

3. Gravitational orbits from n-body rotating particle-particle orbital pairs (a Simulation Hypothesis model)

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Abstract

We present a geometric model of orbital mechanics in which gravitational and atomic orbits emerge from time-averaged networks of rotating point-to-point orbital pairs. The model discretizes macroscopic objects into Planck-mass points, each forming independent orbital pairs with all other points in the system, creating a universe-wide N -body network. Despite using only dimensionless rotating circles governed by the fine structure constant α and π , the model reproduces Kepler's law and anomalous orbital precession. The model operates at the Planck scale, with each orbital rotating through one Planck length per Planck time (velocity c in hypersphere coordinates). Crucially, the model treats particles as oscillations between an electric wave-state (duration: particle frequency) and a mass-point state (duration: one Planck time), thereby replacing 2 abstract forces with 2 distinct states through temporal averaging. We demonstrate that when the gravitational coupling constant α_G is inverted, gravity becomes the dominant force at unit (Planck) time, with its apparent macroscopic weakness arising statistically from the rarity of mass-point states. The model uses only geometry, α , π , and Planck units for dimensional conversion.

Keywords: gravitational orbits, N -body simulation, Planck scale, fine structure constant, orbital precession, Kepler's laws, geometric quantization

1 Motivation

The laws of orbital mechanics, from Kepler's empirical observations to Einstein's general relativistic corrections, describe *what* celestial bodies do but not fundamentally *why* they follow these patterns. Similarly, atomic orbitals are described by the Schrodinger equation's solutions, yet the physical mechanism underlying electron confinement remains interpretational rather than mechanical.

This work and the article on atomic orbitals [6] together propose a unified geometric framework wherein both gravitational and atomic orbits emerge from identical underlying dynamics: discrete rotations of orbital pairs at the Planck scale. The key innovation is treating macroscopic objects not as continuous entities but as collections of Planck-mass points (m_P), each independently orbiting every other point in the universe.

The observed macroscopic orbits are *emergent* phenomena—statistical averages over vast numbers of microscopic orbital pairs. The model forms part of the simulation-universe programme of [1, 2].

2 Wave-particle oscillation

Discrete particles in this model are replaced by a continuous electric wave-state to mass point-state oscillation.

Electric wave-state: Duration = particle frequency (measured in Planck time units). Position undefined; particle exists as extended wave.

Mass point-state: Duration = one Planck time t_p . Position can be defined as a point. The final particle period is $t_{particle} = (\text{wave-state duration} + 1) t_p$.

This is a constant repeating oscillation and not a duality, the particle therefore exists over time and not at unit time, and so quantum theories cannot be applied to the Planck scale as baryonic matter does not exist as we know it at the Planck scale. Each electron oscillation cycle lasts $m_P/m_e \approx 2.39 \times 10^{22}$ units of Planck time, its reduced Compton period [9]. As there are approximately 1.85×10^{43} units of Planck time in 1 second, this gives approximately 7.8×10^{20} oscillations per second. (The full Compton period, 2π times longer, is about $1.5 \times 10^{23} t_p$; the two are different quantities, which accounts for the figures 10^{23} and 2.4×10^{22} quoted in different articles of this series.) This artifice is also used to map atomic orbital transitions using a gravitational orbit simulator [6] as we now have 2 distinct particle states (wave and point) instead of 2 abstract forces (gravitational and electromagnetic).

Mass is not thus a constant property of particles, rather observed mass m_{obs} is the frequency of occurrence of Planck mass units (m_P). If the particle wave-state energy can be represented by $E = hf$ and the mass state by $E = mc^2$, and as for each wave-state there is a corresponding mass state (as the particle oscillates between both states) then we have an equivalence between hf and $m_{obs}c^2$. Both h and c are fixed constants, and so f and m_{obs} are the frequency components; f measures the frequency of occurrence of a unit of h per second and the m_{obs} term measures the frequency of occurrence of a unit of m_P per second (if there are 10 wave-states per second then there are also 10 mass states per second).

Note (Domain Link): The mass point-state corresponds to the **Matter (Integer) Domain** where the particle has defined position and mass. The electric wave-state corresponds to the **Radiation ($\sqrt{\text{Integer}}$) Domain** where the particle exists as an extended wave. This oscillation between domains underlies wave-particle duality (see Article 1 for domain definitions [3,4]).

3 Simulation

As gravitational orbits only emerge over time from the sum of these orbital rotations occurring at unit time, it is helpful to run simulations to measure the outcome. These orbitals can be simulated on a 2-D plane representing 3-D space. Macro-objects $A, B, C, \dots$ are divided into points, each point assigned initial Cartesian co-ordinates (x, y) , and these points then form orbital pairs with all other points. The barycenter for each orbital pairing is its orbital center, the points located at each orbital 'pole'.

The simulation increments in integer steps (each step equates to 1 unit of time), during each step, the orbitals rotate 1 unit of length. Each orbital is calculated independently of all other orbitals, for the simulation there are no macro-objects $A, B, C, \dots$ (there are only discrete orbitals), however the initial (x, y) point co-ordinates will reflect the spatial co-ordinates of these macro-objects.

These rotations at unit time are then summed and averaged to give new co-ordinates, the process repeated and the results then mapped over time to reflect the orbits. The programs used to simulate the orbits can be downloaded here [10].

3.1 Gravity points

Modelling (simulating) gravitational effects at the macro scale requires objects to have (for each unit of Planck time) a minimum mass $\geq$ Planck mass (minimum = 1 mass point). This is because whilst in this mass point-state, a particle can be assigned mapping coordinates. For example, an electron has a frequency of $m_P/m_e \approx 2.39 \times 10^{22} t_p$ and so an electron would have (would be) mass only once every 2.39×10^{22} units of Planck time. If a (hypothetical) object composed only of electrons is to have constant mass (to have 1 unit of Planck mass at every unit of Planck time), then that object will require 2.39×10^{22} electrons, such that on average there will always be 1 electron in the mass point-state. A 1kg satellite would have $1\text{kg}/m_P = 45,940,509$ mass points (45,940,509 of its particles in the mass state) at any 1 unit of Planck time (although at each unit of time different particles would be in the point state as they oscillate). During the wave-state the particle has no fixed co-ordinates (and so in atomic orbital simulations it is represented by a wave-function or probability density).

3.2 Orbital pairs

We can then divide orbiting objects $A, B, C...$ into discrete (Planck mass) points, each point = $1m_P$. Each point in object A then forms an orbital pair with every point in objects $B, C...$, resulting in a universe-wide, n-body network of rotating point-to-point orbital pairs (3 points = 3 orbitals, 4 points = 6 orbitals, 8 points = 28 orbitals ...).

3.3 Clock-rate

The clock-rate of the simulation can be expressed as a programming loop;

```
FOR  $t_{age} = 1$  (big bang) TO (the end)
  rotate all orbital pairs
  sum and average new positions
  assign new co-ordinates to the points
NEXT
```

After each increment to the clock-rate (1 unit of simulation time), all orbitals rotate 1 unit of length, the results are then summed and averaged, and the new co-ordinates assigned to the points.

The model itself is dimensionless, to convert to real world orbits the Planck units can be used; 1 unit of mass == Planck mass m_P , 1 unit of time == Planck time t_p and 1 unit of length == Planck length l_p . This would translate to 2 Planck mass points (2 points per orbital) travelling 1 unit Planck length per unit of Planck time (which is velocity $c = l_p/t_p$) in hypersphere coordinates (3-D space is seen as the surface of a 4-axis expanding hypersphere) [5].

3.4 Radius constant (2-body orbits)

2-body orbits comprise a radius constant $1/\alpha$ (the fine structure constant alpha [8]) and a radius wavelength.

$$\frac{2}{\alpha} = 274.071998354 \quad (1)$$

The radius wavelength $r_{wavelength}$ defines orbital radius in terms of the central mass and the orbiting point, thus quantizing the radius.

$$r_{orbit} = \frac{2}{\alpha} * r_{wavelength} \quad (2)$$

3.5 Angle of rotation (2-body orbits)

The central mass Schwarzschild radius = i and the total mass = j . This $r_{orbital}^{-3/2}$ dependence is fundamental to the model as it determines the velocity of the orbit on a 2-D plane (representing 3-D space). Note, in hypersphere co-ordinates orbital velocity occurs at c but this article is principally concerned with orbits in 3-D space.

$$\beta_{orbital} = \frac{1}{r_{ij} r_{orbital} \sqrt{r_{orbital}}} \quad (3)$$

$$r_{ij} = \sqrt{\frac{2j}{i}} \quad (4)$$

4 2-body orbits

For simple 2-body orbits, to reduce computation 1 point is assigned as the orbiting point and the remaining points are assigned as the central mass. For example the ratio of earth mass to moon mass is 81:1, and so we could simulate this orbit accordingly with 82 points by assigning (x, y) co-ordinates for 81 points in close vicinity (the central mass) and 1 point with co-ordinates at distance from the center (the orbiting mass). However we note that the only actual distinction between a 2-body orbit and a complex multi-body orbit being that the central mass points are assigned co-ordinates relatively close to each other, and the orbiting point is assigned co-ordinates at distance (this becomes the orbital radius) ... this is because the simulation treats all points equally, the center points also orbiting each other according to their orbital pair radius, for the simulation itself there is no distinction between simple 2-body and complex n-body orbits.

The Schwarzschild radius formula in Planck units

$$r_s = \frac{2l_p M}{m_P} \quad (5)$$

As the simulation itself is dimensionless (merely rotating orbitals on a 2-D plane), we can remove the dimensioned Planck length component $2l_p$, and as M is divided into discrete Planck mass units, the Schwarzschild radius for the simulation can then be reduced to the number of central mass points;

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

We then assign (x, y) co-ordinates (to the central mass points) to represent the spatial dimensions of this central mass.

4.1 Key

1. $i = r_s = M/m_P =$ number of center mass points (the orbited object)
2. $j =$ total number of points, as here there is only 1 orbiting point; $j = i + 1$ and i / j is equivalent to reduced mass

$$\frac{i}{j} = \frac{i * 1}{i + 1} \quad (7)$$

3. k_r = a mass to radius co-efficient in the form $j_{max} = (k_r i + 1)$. This function defines orbital radius in terms of the central mass Schwarzschild radius ($k_r \times i$) and the orbiting point (+1), thus quantizing the orbital radius. When $k_r = 1$ then $j_{max} = j$, and the radius is at a minimum. This gives a gravitational principal quantum number analogue:

$$n_g = \frac{j_{max}}{j} \quad (8)$$

Note (Atomic-Gravitational Parallel): The orbital radius formula $r_{orbit} = \frac{2}{\alpha} \times r_{wavelength}$ has the same structure as the atomic Bohr radius: $a_0 = \frac{2}{\alpha} \times \frac{\bar{\lambda}_C}{2}$, with $\bar{\lambda}_C = \hbar/(m_e c)$ the reduced Compton wavelength. In atomic orbitals the wavelength is half the reduced Compton wavelength; in gravitational orbitals it is the Schwarzschild radius. The fine structure constant α appears in both as the sole fundamental coupling constant (see Article 4).

4. (x, y) , start co-ordinates for each point

4.2 Simulation: 11-body orbit

$(i = 10, j = 11, k_r = 24)$

Running this 11-body orbit simulation gave [10];

orbit period = 1076159500

orbit length = 1818510.979169879

orbit barycenter; x = 28942.502425, y = 0.001086

From these simulation results the following formulas were derived.

4.3 Formulas (dimensionless)

radius of orbiting point (from center)

$$r_{orbit} = \frac{2}{\alpha} 2 \frac{(k_r i + 1)^2}{i^2} \quad (9)$$

velocity of orbiting point

$$v_{orbit} = \sqrt{\frac{i}{r_{orbit} j}} \quad (10)$$

reduced mass (orbit occurs around the barycenter)

$$\mu = \frac{i \times 1}{i + 1} = \frac{i}{i + 1} \quad (11)$$

orbiting point period

$$t_{orbit} = 2\pi\mu \frac{r_{orbit}}{v_{orbit}} = 2\pi \frac{8}{\alpha^{3/2}} \frac{(k_r i + 1)^3}{i^{5/2} j^{1/2}} \quad (12)$$

barycenter

$$r_{barycenter} = \frac{r_{orbit}}{j} \quad (13)$$

length of orbit

$$l_{orbit} = 2\pi(r_{orbit} - r_{barycenter}) \quad (14)$$

Solving these equations using the same parameters ($i = 10, j = 11, k_r = 24$)

Calculated (orbital formulas) [10]:

orbit period = 1076159506.7957308
 orbit radius = 318367.514728
 orbit length = 1818510.9916564
 orbit barycenter = 28942.5013389, 0

Significance. The simulation results verify that orbit like conditions can be achieved using rotating orbitals and that this set of formulas can accurately reflect those orbits. The next step is to demonstrate that these formulas can also be applied to real-world orbits, and thereby confirm that this rotating orbital model can in fact replicate gravitational orbits.

4.4 Example: earth-moon orbit

The earth to moon mass ratio approximates 81:1 and so can be simulated as a 2-body orbit with the moon as a single orbiting point as in the above example. Here we use the orbital parameters to determine the value for the mass to radius coefficient k_r . (note: here are used Planck length l_p , Planck mass m_P and c to convert between the dimensionless simulation and dimensioned SI units).

Reference values

$M = 5.9722 \times 10^{24} \text{kg}$ (earth)
 $m = 7.346 \times 10^{22} \text{kg}$ (moon)
 $T_{orbit} = 27.321661 \times 86400 = 2360591.51 \text{s}$

To simplify, we assume a circular orbit which gives this radius

$$R_{orbit} = \left(\frac{G(M + m)T_{orbit}^2}{4\pi^2} \right)^{(1/3)} \quad (15)$$

$R_{orbit} = 384714027 \text{m}$
 $G = 0.66725 \text{e-}10$ (the lattice value [8])

The mass ratio $i = 81.298666$, $j = i + 1$

$$i = \frac{M}{m} \quad (16)$$

We then find a value for k_r using T_o as our reference (reversing the orbit period equation).

$$T_o = T_{orbit} \frac{m_P c}{M l_p} = \frac{16\pi (k_r i + 1)^3}{\alpha^{3/2} i^{5/2} j^{1/2}} \quad (17)$$

$$k_r = \frac{1}{i} \left(\frac{T_o i^{5/2} j^{1/2} \alpha^{3/2}}{16\pi} \right)^{(1/3)} - \frac{1}{i} \quad (18)$$

$k_r = 12581.4468$

We then use the 2-body orbit formulas to solve these parameters (dimensionless)

$r_{orbit} = 86767420100$
 $t_{orbit} = 0.159610040233 \times 10^{18}$
 $r_{barycenter} = 1054299229.62$
 $l_{orbit} = 538551421685$
 $v_{orbit} = 0.33741701 \times 10^{-5}$

Converting back to dimensioned values

$$R = r_{orbit} l_p \frac{M}{m_P} \quad (19)$$

$$T = t_{orbit} \frac{l_p}{c} \frac{M}{m_P} \quad (20)$$

$$R = 384714027\text{m} = R_{orbit}$$

$T = 2360591.51\text{s} = T_{orbit}$ (used to align k_r with the earth-moon orbit). Since k_r is fitted to T_{orbit} , this example is a closure check on the formulas and the Planck-unit conversion rather than an independent prediction; the predictive content of the model is the Kepler form of Section 4.5 with k_r a free per-orbit parameter.

$$B = 4674608.301\text{m} \text{ (barycenter)}$$

$$L = 2387858091.51\text{m} \text{ (distance travelled by the moon)}$$

$$V = 1011.551\text{m/s} \text{ (velocity of the moon around the barycenter)}$$

If we expand the velocity term

$$v_{orbit} = \sqrt{\frac{i}{r_{orbit} j}} \quad (21)$$

$$v_{orbit}^3 = \frac{GM}{T_{orbit}} 2\pi \frac{i^2}{j^2} \quad (22)$$

4.5 Kepler's formula

Using our orbital formulas, we find that Kepler's formula reduces to G

$$R = \frac{2}{\alpha} 2 \frac{(k_r i + 1)^2}{i^2} l_p \frac{M}{m_P} \quad (23)$$

$$T = \frac{16\pi}{\alpha^{3/2}} \frac{(k_r i + 1)^3}{i^{5/2} (i + 1)^{1/2}} \frac{l_p}{c} \frac{M}{m_P} \quad (24)$$

$$M + m = M \left(\frac{i + 1}{i} \right) \quad (25)$$

$$\frac{4\pi^2 R^3}{(M + m) T^2} = \frac{l_p c^2}{m_P} = G \quad (26)$$

Maple code

$R := (2/\alpha) * 2 * ((k_r * i + 1)^2 / i^2) * l_p * (M/m_P) :$

$T := (16 * \pi / \alpha^{3/2}) * ((k_r * i + 1)^3 / (i^{5/2} * (i + 1)^{1/2})) * (l_p / c) * (M/m_P) :$

$Mm := M * (i + 1) / i :$

$\text{simplify}(4 * \pi^2 * R^3 / (Mm * T^2)) ;$

Output: $l_p * c^2 / m_P$

5 Orbital trajectory

Orbital trajectory is a measure of alignment of the orbitals. In the above examples, all orbitals rotate in the same direction = aligned. If all orbitals are unaligned the object will appear to 'fall' = straight line orbit.

In this example (fig.1), for comparison, onto an 8-body orbit (blue circle orbiting the purple center mass), is imposed a single point (yellow dot) with a ratio of 1 orbital (anti-clockwise around the center mass) to 2 orbitals (clockwise around the center mass) giving an elliptical orbit.

The change in orbit velocity (acceleration towards the center and deceleration from the center) derives automatically from the change in the orbital radius, the only additional information is the orbital rotation direction.

An orbital drift (as determined where the blue and yellow meet) naturally occurs; the eccentricity (shape) of the orbit a function of center mass and the ratio of alignment of the orbitals. A near straight line orbit will have a greater drift and a greater eccentricity than a near circular orbit. A circular orbit closes after 360° (the sidereal period); the elliptical orbit has a longer period, closing only after 360° plus the precession angle (the anomalistic period). Note: in these simulations there are only 2 orbital types; clock-wise and anti-clockwise ... in a real world orbit there will be a complex mixture.

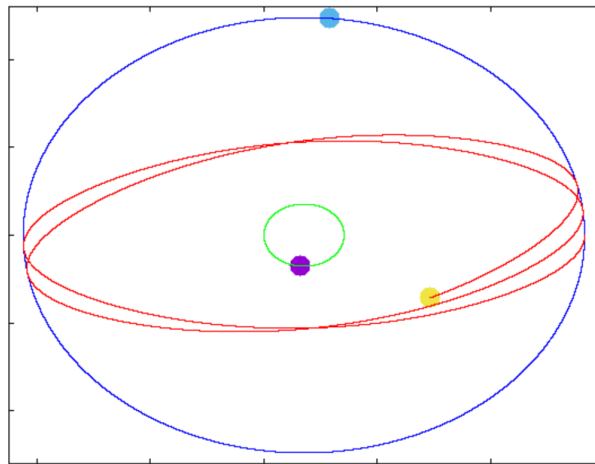


Figure 1: 8-body circular orbit plus 1-body with opposing orbitals 1:2

5.1 Principle of Least Action

In classical mechanics, systems evolve along paths that minimize the action integral $S = \int (KE - PE) dt$. In this model, the principle of least action emerges organically from geometric averaging.

Mechanism: Consider a 1kg satellite orbiting Earth. At any unit of Planck time, approximately 10^{40} distinct orbital pairs are active. Each orbital pair rotates independently, contributing to the satellite's trajectory.

Key insight: The satellite, through its constituent particles, is simultaneously following *every possible path*—each orbital pair represents one trajectory component. The observed macroscopic path is the *statistical average* of all these paths.

- **GPE (Gravitational Potential Energy):** Measures how many orbitals are misaligned (opposing rotation directions)

- **GKE (Gravitational Kinetic Energy):** Measures how many orbitals are aligned (same rotation direction)

The path of minimum action corresponds to the configuration where orbital alignment (GKE) and misalignment (GPE) balance optimally. This is not imposed as a constraint but emerges from the averaging process over $\sim 10^{40}$ orbitals.

Implication: The variational principles of classical and quantum mechanics (Lagrangian, Hamiltonian, Feynman path integral) can be understood as emergent statistical properties of this underlying geometry. Articles 4 and 5 extend this mechanism to atomic transitions and vacuum polarization [6, 7].

5.2 Precession

Precession is a change in the orientation of the rotational axis of a rotating body. The first of three tests to establish observational evidence for the theory of general relativity, as proposed by Albert Einstein in 1915, concerned the "anomalous" precession of the perihelion of Mercury. This precession is not predicted by Newtonian gravity.

The formula for precession uses the semi-major axis a and the semi-minor axis b .

$$e = \sqrt{1 - \frac{b^2}{a^2}} \quad (27)$$

$$\theta = \frac{6\pi GM}{a(1 - e^2)c^2} \quad (28)$$

Where e is the eccentricity of the orbit and θ is the precession angle.

As the center-mass Schwarzschild radius is $i \cdot 2l_p$ (with i the number of Planck mass points in the center mass and l_p the Planck length), a and b become

$$a = r_a i 2l_p \quad (29)$$

$$b = r_b i 2l_p \quad (30)$$

The Schwarzschild radius of the sun $\lambda_{sun} = 2953.25\text{m}$. The eccentricity of Mercury $e = 0.20563$ (where $a = 57909050\text{km}$ and $b = 56671523\text{km}$). From observational data, Mercury's perihelion advances by 43.1 arcseconds per century (after removing planetary perturbations).

$$\theta_{GR} = \frac{6\pi GM_{\odot}}{ac^2(1 - e^2)} = \frac{6\pi \lambda_{sun}}{2a(1 - e^2)} \quad (31)$$

$$\theta_{GR} = \frac{6\pi \times 2,953}{2 \times 5.791 \times 10^{10} \times (1 - 0.2056^2)} = 0.501866 \times 10^{-5} \text{ rad} \quad (32)$$

When comparing the simulated N-body precession against the continuous GR prediction, a profound relationship emerges depending on the ratio of the central mass to the orbiting mass (M/m).

As shown in Figure 2, at small mass ratios (e.g., $M = 24m_P$), the simulation produces a periapsis precession vastly larger than what standard isolated two-body General Relativity predicts. We term this phenomenon *discrete frame-dragging* (a discreteness effect of the point-mass core, distinct from the rotational frame-dragging of the Kerr metric). Because the central mass M is composed of discrete points (each also orbiting each other as an n-body orbit, thus the effect is magnified by a gaseous object such as a star as opposed to a Newtonian object with a rigid core), the gravitational pull from the orbiting body m

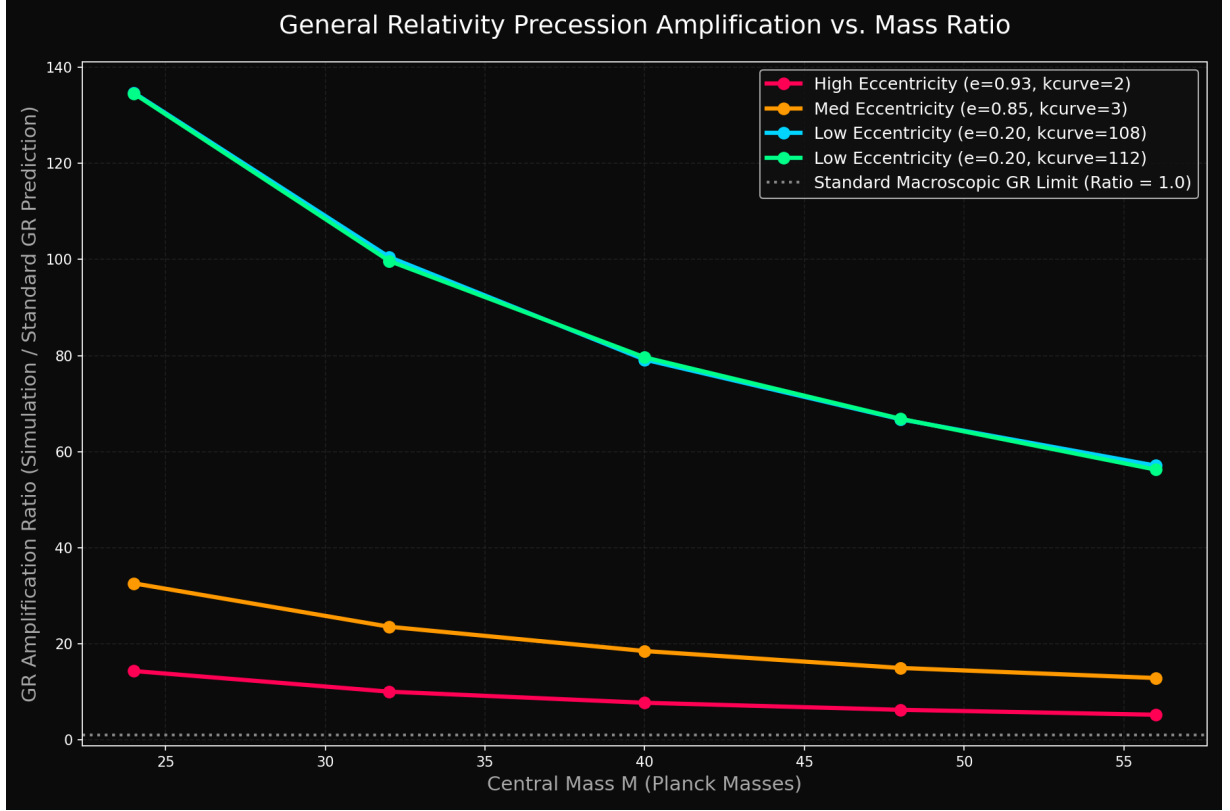


Figure 2: General Relativity Precession Amplification vs. Mass Ratio (M/m)

causes the internal structure of the core to "slosh" or physically displace in a rhythmic wobble (barycenter displacement). This violent internal core movement heavily warps the local orbital frame, dragging the reference particle and inducing a significantly amplified precession.

However, as the central mass integer grows ($M \gg m$), the internal rigidity of the barycenter increases, and the amplification factor drops asymptotically toward 1.0.

The convergence is quantitative. Fitting the data of Table 1, the excess amplification over unity falls approximately as $1/M$:

$$\text{amplification} \approx 1 + \frac{C(e)}{M}, \quad C(e \approx 0.2) \approx 3.2 \times 10^3 m_P, \quad (33)$$

with C smaller, and the fall-off slightly faster than $1/M$, at higher eccentricity. Extrapolated to a macroscopic central mass such as the sun ($M_\odot \approx 9.1 \times 10^{37} m_P$), the excess over the GR prediction is of order 10^{-35} : at solar-system scales the discrete model is indistinguishable from continuous GR, while the amplified regime it predicts is confined to near-Planck-mass central objects.

To allow for independent confirmation of these findings, the raw data comparing the simulated precession against the expected macroscopic GR prediction for four different eccentricity profiles (e) is provided in Table 1. These 4 data sets are from a clockwise-anticlockwise orbital ratio: 112:1, 108:1, 3:1, 2:1

Table 1: Precession Amplification Factor (Simulated / GR Prediction) by (M)

Central Mass (M)	$e \approx 0.93$	$e \approx 0.85$	$e \approx 0.20$ (Curve A)	$e \approx 0.20$ (Curve B)
$24m_P$	14.32	32.58	134.73	134.59
$32m_P$	10.02	23.53	100.51	99.70
$40m_P$	7.71	18.48	79.16	79.63
$48m_P$	6.24	14.95	66.75	66.85
$56m_P$	5.21	12.86	57.09	56.25
...	...	...	...	...
∞	≈ 1.00	≈ 1.00	≈ 1.00	≈ 1.00

Significance

Despite quantitative limitations, the key achievement is that **orbital precession can emerge naturally** from purely geometric principles:

- No curved space-time required
- No Einstein field equations
- Pure consequence of orbital-pair alignment
- Scales directly with Mass Ratio and naturally unifies discrete quantum frame-dragging with macroscopic GR
- Correct dependence on eccentricity and orbital parameters

6 Gravitational coupling constant

In the above, particles were assigned a mass as a unit of Planck mass. Conventionally, the gravitational coupling constant α_G characterizes the gravitational attraction between a given pair of elementary particles in terms of a particle (i.e.: electron) mass to Planck mass ratio;

$$\alpha_G = \frac{Gm_e^2}{\hbar c} = 1.75... \times 10^{-45} \quad (34)$$

In the simulation, particles are treated as an oscillation between an electric wave-state (duration particle frequency) and a mass point-state (duration 1 unit of Planck time). This α_G then represents the probability that any 2 specific electrons will be in the mass point-state at the same unit of Planck time $= (\frac{m_e}{m_P})^2$.

$$\alpha_G = \frac{Gm_e^2}{\hbar c} = (\frac{m_e}{m_P}) * (\frac{m_e}{m_P}) = 1.75... \times 10^{-45} \quad (35)$$

As 1 second requires about 1.85×10^{43} units of Planck time, this will occur about once every 31 seconds ($1/\alpha_G \approx 5.7 \times 10^{44}$ units of Planck time), and so gravity's apparent weakness is simply because the mass-state occurs so seldom relative to the particle wave-state.

We can define the coupling between any 2 objects; for a 1kg satellite orbiting the earth, for any unit of time the satellite (A) will have $1kg/m_P = 45.9 \times 10^6$ particles in the point-state. The earth (B) will have $5.97 \times 10^{24}kg/m_P = 0.274 \times 10^{33}$ particles in the point-state, and so the number of links (rotating orbital pairs for any unit time) between the earth and the satellite will sum to;

$$N_{orbitals} = \frac{m_A m_B}{m_P^2} = 0.126 \times 10^{41} \quad (36)$$

With each increment to the simulation clock, the rotating orbital pairs will change as different particles enter/leave the mass-point state, nevertheless the average number of mass points per unit time remains the same.

Earth parameters: (mass = 5.9722e24kg)

$$i = \frac{M_{earth}}{m_P} = 0.274366 \times 10^{33} \quad (37)$$

$$i2l_p = 0.00887m \text{ (Schwarzschild radius)} \quad (38)$$

$$s = \frac{1kg}{m_P} = 45940509 \quad (39)$$

$$N_{orbitals} = i * s = 0.126045 \times 10^{41} \quad (40)$$

6.1 2-graviton model

In the 2-photon model [6], (mathematically) we separate the incoming photon into 2 photons (initial and final) as per the Rydberg formula.

$$\lambda_{photon} = R \left(\frac{1}{n_i^2} - \frac{1}{n_f^2} \right) = \frac{R}{n_i^2} - \frac{R}{n_f^2} \quad (41)$$

$$\lambda_{photon} = (\lambda_i) - (\lambda_f)$$

(the model's constant R carries the wavelength dimension; the corresponding standard form is the reciprocal relation $1/\lambda_{photon} = R_\infty(1/n_i^2 - 1/n_f^2)$) (λ_i) is equivalent to the existing orbital and (λ_f) is equivalent to the final orbital and so we are changing 1 orbital for another orbital. We can use the same model here.

Gravitational Rydberg

$$r_{orbit} = \frac{2}{\alpha} * r_{wavelength} \quad (42)$$

$$E_{orbital} = \frac{hc}{2\pi r_{orbit}} \quad (43)$$

Separating the fixed constants from the variable (the radius 'wavelength component')

$$R_g = \frac{hc\alpha}{4\pi} \quad (44)$$

Example: Energy Requirements to lift a 1 kg satellite from Earth's surface to geosynchronous orbit ($R = 42,164$) km. We can calculate the wavelength part of each orbit;

$$r_{6731} = 6371000 \times \frac{\alpha}{2}$$

$$r_{42164} = 42164000 \times \frac{\alpha}{2}$$

Per orbital pair:

$$E_{orbital} = R_g \left(\frac{1}{r_{6731}} - \frac{1}{r_{42164}} \right) = 4.21255 \times 10^{-33} \text{ J} \quad (45)$$

Number of orbital pairs:

$$N_{pairs} = \frac{M_{Earth} \cdot 1 \text{ kg}}{m_P^2} = 1.26045 \times 10^{40} \quad (46)$$

Total energy:

$$E_{\text{total}} = E_{\text{orbital}} \times N_{\text{pairs}} = 5.3097 \times 10^7 \text{ J} = 53.1 \text{ MJ/kg} \quad (47)$$

That the sum reproduces the Newtonian potential difference follows from the Planck-unit identity $\hbar c = Gm_P^2$: each orbital pair contributes $\hbar c \Delta(1/r) = Gm_P^2 \Delta(1/r)$, and summing over $N_{\text{pairs}} = Mm/m_P^2$ pairs returns $\Delta U = GMm \Delta(1/r)$.

This closely matches the actual Δv energy requirement for launch to geosynchronous orbit ($\sim 50\text{--}60$ MJ/kg), validating the model's energy accounting. A full discussion of the 2-photon model is given in the article on atomic orbital transitions and so is not repeated here [6].

6.2 Earth-Moon system:

$$N_{\text{Earth-Moon}} = \frac{M_{\text{earth}} m_{\text{moon}}}{m_P^2} = \frac{(5.972 \times 10^{24}) \cdot (7.346 \times 10^{22})}{(2.176 \times 10^{-8})^2} \approx 9 \times 10^{62} \quad (48)$$

At any unit of Planck time, approximately 10^{62} orbital pairs are active. Over one second ($\sim 10^{43}$ Planck times), the total number of orbital-pair rotation events is:

$$N_{\text{events}} = N_{\text{orbitals}} \times \frac{1 \text{ s}}{t_p} \approx 10^{106} \quad (49)$$

This astronomical number explains why macroscopic gravity appears smooth and continuous—it's a statistical average over incomprehensibly many discrete events.

6.3 Planetary Orbital Angular Momentum

The orbital angular momentum of a planet can be calculated directly from the number of orbital pairs. For a planet of mass M_{planet} orbiting the Sun ($M_{\text{sun}} = 1.988435 \times 10^{30}$ kg):

$$\frac{L}{v_{\text{orbit}}} = \frac{M_{\text{sun}}}{m_P} \cdot \frac{M_{\text{planet}}}{m_P} \cdot \frac{\hbar c}{2\pi} \cdot \frac{1}{v_{\text{orbit}}} = \frac{N_{\text{orbitals}} \hbar c}{v_{\text{orbit}}} \quad (50)$$

The per-pair contribution $\hbar c$ carries the units of angular momentum $\times$ velocity, so dividing by the orbital velocity yields L ; Table 2 compares the result with the observed $L = M_{\text{planet}} v r$:

Table 2: Planetary Angular Momentum from Orbital Pairs

Planet	Mass (kg)	Velocity (m/s)	Estimated	Calculated
Mercury	3.302×10^{23}	47870	9.1×10^{38}	9.15×10^{38}
Venus	4.867×10^{24}	35020	1.8×10^{40}	1.84×10^{40}
Earth	5.972×10^{24}	29780	2.66×10^{40}	2.66×10^{40}
Mars	6.417×10^{23}	24130	3.52×10^{39}	3.53×10^{39}
Saturn	5.683×10^{26}	9670	7.9×10^{42}	7.80×10^{42}
Jupiter	1.899×10^{27}	13070	2.0×10^{43}	1.93×10^{43}

The close agreement between observed (estimated) angular momentum and the orbital-pair calculation demonstrates that planetary orbital dynamics can be derived directly from the number of Planck-scale rotating orbital pairs.

Significance: In standard cosmology, planetary orbital angular momentum is understood as inherited from the angular momentum of the primordial gas and dust cloud that formed the Solar System—a *historical* property. In this model the relation between

angular momentum, mass and velocity is a *geometric consequence* of the orbital pair structure: since $\hbar c = Gm_p^2$ identically in Planck units, the per-pair contribution $\hbar c$ sums to $GM_{sun}M_{planet}$, and the tabulated identity $N\hbar c/v = Mvr$ is the circular-orbit condition $v^2r = GM_{sun}$ restated in pair counts. The observed velocity remains an input, so the comparison demonstrates that pair-counting is consistent with Newtonian balance rather than deriving the orbit independently of initial conditions; what the model adds is that no force law is assumed, the balance emerging from the averaging of pair rotations.

6.4 Gravity as Emergent Phenomenon

Key insights:

1. **At unit (Planck) time, there is no Earth or Moon**—only transient configurations of waves and point masses
2. **Gravitational "force" doesn't pull objects together**—orbital pairs rotate, and averaging produces apparent attraction
3. **Gravity's weakness is statistical, not fundamental**—the small duty cycle of mass-states suppresses the interaction
4. **Macroscopic objects are time-averaged constructs**—they exist as persistent entities only over significant timescales

This resolves the "hierarchy problem" of why gravity is 10^{40} times weaker than electromagnetism: it's a consequence of temporal duty cycles, not coupling strengths.

7 N-body orbits

The simulation itself does not distinguish between objects, it treats all points independently and so an orbit with 3 points is a 3-body orbit (3 orbitals), 26 points is a 26-body orbit (325 orbitals). In the 2 body examples above however we have placed most points in relatively close vicinity to simulate a center object around which a point then rotates. The resulting orbit derives from the start co-ordinates assigned to the points, assigning the points start co-ordinates via random numbers will result in a 'dust' cloud orbit.

Examples:

A 26 point orbit divided into 2 objects (17 points and 7 points) and 2 of 1 point each.

8 Hypersphere Cosmology

8.1 Four-Dimensional Expansion

The simulation embeds 3D space in a 4D hypersphere expanding at constant velocity [5]. Coordinates are:

- (x, y) : Projection of 3D space onto 2D plane (for computational simplicity)

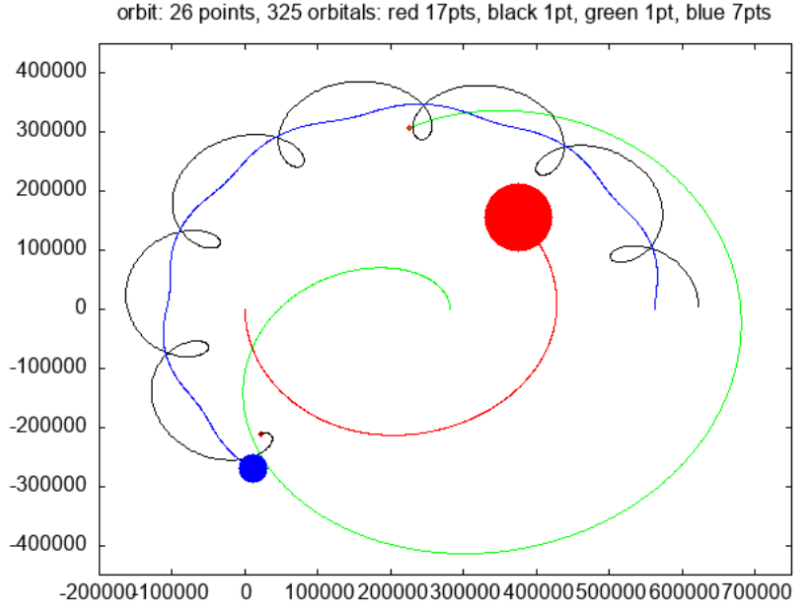


Figure 3: 26 points, 325 orbitals, non-symmetrical orbit

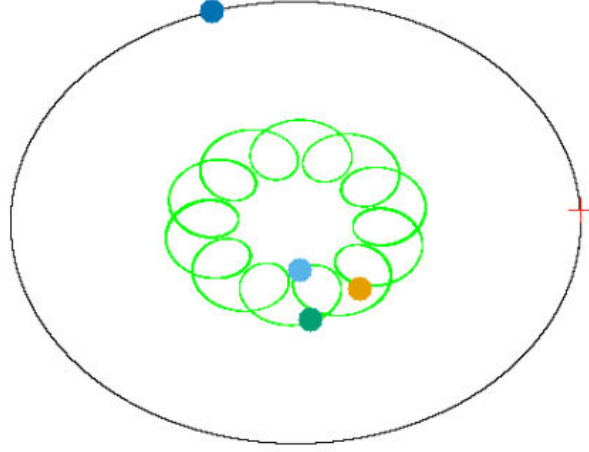


Figure 4: 4 point symmetrical orbit

- z : Expansion axis (time direction)
- Hypersphere radius $R(t) = ct$ expands at speed of light

Expansion rate:

$$\frac{dR}{dt} = c = \frac{l_p}{t_p} \quad (51)$$

All particles are "carried along" by this expansion. In the hypersphere reference frame:

$$\vec{v}_{\text{total}}^2 = \vec{v}_{\text{spatial}}^2 + \vec{v}_{\text{expansion}}^2 = c^2 \quad (52)$$

Therefore, if an object has spatial velocity v (e.g., orbiting), its expansion velocity is:

$$v_{\text{expansion}} = \sqrt{c^2 - v^2} \approx c \left(1 - \frac{v^2}{2c^2} \right) \quad (53)$$

This automatically produces **time dilation**—objects moving spatially experience slower expansion (aging) relative to stationary objects.

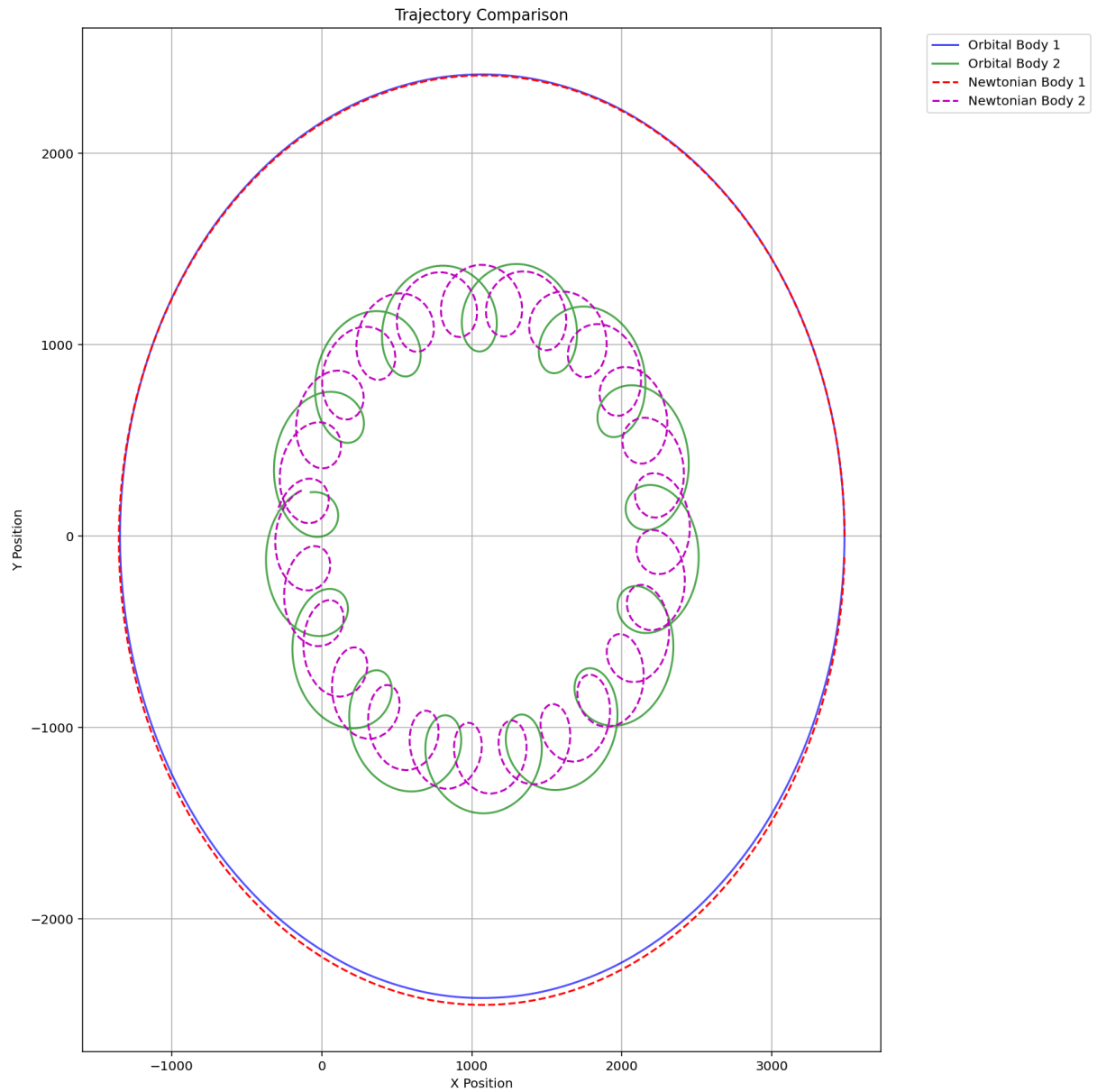


Figure 5: Newtonian vs Orbital comparison for 3 body orbit [10]

8.2 Orbital Motion in Hypersphere

An object B orbiting object A traces a helical path in 4D:

- Circular motion in (x, y) plane (spatial orbit)
- Linear motion along z axis (time/expansion)
- Combined: cylindrical helix around A 's worldline

From A 's perspective:

- A is stationary in (x, y, z) space but moves along z at rate c
- B 's spatial orbit is visible in (x, y)
- B 's expansion motion along z is "invisible" (shared with A)

This explains why orbital mechanics calculations use 3D spatial coordinates only—the z component is universal and cancels out in relative measurements.

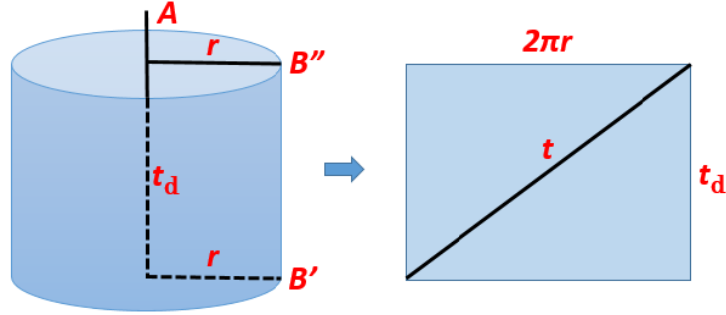


Figure 6: illustration of B 's orbit relative to the A time-line axis

In (fig. 6), while B (satellite) has a circular orbit period on a 2-axis plane (horizontal axis as 3-D space) around A (planet), it also follows a cylindrical orbit (from B' to B'') around the A (vertical) time-line expansion axis. A moves with the universe expansion (along the time-line z axis) at ($v = c$) but is stationary in 3-D space ($v = 0$). B is orbiting A at ($v = c$) but the time-line axis motion is equivalent (and so 'invisible') to both A and B , as a result the orbital period and velocity measures will be defined in terms of 3-D space co-ordinates by observers on A and B .

8.3 Connection to General Relativity

The hypersphere model bears formal resemblance to:

1. **FLRW cosmology:** Expanding universe with constant expansion rate (de Sitter-like)
2. **Kaluza-Klein theory:** Extra dimension compactified (here: expansion dimension)
3. **Regge calculus:** Spacetime approximated by discrete simplicial complex
4. **Wheeler-DeWitt equation:** Time emerges from geometry rather than being fundamental

9 Comparison with Established Theory

9.1 Newtonian Mechanics

Table 3: Comparison: Geometric orbital model vs. Newton

Aspect	Newton	This Model
Force law	$F = Gm_1m_2/r^2$	No forces; rotating orbitals
Action-at-a-distance	Instantaneous	Mediated by point-pair rotations
Continuous trajectories	Yes	Emergent from discrete events
Kepler's laws	Derived from $F = ma$	Derived from geometric averaging
Precession	Requires perturbations	Emerges from orbital misalignment
Gravitational constant	Fundamental parameter	Derived: $G = l_p c^2 / m_P$

Agreement: Both reproduce Kepler's laws and two-body orbital mechanics to high precision.

Divergence: Newton treats gravity as an instantaneous force; our model treats it as a statistical average of local rotations propagating at c .

9.2 General Relativity

Table 4: Comparison: Geometric orbital model vs. Einstein

Aspect	GR	This Model
Spacetime	Continuous manifold	Discrete network of events
Curvature	Riemann tensor	Orbital-pair interference
Geodesics	Extremal proper time	Averaged orbital paths
Perihelion precession	Schwarzschild metric	Geometric misalignment
Frame dragging	Kerr metric	Central mass rotation
Gravitational waves	Ripples in spacetime	(Not yet explored)
Planck scale	Breakdown scale	Fundamental scale

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