

# Planck unit quantum gravity (gravitons) for Simulation Hypothesis modeling

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Defined are gravitational formulas in terms of Planck units and units of  $\hbar c$ . Mass is not assigned as a constant property but is instead treated as a discrete event defined by units of Planck mass with gravity as an interaction between these units, the gravitational orbit as the sum of these mass-mass interactions and the gravitational coupling constant as a measure of the frequency of these interactions and not the magnitude of the gravitational force itself. Each particle that is in the mass-state (defined by a unit of Planck mass) per unit of Planck time is directly linked to every other particle also in the mass-state by a discrete unit of  $m_P v^2 r = \hbar c$ , the velocity of a gravitational orbit is summed from these individual  $v^2$ . As this approach presumes a digital time, it is suitable for use in programming Simulation Hypothesis models. As this link is responsible for the particle-particle interaction it is analogous to the graviton. 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.

## 1 Introduction

A method for programming the Planck units for mass, length, time and charge from a mathematical electron has been proposed [1]. This approach uses frequencies (the frequency of occurrence of an event at unit Planck time) instead of probabilities, 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 therefore not considered 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 gravitational interactions. Gravity, as with mass, is also not treated as a constant property but rather as a discrete event, the magnitude of the gravitational interaction per unit time approximates the magnitude of the strong force, the gravitational coupling constant represents 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 Planck mass  $m_P$ , velocity  $v^2$  and distance  $r$  whereby  $m_P v^2 r = \hbar c$  (an orbital). The velocity of a gravitational orbit is summed from these individual particle-particle  $v^2$ .

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 this method uses discrete Planck units and a digital Planck time it may be suitable for use in Planck unit Simulation Hypothesis modeling. Each particle is

assigned a Planck mass center (an array address) and an oscillation frequency. A 4-axis expanding hyper-sphere array has been proposed to include relativistic effects [2] [3]. As orbits are the result of summed particle-particle links, information regarding macro orbiting objects is not required.

## 2 Gravitational coupling constant

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

$$\alpha_G = \frac{Gm_e^2}{\hbar c} = \frac{m_e^2}{m_P^2} = 1.75...x10^{-45} \quad (1)$$

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  $t$  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 gravitational coupling links between the earth and the satellite will sum to;

$$N_{links} = \frac{m_A m_B}{m_P^2} = 0.126 x10^{41} \quad (2)$$

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  $t$ ,  $N = \alpha_G$  and so a gravitational interaction between these 2 electrons will occur only once every  $10^{45}$  units of Planck time.

## 3 Planck unit gravitational formulas

 (inverse) fine structure constant  $\alpha = 137.03599\dots$ 
 $n_p =$  number of Planck units

 $\lambda_{object} =$  Schwarzschild radius

distance from a point mass

$$r = \alpha n_p 2l_p \quad (3)$$

orbital velocity associated with a point mass

$$v = \frac{c}{\sqrt{2\alpha n_p}} \quad (4)$$

orbital period

$$T = \frac{2\pi r}{v} \quad (5)$$

number of particles in the Planck mass point-state per unit of Planck time per object mass M

$$N_{points} = \frac{M}{m_P} \quad (6)$$

gravitational analogue to the principal quantum number

$$n = \sqrt{\frac{n_p}{N_{points}}} \quad (7)$$

distance from a center of mass

$$r_g = \alpha n_p 2l_p = \alpha n^2 N_{points} 2l_p = \alpha n^2 \lambda_M \quad (8)$$

gravitational orbit velocity from summed point velocities

$$v_g = \sqrt{N_{points}} v = \frac{c}{\sqrt{2\alpha n}} \quad (9)$$

gravitational acceleration

$$a_g = \frac{v_g^2}{r_g} \quad (10)$$

gravitational orbital period

$$T_g = \frac{2\pi r_g}{v_g} \quad (11)$$

orbital angular momentum

$$L_{oam} = N_{links} n \frac{h}{2\pi} \sqrt{2\alpha} \quad (12)$$

rotational angular momentum

$$L_{ram} = \left(\frac{2}{5}\right) N_{links} n \frac{h}{2\pi} \quad (13)$$

## 3.1. Example - Earth orbits

$$N_{points} = M_{earth}/m_P$$

Earth surface orbits

$$\begin{aligned} r_g &= 6371.0 \text{ km} \\ a_g &= 9.820 \text{ m/s}^2 \\ T_g &= 5060.837 \text{ s} \\ v_g &= 7909.792 \text{ m/s} \end{aligned}$$

Geosynchronous orbit

$$\begin{aligned} r_g &= 42164.0 \text{ km} \\ a_g &= 0.2242 \text{ m/s}^2 \\ T_g &= 86163.6 \text{ s} \\ v_g &= 3074.666 \text{ m/s} \end{aligned}$$

Moon orbit (d = 84600s)

$$\begin{aligned} r_g &= 384400 \text{ km} \\ a_g &= .0026976 \text{ m/s}^2 \\ T_g &= 27.4519 \text{ d} \\ v_g &= 1.0183 \text{ km/s} \end{aligned}$$

## 3.2. Example - Planetary orbits

$$N_{points} = M_{sun}/m_P$$

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

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).

$$E_{orbital} = \frac{hc}{2\pi r_{6371}} - \frac{hc}{2\pi r_{42164}} \quad (14)$$

$$N_{links} = (M_{earth} m_{satellite})/m_P^2 = 0.126x10^{41}$$

$$E_{total} = E_{orbital} N_{links} = 53MJ/kg$$

## 4 Angular momentum

$$N_{sun} = \frac{M_{sun}}{m_P} \quad (15)$$

$$N_{planet} = \frac{M_{planet}}{m_P} \quad (16)$$

$$N_{links} = N_{sun} N_{planet} \quad (17)$$

 4.1 Orbital angular momentum  $L_{oam}$ 

$$\begin{aligned} L_{oam} &= 2\pi \frac{Mr^2}{T} = N_{sun} N_{planet} \frac{h}{2\pi} \sqrt{\frac{2\alpha n_p}{N_{sun}}} \\ &= N_{links} n \frac{h}{2\pi} \sqrt{2\alpha}, \frac{kgm^2}{s} \end{aligned} \quad (18)$$

Orbital angular momentum of the planets;

$$\begin{aligned} \text{mercury} &= .9153 \times 10^{39} \\ \text{venus} &= .1844 \times 10^{41} \\ \text{earth} &= .2662 \times 10^{41} \\ \text{mars} &= .3530 \times 10^{40} \\ \text{jupiter} &= .1929 \times 10^{44} \\ \text{pluto} &= .365 \times 10^{39} \end{aligned}$$

Angular momentum combined with orbit velocity reduces to a unit of  $\hbar c$  irrespective of distance between the orbiting bodies.

$$L_{oam}v_g = N_{links} \frac{\hbar c}{2\pi}, \frac{kgm^3}{s^2} \quad (19)$$

4.2 Rotational angular momentum  $L_{ram}$

$$N_{links} = (N_{planet})^2 \quad (20)$$

Rotational angular momentum contribution to planet rotation.

$$v_{rot} = \sqrt{N_{points}} \frac{c}{2\alpha\sqrt{n_p}} = \frac{c}{2\alpha n} \quad (21)$$

$$T_{rot} = \frac{2\pi r}{v_{rot}} \quad (22)$$

$$L_{ram} = \left(\frac{2}{5}\right) \frac{2\pi M r^2}{T} = \left(\frac{2}{5}\right) N_{links} n \frac{\hbar}{2\pi}, \frac{kgm^2}{s} \quad (23)$$

$$n_{earth} = 2289.4 \text{ (radius} = 6371\text{km)}$$

$$T_{rot} = 83847.7s \text{ (86400)}$$

$$v_{rot} = 477.8m/s \text{ (463.3)}$$

$$L_{ram} = .727 \times 10^{34} \frac{kgm^2}{s} \text{ (.705)}$$

$$n_{mars} = 5094.7 \text{ (radius} = 3390\text{km)}$$

$$T_{rot} = 99208s \text{ (88643)}$$

$$v_{rot} = 214.7m/s \text{ (240.29)}$$

$$L_{ram} = .187 \times 10^{33} \frac{kgm^2}{s} \text{ (.209)}$$

$$L_{ram}v_{rot} = \left(\frac{2}{5}\right) N_{links} \frac{\hbar c}{2\pi 2\alpha}, \frac{kgm^3}{s^2} \quad (24)$$

4.3. Time dilation.

4.3.1. Velocity: In the article ‘Programming Relativity in a Planck unit Universe’, a model of a virtual hyper-sphere universe expanding in Planck steps was proposed [2]. In that model the universe hyper-sphere expands in all directions evenly, 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 has a cylindrical orbit around the A (planet) time-line axis in the hyper-sphere co-ordinates with orbital period  $T_g c$  (from  $B^1$  to  $B^2$ ) at radius  $r_g$  and orbital velocity  $v_g$ . If A is moving with the universe expansion (albeit stationary in 3-D space) then the orbital time  $t_g$  alongside the A time-line axis (fig. 1) becomes;

$$t_g = \sqrt{(T_g c)^2 - (2\pi r_g)^2} = (T_g c) \sqrt{1 - \frac{v_g^2}{c^2}} \quad (25)$$

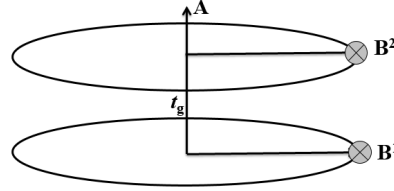


Fig. 1: orbit relative to A timeline axis

4.3.2. Gravitational:

$$v_s = v_{escape} = \sqrt{2} \cdot v_g \quad (26)$$

$$\sqrt{1 - \frac{2GM}{r_g c^2}} = \sqrt{1 - \frac{v_s^2}{c^2}} \quad (27)$$

4.4. Binding energy in the nucleus

$$m_{nuc} = m_p + m_n \quad (28)$$

$$\lambda_s = \frac{l_p m_p}{m_{nuc}} \quad (29)$$

$$r_0 = \sqrt{\alpha} \lambda_s \quad (30)$$

$$R_s = \alpha \lambda_s \quad (31)$$

$$v_s^2 = \frac{c^2}{\alpha} \quad (32)$$

The gravitational binding energy ( $\mu_G$ ) is the energy required to pull apart an object consisting of loose material and held together only by gravity.

$$\mu_G = \frac{3Gm_{nuc}^2}{5R_s} = \frac{3m_{nuc}c^2}{5\alpha} = \frac{3m_{nuc}v_s^2}{5} \quad (33)$$

Nuclear binding energy is the energy required to split a nucleus of an atom into its component parts. The electrostatic coulomb constant;

$$a_c = \frac{3e^2}{20\pi\epsilon_0} \quad (34)$$

$$E = \sqrt{(\alpha)} a_c = \frac{3m_{nuc}c^2}{5\alpha} = \frac{3m_{nuc}v_s^2}{5} \quad (35)$$

Average binding energy in nucleus;

$$\mu_G = 8.22\text{MeV/nucleon}$$

4.5. Anomalous precession

$$\text{semi-minor axis: } b = \alpha l^2 \lambda_{sun}$$

$$\text{semi-major axis: } a = \alpha n^2 \lambda_{sun}$$

radius of curvature L

$$L = \frac{b^2}{a} = \frac{\alpha l^4 \lambda_{sun}}{n^2} \quad (36)$$

$$\frac{3\lambda_{sun}}{2L} = \frac{3n^2}{2\alpha l^4} \quad (37)$$

$$precession = \frac{3n^2}{2\alpha l^4} \cdot 1296000 \cdot (100T_{earth}/T_{planet}) \quad (38)$$

Mercury = 42.9814  
 Venus = 8.6248  
 Earth = 3.8388  
 Mars = 1.3510  
 Jupiter = 0.0623

4.6.  $F_p$  = Planck force;

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

$$M_a = \frac{m_P \lambda_a}{2l_p}, \quad m_b = \frac{m_P \lambda_b}{2l_p} \quad (39)$$

$$F_g = \frac{M_a m_b G}{R^2} = \frac{\lambda_a \lambda_b F_p}{4R_g^2} = \frac{\lambda_a \lambda_b F_p}{4\alpha^2 n^4 (\lambda_a + \lambda_b)^2} \quad (40)$$

a)  $M_a = m_b$

$$F_g = \frac{F_p}{(4\alpha n^2)^2} \quad (41)$$

b)  $M_a \gg m_b$

$$F_g = \frac{\lambda_b F_p}{(2\alpha n^2)^2 \lambda_a} = \frac{m_b c^2}{2\alpha^2 n^4 \lambda_a} = m_b a_g \quad (42)$$

## 5 Orbital transition

Atomic electron transition is defined as a change of an electron from one energy level to another, theoretically this should be a discontinuous electron jump from one energy level to another although the mechanism for this is not clear. The following presumes ‘physical links’ instead of mathematical orbital regions.

Let us consider the Hydrogen Rydberg formula for transition between an initial  $i$  and a final  $f$  orbit. The incoming photon  $\lambda_R$  causes the electron to ‘jump’ from the  $n = i$  to  $n = f$  orbit.

$$\lambda_R = R \cdot \left( \frac{1}{n_i^2} - \frac{1}{n_f^2} \right) = \frac{R}{n_i^2} - \frac{R}{n_f^2} \quad (43)$$

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  $(-\lambda_f)$ .

## References

1. Macleod, Malcolm J., Programming Planck units from a virtual electron; a Simulation Hypothesis Eur. Phys. J. Plus (2018) 133: 278
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