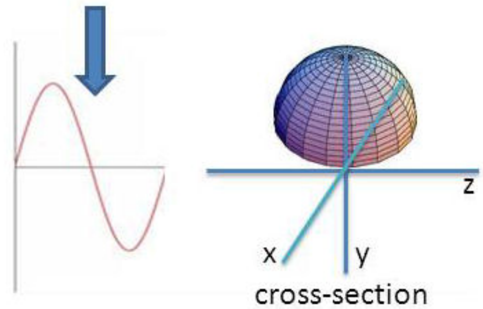

Fig. 27: 3D sine wave

However $f_e = 4\pi^2 r^3$ (units = 1) is equivalent to 2 wavelengths and so we must rotate the 4D electron sphere such that the sine wave returns to the original position after 720 degrees.

References

1. Macleod, Malcolm J., Programming Planck units from a virtual electron; a Simulation Hypothesis Eur. Phys. J. Plus (2018) 133: 278
2. Macleod, Malcolm J., Source Code of the Gods, online edition http://platoscode.com/
3. M. Tegmark 2014, Our Mathematical Universe, Knopf