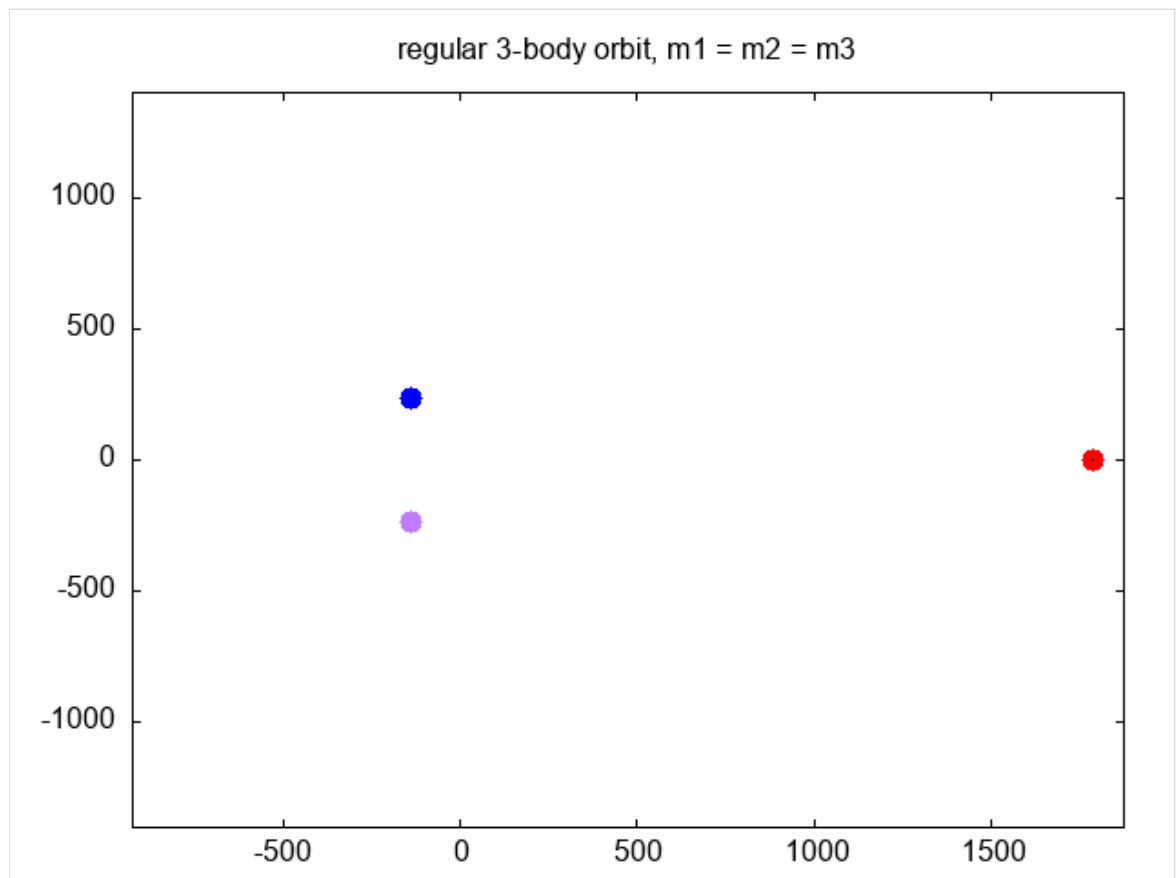




Quantum gravity (Planck)

Simulating gravitational and atomic orbits via n-body rotating particle-particle orbital pairs at the Planck scale

The following describes a geometrical method for simulating gravitational orbits and atomic orbitals via an n-body network of rotating individual particle-particle orbital pairs ^[1]. Although the simulation is dimensionless (the only physical constant used is the fine structure constant alpha), it can translate via the Planck units for comparisons with real world orbits. The orbits generated by this dimensionless geometrical approach can be formulated, and despite not using Newtonian physics these formulas demonstrate consistency; for example the derived formulas for radius R, period T and (M + m) will reduce Kepler's formula to G. Likewise the atomic orbital shells naturally quantize according to pi without relying on built-in postulates.



A regular 3-body orbit. The simulation begins with the start (x, y) co-ordinates of each point. No other parameters are required. $r_0=2*\alpha$; $x_1=1789.5722983$; $y_1=0$; $x_2=\cos(\pi*2/3)*r_0$; $y_2=\sin(\pi*2/3)*r_0$; $x_3=\cos(\pi*2/3)*r_0$; $y_3=\sin(\pi*2/3)*r_0$

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

For simulating gravity, orbiting objects $A, B, C...$ are sub-divided into discrete points, each point can be represented as 1 unit of Planck mass m_p (for example, a 1kg satellite would be divided into $1\text{kg}/m_p = 45940509$ points). 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 .

Each orbital pair rotates 1 unit of length per unit of time, when these orbital pair rotations are summed and mapped over time, gravitational orbits emerge between the objects $A, B, C...$

The base simulation requires only the start position (x, y coordinates) of each point, as it maps only rotations of the points within their respective orbital pairs then information regarding the macro objects $A, B, C...$; momentum, center of mass, barycenter etc ... is not required (each orbital is calculated independently of all other orbitals).

For simulating electron transition within the atom, the electron is assigned as a single mass point, the nucleus as multiple points clustered together (a 2-body orbit), and an incoming 'photon' is added to the orbital radius in a series of discrete steps (rather than a single 'jump' between orbital shells). As the electron continues to orbit the nucleus during this transition phase, the electron path traces a hyperbolic spiral. Although we are mapping the electron transition as a gravitational orbit on a 2-D plane, periodically the transition spiral angles converge to give an integer orbital radius ($360^\circ=4r$, $360+120^\circ=9r$, $360+180^\circ=16r$, $360+216^\circ=25r$... $720^\circ=\infty r$), a radial quantization (as a function of π and so of geometrical origin) naturally emerges. Furthermore, the transition steps between these radius can then be used to solve the transition frequency, replicating the Bohr model. In this context the Bohr model is a gravitational model, and thus is not superseded by the Schrodinger wave equation, but rather is complementary to this equation (they each measure different aspects of the transition).

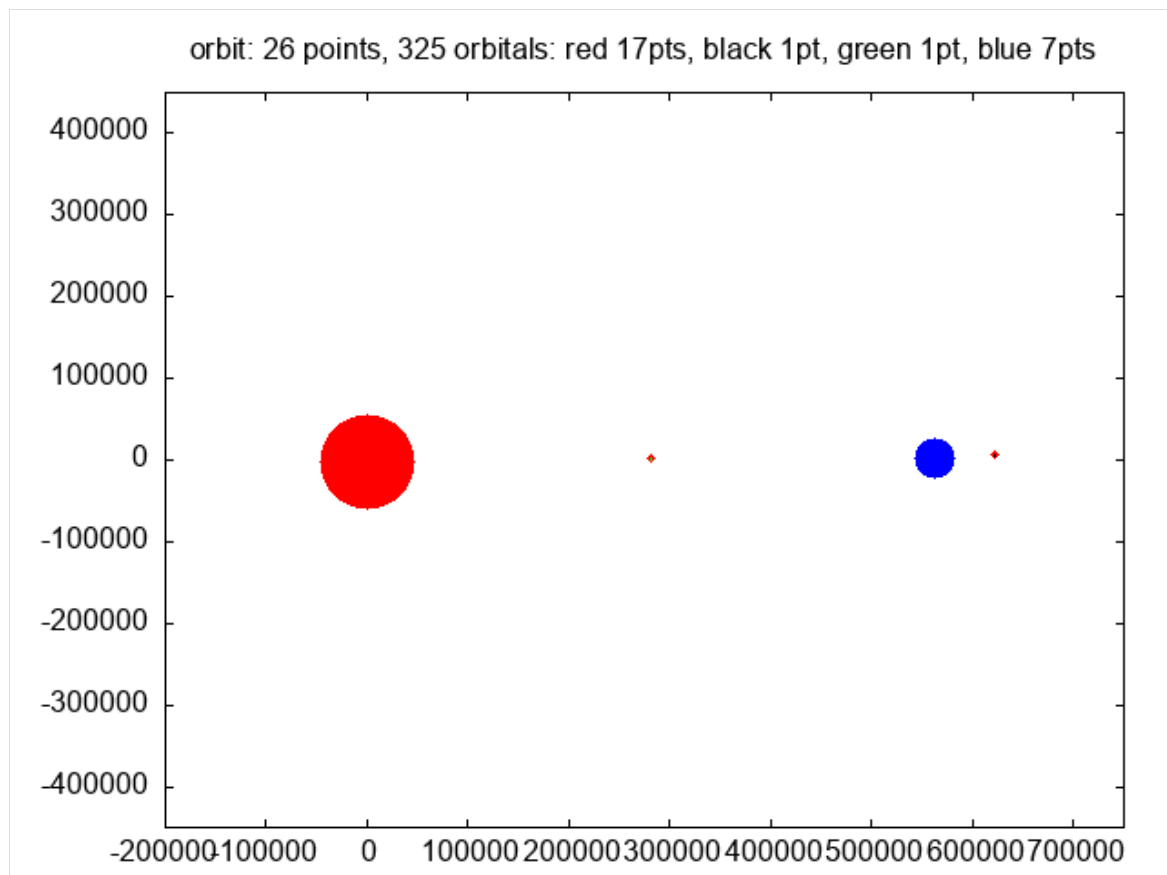
Theory

In the simulation, particles are treated as an electric wave-state to (Planck) mass point-state oscillation, the wave-state as the duration of particle frequency in Planck time units, the point-state duration as 1 unit of Planck time (as a point, this state can be assigned mapping coordinates), the particle itself is a continuous oscillation between these 2 states (i.e.: the particle is not a fixed entity). For example, an electron has a frequency (wave-state duration) = 10^{23} units of Planck time followed by the mass state (1 unit of Planck time). The background to this oscillation is given in the mathematical electron model.

If the electron **has (is)** mass (1 unit of Planck mass) for 1 unit of Planck time, and then **no** mass for 10^{23} units of Planck time (the wave-state), then in order for a (hypothetical) object composed only of electrons to **have (be)** 1 unit of Planck mass at every unit of Planck time, the object will require 10^{23} electrons. This is because orbital rotation occurs at each unit of Planck time and so the simulation requires this object to have a unit of Planck mass at each unit of Planck time (i.e.: on average there will always be 1 electron in the mass point state). We would then measure the mass of this object as 1 Planck mass (the measured mass of an object reflects the average number of units of Planck mass per unit of Planck time). For the simulation program, this Planck mass object can now be defined as a point (it will have point co-ordinates at each unit of Planck time and so can be mapped). As the simulation is dividing the mass of objects into these Planck mass size points and then rotating these points around each other as point-to-point orbital pairs, then by definition gravity is a mass to mass interaction.

Nevertheless, although this is a mass-point to mass-point rotation, and so referred to here as a point-point orbital, it is still a particle to particle orbital, albeit the particles are both in the mass state. We can also map individual particle to particle orbitals albeit as gravitational orbits, the H atom is a well-researched particle-to-particle orbital pair (an electron orbiting a proton) and so can be used as reference. To map orbital transitions between energy levels, the

simulation uses the photon-orbital model, in which the orbital (Bohr) radius is treated as a 'physical wave' akin to the photon albeit of inverse or reverse phase. The photon can be considered as a moving wave, the orbital radius as a



By selecting the start co-ordinates on a 2-D plane for each point accordingly, we can 'design' the required orbits. The 26 points orbit each other resulting in 325 point-point orbitals.

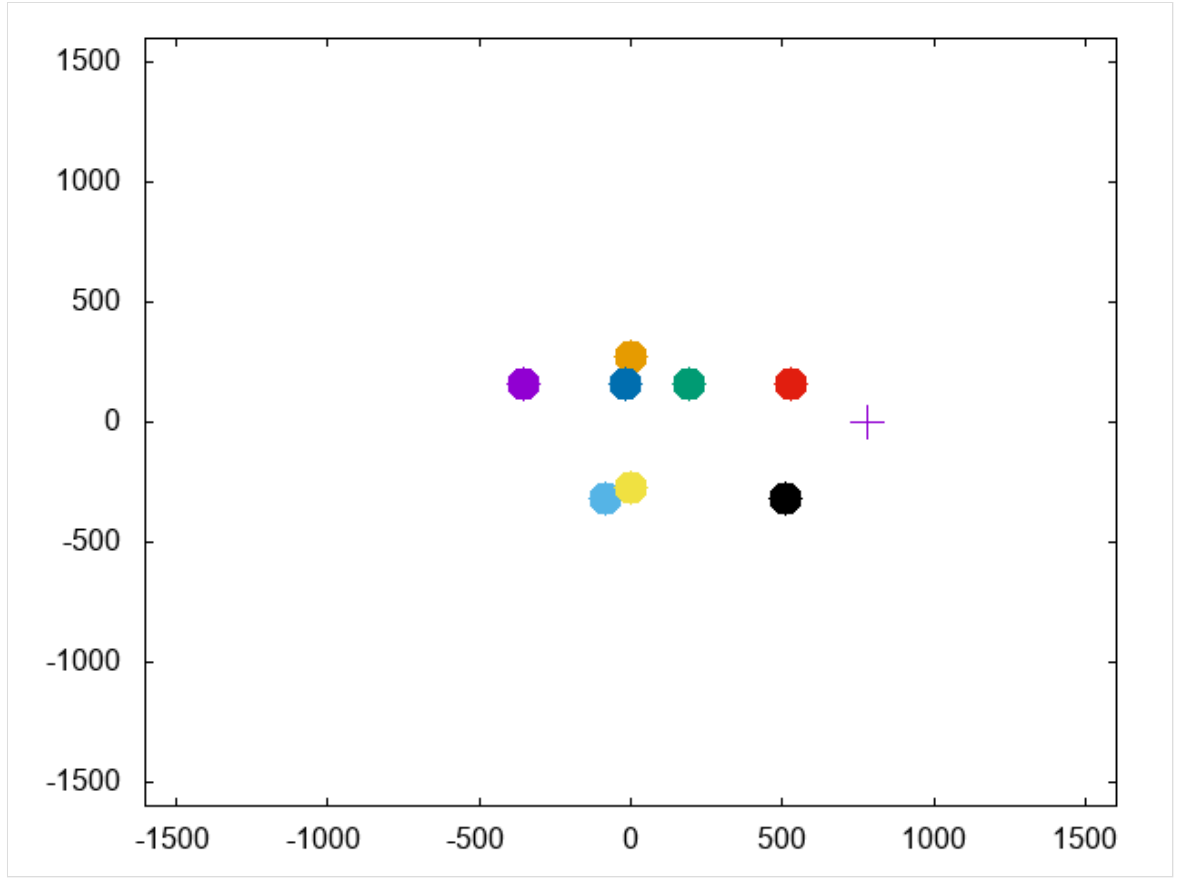
standing/rotating wave (trapped between the electron and proton).

Orbital momentum derives from this orbital radius, it is the rotation of the orbital radius that pulls the electron, resulting in the electron orbit around the nucleus. Furthermore, orbital transition (between orbitals) occurs between the orbital radius and the photon, the electron has a passive role. Transition (the electron path) follows a specific hyperbolic spiral for which the angle component periodically converges to give integer radius where $r = \text{Bohr radius}$; at 360° radius $= 4r$, $360+120^\circ=9r$, $360+180^\circ=16r$, $360+216^\circ=25r$... $720^\circ=\infty r$. As these spiral angles (360° , $360+120^\circ$, $360+180^\circ$, $360+216^\circ$...) are linked directly to π , and as the electron is following a semi-classical gravitational orbit, this particular quantization has a geometrical origin.

Although the simulation is not optimized for atomic orbitals (the nucleus is treated simply as a cluster of points), the transition period t measured between these integer radius can be used to solve the transition frequencies f via the general formula $f/c = t\lambda_H/(n_f^2 - n_i^2)$.

In summary, both gravitational and atomic orbitals reflect the same particle-to-particle orbital pairing, the distinction being the state of the particles; gravitational orbitals are mass to mass whereas atomic orbitals are predominately wave to wave. There are not 2 separate forces used by the simulation, instead particles are treated as oscillations between the 2 states (electric wave and mass point). The gravity-mass Bohr model can then be seen as complementary to the electric-wave Schrödinger equation.

N-body orbitals



8-body (8 mass points, 28 orbitals), the resulting orbit is a function of the start positions of each point

The simulation universe is a 4-axis hypersphere expanding in increments ^[2] with 3-axis (the hypersphere surface) projected onto an (x, y) plane with the z axis as the simulation timeline (the expansion axis). Each point is assigned start (x, y, z = 0) co-ordinates and forms pairs with all other points, resulting in a universe-wide n-body network of point-point orbital pairs. The barycenter for each orbital pairing is its center, the points located at each orbital 'pole'.

The simulation itself is dimensionless, simply rotating circles. To translate to dimensioned gravitational or atomic orbits, we can use the Planck units (Planck mass m_p , Planck length l_p , Planck time t_p), such that the simulation increments in discrete steps (each step assigned as 1 unit of Planck time), during each step (for each unit of Planck time), the orbitals rotate 1 unit of (Planck) length (at velocity $c = l_p/t_p$) in hyper-sphere co-ordinates. These rotations are then all summed and averaged to give new point co-ordinates. As this occurs for every point before the next increment to the simulation clock (the next unit of Planck time), the orbits can be updated in 'real time' (simulation time) on a serial processor.

Orbital pair rotation on the (x, y) plane occurs in discrete steps according to an angle β as defined by the orbital pair radius (the atomic orbital β has an additional alpha term).

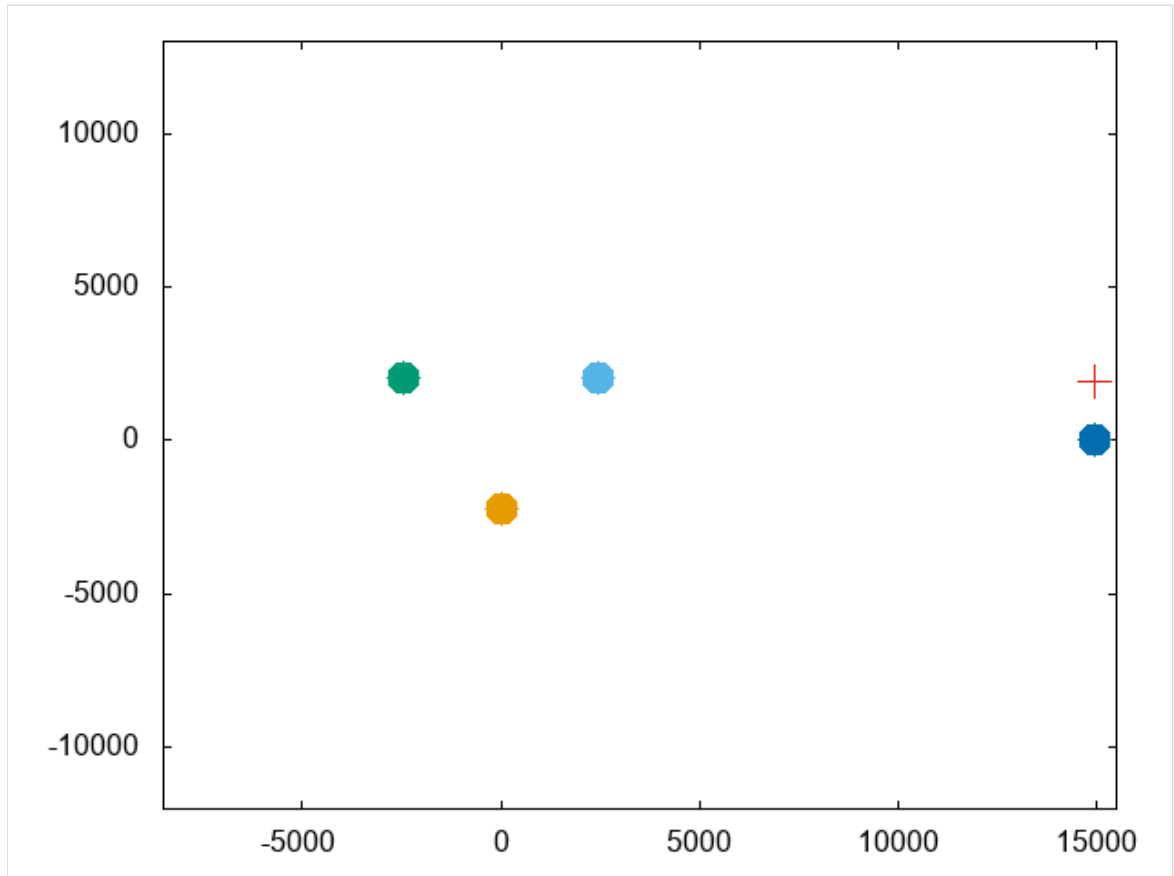
$$\beta_{gravity} = \frac{1}{r_{ij} r_{orbital} \sqrt{r_{orbital}}}$$

$$\beta_{atomic} = \frac{1}{\sqrt{2\alpha} r_{orbital} \sqrt{r_{orbital}}}$$

As the simulation treats each (point-point) orbital independently (independent of all other orbitals), no information regarding the points (other than their initial start coordinates) is required by the simulation.

Although orbital and so point rotation occurs at c , the hyper-sphere expansion [3] is equidistant and so 'invisible' to the observer. Instead observers (being constrained to 3D space) will register these 4-axis orbits (in hyper-sphere co-ordinates) as a circular motion on a 2-D plane (in 3-D space). An apparent time dilation effect emerges as a consequence.

2 body orbits (x, y plane)



Symmetrical 4 body orbit; (3 center mass points, 1 orbiting point, 6 orbital pairs). Note that all points orbit each other.

For simple 2-body orbits, to reduce computation only 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 can simulate this orbit accordingly. However we note that the only actual distinction between a 2-body orbit and a complex orbit being that the central mass points are assigned (x, y) co-ordinates relatively close to each other, and the orbiting point is assigned (x, y) co-ordinates distant from the central points (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 radius, for the simulation itself there is no difference between simple 2-body and complex n-body orbits.

The Schwarzschild radius formula in Planck units

$$r_s = \frac{2l_p M}{m_P}$$

As the simulation itself is dimensionless, we can remove the dimensioned length component $2l_p$, and as each point is analogous to 1 unit of Planck mass m_p , then the Schwarzschild radius for the simulation becomes the number of central mass points. We then assign (x, y) co-ordinates (to the central mass points) within a circle radius r_s = number of central points = total points - 1 (the orbiting point).

After every orbital has rotated 1 length unit (anti-clockwise in these examples), the new co-ordinates for each rotation per point are then averaged and summed, the process then repeats. After 1 complete orbit (return to the start position by the orbiting point), the period t (as the number of increments to the simulation clock) and the (x, y) plane orbit length l (distance as measured on the 2-D plane) are noted.

Key:

1. $i = r_s$; the number of center mass points (the orbited object).
2. j = total number of points, as here there is only 1 orbiting point; $j = i + 1$
3. k_r is 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 (i) and the orbiting point (1), thus quantizing the radius. When $k_r = 1$ then $j_{max} = j$, and the radius is at a minimum giving an analogue gravitational principal quantum number $n_g = j_{max}/j$.
4. x, y = start co-ordinates for each point (on a 2-D plane), $z = 0$.
5. r_α = a radius constant, here $r_\alpha = \sqrt{2\alpha} = 16.55512$; where α = inverse fine structure constant = 137.035 999 084 (CODATA 2018). This constant adapts the simulation specifically to gravitational and atomic orbitals.

$$r_\alpha = \sqrt{2\alpha}$$

$$r_{orbit} = r_\alpha^2 * r_{wavelength}$$

6. Rotation angle β

$$\beta_{orbital} = \frac{1}{r_{ij} r_{orbital} \sqrt{r_{orbital}}}$$

$$r_{ij} = \sqrt{\frac{2j}{i}} \text{ (for each gravitational orbital in the simulation)}$$

$$r_{ij} = \sqrt{2\alpha} \text{ (for each atomic orbital in the simulation)}$$

Orbital formulas (2-D plane)

$$j = i + 1$$

$$r_{orbit} = 2\alpha 2 \frac{(k_r i + 1)^2}{i^2}, \text{ orbital radius (center mass to point)}$$

$$r_{ij} = \sqrt{\frac{i}{j}} \text{ (averaged for each orbit)}$$

$$t_{orbit} = \frac{2\pi}{\beta_{orbit}} = 16\pi\alpha^{3/2} \frac{(k_r i + 1)^3}{i^{5/2} j^{1/2}}, \text{ orbiting point period}$$

$$r_{barycenter} = \frac{r_{orbit}}{j}$$

$$l_{orbit} = 2\pi(r_{orbit} - r_{barycenter}), \text{ distance travelled by orbiting point}$$

$$v_{orbit} = \sqrt{\frac{i}{r_{orbit}j}}, \text{ orbiting point velocity}$$

Examples (dimensionless). The simulation parameters agree closely with the calculated parameters:

a)

source code [4]
 points = 8 (1 orbiting point and 7 center mass points)
 i = 7, j = 8
 k_r = 32
 $\sqrt{2j/i} = 1.511858$

Calculated

calculated orbit period = 2504836149.00059
 calculated orbit radius = 566322.241497
 calculated orbit length = 3113519.13854
 calculated orbit barycenter = 70790.280187, 0
 n_g = (k_r i + 1)/j = 28.125

Simulation

```
simulation orbit period = 2504839696    (simulated/calculated =
1.000001416)
simulation orbit length = 3113519.129787637 (1.0000000028)
simulation orbit barycenter; x = 70790.28092, y = 0.000732
simulation orbit radius = 566322.240887
```

b)

points = 82 (1 orbiting point and 81 center mass points)
 i = 81, j = 82
 k_r = 14
 $\sqrt{2j/i} = 1.422916$

Calculated

calculated orbit period = 220490545.8705734
 calculated orbit radius = 107625.788776

calculated orbit length = 667986.0335558
calculated orbit barycenter = 1312.5096192, 0
 $n_g = (k_r i + 1)/j$ ratio = 13.84

Simulation

simulation orbit period = 222295442 (1.0081858)
simulation orbit length = 667954.5848732
simulation orbit barycenter; x = 1309.983113, y = 19.760475

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 . Planck length l_p , Planck mass m_P and c are used to convert between the dimensionless formulas 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 then gives us this radius

$$R_{orbit} = \left(\frac{G(M + m)T_{orbit}^2}{4\pi^2} \right)^{(1/3)} = 384714027 \text{m}$$

$$G = \frac{l_p c^2}{m_P} = 0.66725 \text{e-10}$$

The mass ratio

$$i = \frac{M}{m} = 81.298666, j = i + 1$$

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

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

$$k_r = \frac{1}{i} \left(\frac{T_o i^{5/2} j^{1/2}}{16\pi\alpha^{3/2}} \right)^{(1/3)} - \frac{1}{i} = 12581.4468$$

Dimensionless solutions

$$r_{orbit} = 2\alpha 2 \frac{(k_r i + 1)^2}{i^2} = 86767420100$$

$$t_{orbit} = 16\pi\alpha^{3/2} \frac{(k_r i + 1)^3}{i^{5/2} j^{1/2}} = 0.159610040233 \times 10^{18}$$

$$r_{barycenter} = \frac{r_{orbit}}{j} = 1054299229.62$$

$$l_{orbit} = 2\pi(r_{orbit} - r_{barycenter}) = 538551421685$$

$$v = \sqrt{\frac{i}{r_{orbit} j}} = 0.33741701 \times 10^{-5}$$

Converting back to dimensioned values

$$R = r_{orbit} l_p \frac{M}{m_P} = R_{orbit} = 384714027\text{m}$$

$$T = t_{orbit} \frac{l_p}{c} \frac{M}{m_P} = T_{orbit} = 2360591.51\text{s}$$

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

$$L = 2\pi(R - B) = 2387858091.51\text{m (distance moon travelled around the barycenter)}$$

$$V = c \sqrt{\frac{i}{r_{orbit} j}} = 1011.551\text{m/s (velocity of the moon around the barycenter)}$$

If we expand the velocity term

$$v_{orbit} = c \sqrt{\frac{i}{r_{orbit} j}}$$

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

Note: The standard gravitational parameter μ is the product of the gravitational constant G and the mass M of that body. For several objects in the Solar System, the value of μ is known to greater accuracy than either G or M .

$$\mu_{earth} = 3.986004418(8)\text{e}14$$

$$\mu_{moon} = 4.9048695(9)e12$$

$$i = \frac{\mu_{earth}}{\mu_{moon}} = 81.2662685$$

$$k_r = \frac{c}{2\sqrt{\alpha}} \left(\frac{T_{orbit}}{2\pi\mu_{earth}} \right)^{1/3} \frac{(i+1)^{1/6}}{i} - \frac{1}{i} = 12580.3462$$

$$t_{orbit} = 0.15956776936 \times 10^{18}$$

$$r_{orbit} = 86752239934$$

Kepler's formula = G

Kepler's formula reduces to G

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

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

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

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

Orbital vs. Newton

A 3-body orbit is compared with the equivalent orbit using Newtonian dynamics. The start positions are the same

```
r0=2*a; x1=3490.3069; y1=0; x2=cos(pi*2/3)*r0; y2=sin(pi*2/3)*r0;
x3=cos(pi*2/3)*r0; y3=sin(pi*2/3)*r0
```

The m1 orbit (orbiting point) was used to determine the optimal G for the Newtonian orbit (G = 0.4956). The initial velocities for the Newtonian orbit were estimated by taken the difference between the first 2 orbital points (x1, y1), (x2, y2), (x3, y3)

1,	3490.306899038,	0.000000000,	-137.035999177,	237.353313041,
	-137.035999177,	-237.353313041		
2,	3490.306898988,	0.013513518,	-137.055178780,	237.346554801,
	-137.016819523,	-237.360068318		

Period of orbit ($k_r = 2.19006$)

$t_{calc} = 1122034$
 $t_{orbital} = 1121397$
 $t_{newton} = 1125633$

1. Code for calculating Newtonian orbit [5]
2. Orbital data file [6]
3. Comparison data [7]

Qu for AI. These plots are of a 3-body gravitational orbit using 2 different simulation methods; Orbital and Newtonian. Analyze the plots and then compare the 2 orbital methods. (note: access to links may require to login, chatgpt does not save when text has images).

1. Analysis by Qwen[8]

Orbital Method

****Key Strength:**** Demonstrates superior long-term orbital stability, maintaining circular orbits for all bodies (m_1, m_2, m_3) without significant precession or drift.

****Methodological Insight:**** Likely employs a higher-order or adaptive-step integration scheme, or incorporates corrections to preserve angular momentum and energy. This aligns with its ability to sustain symmetry and minimize cumulative errors over time.

****Probable Applications:****

- High-precision astrophysical simulations (e.g., exoplanet dynamics, binary star systems).
- Long-term stability studies (e.g., solar system evolution, galactic dynamics).

****Symmetry:****

- Maintains near-perfect symmetry in both $x_2 - x_3$ and $y_2 + y_3$ deviations (see symmetry check plot), indicating robust conservation of system invariants.

- ****Methodological Advantage:**** Likely incorporates explicit constraints or higher-order force calculations to enforce symmetry, reducing numerical artifacts.

Newtonian Method

****Key Strength:**** Simplicity and computational efficiency via the leapfrog integrator, which conserves phase-space volume and energy over short timescales.

****Limitations:**** Accumulates numerical errors in long-term simulations, leading to orbital precession (e.g., m2/m3 drifting into elliptical orbits) and asymmetry (notably in the y-direction).

****Probable Applications:****

- Rapid prototyping or educational demonstrations of gravitational systems.

- Short-term simulations where exact energy conservation is less critical (e.g., collisional stellar dynamics).

****Symmetry:****

- Exhibits growing asymmetry in $y_2 + y_3$ deviations, suggesting energy leakage and phase errors.

- ****Root Cause:**** The leapfrog integrator, while symplectic, is a second-order method prone to secular drift in angular momentum and energy over long integration periods.

2. Analysis by Claude^[9]

Orbital Method Advantages:

Superior long-term stability for predicting general orbital structure
Better preservation of symmetry properties
More consistent orbital parameters over extended timeframes
Potentially more efficient for extremely long simulations where qualitative behavior is more important than exact positions

Newtonian Method Advantages:

More physically complete treatment of gravitational interactions
Better representation of subtle dynamical evolution
Allows natural emergence of secular effects
More suitable for studying the intrinsic chaos of three-body systems

Gravitational coupling constant

In the above, the points were assigned a mass as a theoretical 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;

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

For the purposes of this 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 inverse α_G then represents the probability that any 2 electrons will be in the mass point-state at any unit of Planck time (wave-mass oscillation at the Planck scale ^[10]).

$$\alpha_G^{-1} = \frac{m_P^2}{m_e^2} = 0.57... \times 10^{45}$$

As mass is not treated as a constant property of the particle, measured particle mass becomes the averaged frequency of discrete point mass at the Planck level. If 2 dice are thrown simultaneously and a win is 2 'sixes', then approximately every $(1/6) \times (1/6) = (1/36) = 36$ throws (frequency) of the dice will result in a win. Likewise, the inverse of α_G is the frequency of occurrence of the mass point-state between the 2 electrons. As 1 second requires 10^{42} units of Planck time ($t_p = 10^{-42} s$), this occurs about once every 3 minutes.

$$\frac{\alpha_G^{-1}}{t_p}$$

Gravity now has a similar magnitude to the strong force (at this, the Planck level), albeit this interaction occurs seldom (only once every 3 minutes between 2 electrons), and so when averaged over time (the macro level), gravity appears weak.

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 will simultaneously be in the mass point-state. If an assigned point contains only electrons, and as the frequency of the electron = f_e , then the point will require 10^{23} electrons so that, on average for each unit of Planck time there will be 1 electron in the mass point state, and so the point will have a mass equal to Planck mass (i.e.: experience continuous gravity at every unit of Planck time).

$$f_e = \frac{m_P}{m_e} = 10^{23}$$

For example a 1kg satellite orbits the earth, for any given unit of Planck time, satellite (B) will have $1kg/m_P = 45940509$ particles in the point-state. The earth (A) will have $5.9738 \times 10^{24} kg/m_P = 0.274 \times 10^{33}$ particles in the point-state, and so the earth-satellite coupling constant becomes the number of rotating orbital pairs (at unit of Planck time) between earth and the satellite;

$$N_{orbitals} = \left(\frac{m_A}{m_P}\right)\left(\frac{m_B}{m_P}\right) = 0.1261 \times 10^{41}$$

Examples:

$$i = \frac{M_{earth}}{m_P} = 0.27444 \times 10^{33} \text{ (earth as the center mass)}$$

$$i2l_p = 0.00887 \text{ (earth Schwarzschild radius)}$$

$$s = \frac{1kg}{m_P} = 45940509 \text{ (1kg orbiting satellite)}$$

$$j = N_{orbitals} = i * s = 0.1261 \times 10^{41}$$

1) 1kg satellite at earth surface orbit

$$r_o = 6371000km \text{ (earth surface)}$$

$$j_{max} = \frac{j}{r_{\alpha}} \sqrt{\frac{r_o}{il_p}} = 0.288645 \times 10^{44}$$

$$n_g = \frac{j_{max}}{j} = 2289.41$$

$$r = r_{\alpha}^2 n_g^2 il_p = r_o$$

$$v = \frac{c}{n_g r_{\alpha}} = 7909.7924 \text{ m/s}$$

$$t = 2\pi \frac{r_{outer}}{v_{outer}} = 5060.8374 \text{ s}$$

2) 1kg satellite at a synchronous orbit radius

$$r_o = 42164.17 \text{ km}$$

$$j_{max} = \frac{j}{r_{\alpha}} \sqrt{\frac{r_o}{il_p}} = 0.74256 \times 10^{44}$$

$$n_g = \frac{j_{max}}{j} = 5889.674$$

$$r = r_{\alpha}^2 n_g^2 il_p = r_o$$

$$v = \frac{c}{n_g r_{\alpha}} = 3074.66 \text{ m/s}$$

$$t = 2\pi \frac{r_{outer}}{v_{outer}} = 86164.09165 \text{ s}$$

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

$$E_{orbital} = \frac{hc}{2\pi r_{6371}} - \frac{hc}{2\pi r_{42164}} = 0.412 \times 10^{-32} \text{ J (energy per orbital)}$$

$$N_{orbitals} = \frac{M_{earth} m_{satellite}}{m_P^2} = 0.126 \times 10^{41} \text{ (number of orbitals)}$$

$$E_{total} = E_{orbital} N_{orbitals} = 53 \text{ MJ/kg}$$

4) The orbital angular momentum of the planets derived from the angular momentum of the respective orbital pairs.

$$N_{sun} = \frac{M_{sun}}{m_P}$$

$$N_{planet} = \frac{M_{planet}}{m_P}$$

$$N_{orbitals} = N_{sun} N_{planet}$$

$$n_g = \sqrt{\frac{R_{radius} m_P}{2\alpha l_p M_{sun}}}$$

$$L_{oam} = 2\pi \frac{Mr^2}{T} = N_{orbitals} n_g \frac{h}{2\pi} \sqrt{2\alpha}, \frac{kgm^2}{s}$$

The orbital angular momentum of the planets;

```
mercury = .9153 x1039
venus    = .1844 x1041
earth    = .2662 x1041
mars     = .3530 x1040
jupiter  = .1929 x1044
pluto    = .365 x1039
```

Orbital angular momentum combined with orbit velocity cancels n_g 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.

$$L_{oam} v_g = N_{orbitals} \frac{hc}{2\pi}, \frac{kgm^3}{s^2}$$

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.

Schwarzschild radius $\lambda_{sun} = i2l_p = 2953.25m$

from

$$r_o = 2\alpha n_g^2 i l_p = \alpha n_g^2 \lambda_{sun}$$

$$n_g = \frac{j_{max}}{j}$$

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

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

$$\text{radius of curvature : } L = \frac{b^2}{a} = \frac{al^4 \lambda_{sun}}{n^2}$$

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

The conversion factor from radians to arcseconds

$$2\pi = 1296000 \text{ arcseconds}$$

$$T_{earth} = 365.25 \text{ days}$$

arcseconds per 100 years (drift)

$$\text{drift} = \frac{3n^2}{2\alpha l^4} * 1296000 * \frac{100T_{earth}}{T_{planet}}$$

By inserting the above formulas for a and b , the standard formula for precession reduces to ^[11] (note: all 3 tests in terms of α , n , l are shown here ^{[12][13]});

$$\frac{6\pi GM}{a(1-e^2)c^2} = \frac{3\pi n^2}{\alpha l^4} = \frac{3n^2}{2\alpha l^4} * 1296000$$

Mercury (eccentricity = 0.205630)
 T = 87.9691 days
 a = 57909050 km ($n = 378.2734$)
 b = 56671523 km ($l = 374.2096$)
 drift = 42.98

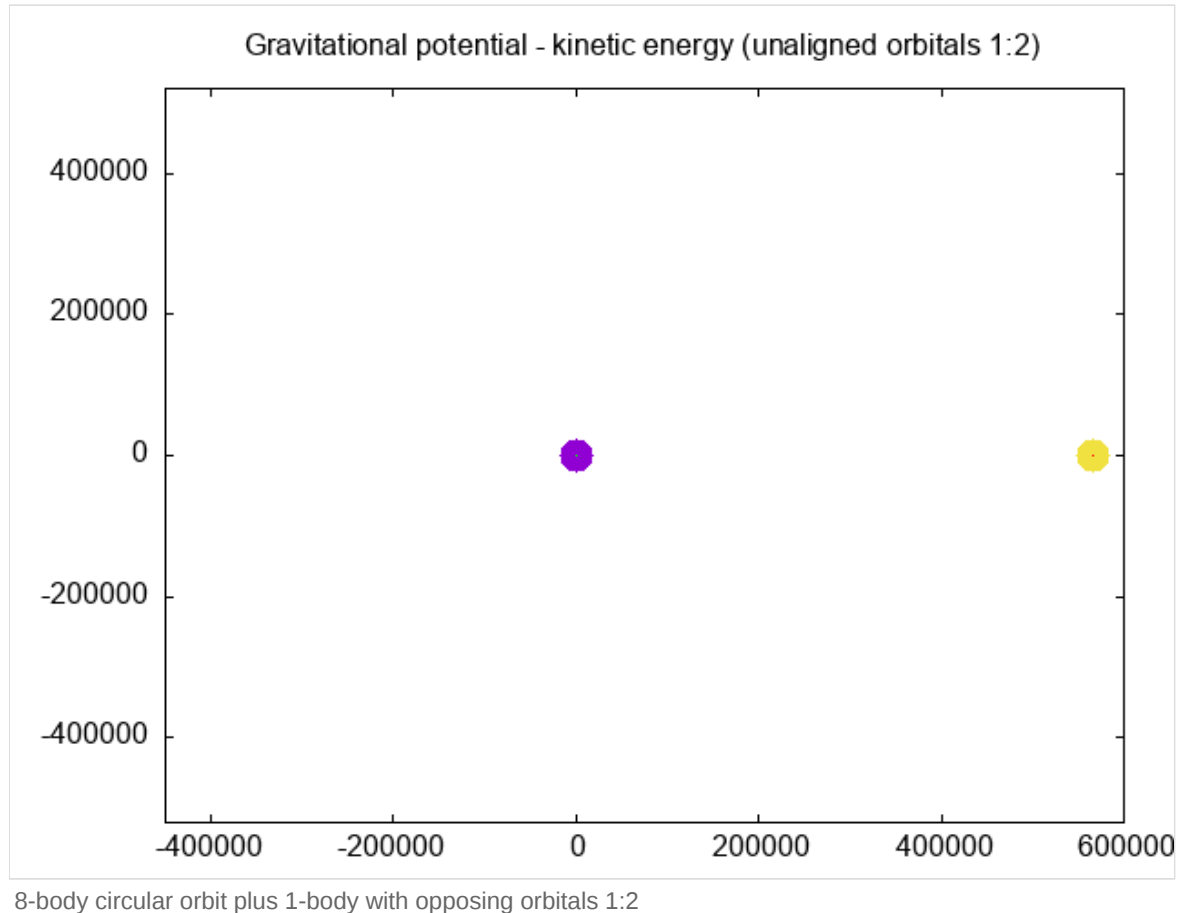
Venus (eccentricity = 0.006772)
 T = 224.701 days
 a = 108208000 km ($n = 517.085$)
 b = 108205519 km ($l = 517.079$)
 drift = 8.6247

Earth (eccentricity = 0.0167)
 T = 365.25 days
 a = 149598000 km ($n = 607.989$)
 b = 149577138 km ($l = 607.946$)
 drift = 3.8388

Mars (eccentricity = 0.0934)
 T = 686.980 days

a = 227939366 km ($n = 750.485$)
b = 226942967 km ($I = 748.843$)
drift = 1.351

Orbital alignment



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 (source code [\[14\]](#)).

In this example, for comparison, onto an 8-body orbit (blue circle orbiting the center mass green circle), 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 (there is no barycenter).

The orbital drift (as determined where the blue and yellow meet) is due to orbiting points rotating around each other. Note: if all orbitals are aligned only along the orbital path, as in this simulation, then the semi-major axis = orbital radius.

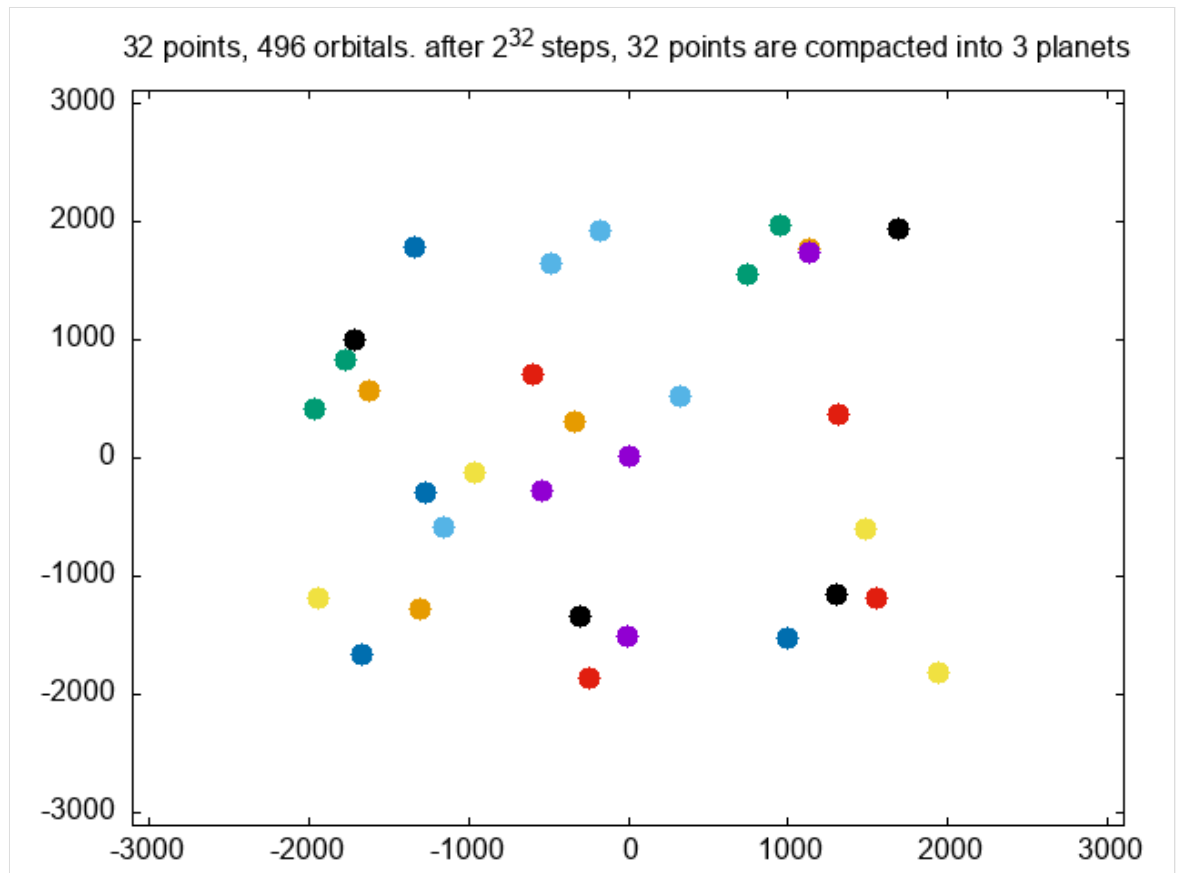
AI comparisons between angular momentum (standard physics) and orbital alignment; conclusions and links;

1. Grok: The classical model uses angular momentum to shape orbits, while the orbital pair model uses alignment, yet both parameters function analogously: maximum values yield circular orbits, zero values yield linear paths, and intermediate values yield ellipses. This functional similarity, supported by a possible mathematical mapping (e.g., $\hbar \propto |S| \hbar$), demonstrates their mutual consistency in describing orbital dynamics. ^[15]
2. Chat: Thus angular momentum in the usual sense and orbital-pair alignment at the Planck scale are two faces of the same coin: they both track exactly the net rotational “pull” around the center, and this single scalar L fully determines whether you orbit in a circle, ellipse, or straight line. ^[16]
3. Qwen: Key Equation This bridges classical angular momentum and the alignment framework, proving their consistency ^[17]
4. DeepSeek: The classical angular momentum model and the Planck-scale orbital alignment model describe the same physical reality at different scales ... This consistency arises because the Planck-scale model quantizes angular momentum, preserving its vector nature and conservation—proving it is not a replacement but a discrete reformulation of classical principles ^[18].

Freely moving points

The simulation calculates each point as if freely moving in space, and so is useful with 'dust' clouds where the freedom of movement is not restricted.

In this animation, 32 mass points begin with random co-ordinates (the only input parameter here are the start (x, y) coordinates of each point). We then fast-forward 2^{32} steps to see that the points have now clumped to form 1 larger mass and 2 orbiting masses. The larger center mass is then zoomed in on to show the component points are still orbiting each other, there are still 32 freely orbiting points, only the proximity between them has changed, they have formed *planets*.



32 mass points (496 orbitals) begin with random co-ordinates, after 2^{32} steps they have clumped to form 1 large mass and 2 orbiting masses.

Hyper-sphere orbit

Main resource: [Relativity \(Planck\)](#)

Each point moves 1 unit of (Planck) length per 1 unit of (Planck) time in x, y, z (hyper-sphere) co-ordinates, the simulation 4-axis hyper-sphere universe expanding in uniform (Planck) steps (the simulation clock-rate) as the origin of the speed of light, and so (hyper-sphere) time and velocity are constants. Particles are pulled along by this expansion, the expansion as the origin of motion, and so all objects, including orbiting objects, travel at, and only at, the speed of light in these hyper-sphere co-ordinates ^[19]. Time becomes time-line.

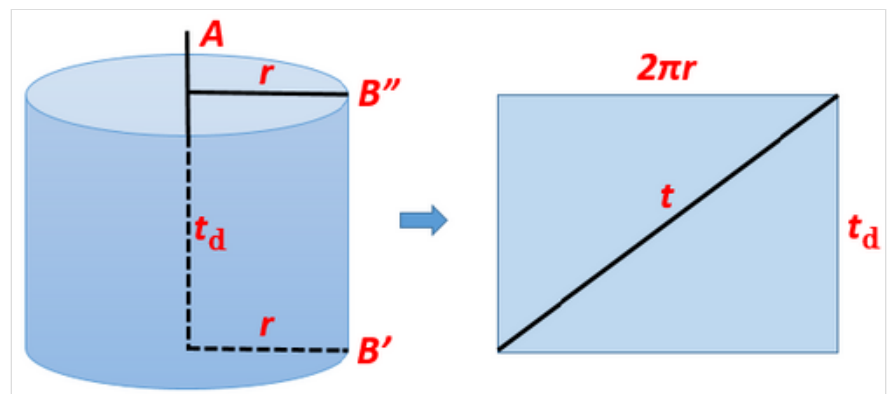


Illustration of B's cylindrical orbit relative to A's time-line axis

While B (satellite) has a circular orbit period on a 2-axis plane (the horizontal axis representing 3-D space) around A (planet), it also follows a cylindrical orbit (from B^1 to B^{11}) around the A time-line (vertical expansion) axis (t_d) in hyper-sphere co-ordinates. A is moving with the universe expansion (along the time-line 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 .

For object **B**

$$t_d = t\sqrt{1 - v_{outer}^2}$$

For object **A**

$$t_d = t\sqrt{1 - v_{inner}^2}$$

Atomic orbitals

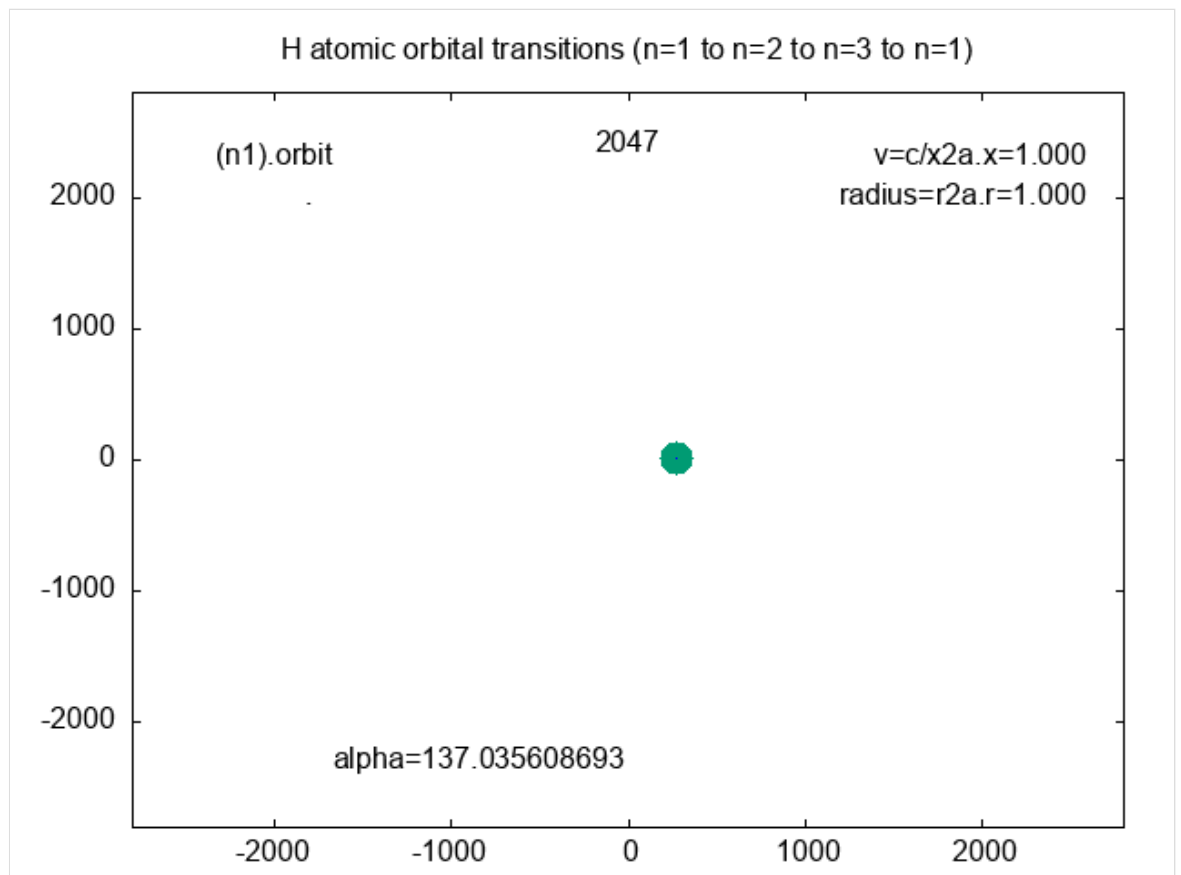


fig 5. H atom orbital transitions from n1-n2, n2-n3, n3-n1 via 2 photon capture, photons expand/contract the orbital radius. The spiral pattern emerges because the electron is continuously pulled in an anti-clockwise direction by the rotating orbital.

In the atom we find individual particle to particle orbitals, and as such the atomic orbital is principally a wave-state orbital (during the orbit the electron is predominately in the electric wave-state). The wave-state is defined by a wave-function, we can however map (assign co-ordinates to) the mass point-states and so follow the electron orbit, for example, in 1 orbit at the lowest energy level in the H atom, the electron will oscillate between wave-state to point-state approximately $2\pi 4\alpha^2 = 471960$ times, and so a plot of the electron as a circular obit around the nucleus will be the sum of 471960 'dots'.

This permits us to treat the electron orbit around the nucleus as a simple 2-body gravitational orbit with the electron as the orbiting point. Although this (gravitational orbit) approach can only map the electron-as-mass point-state (and so offers no direct information regarding the electron as a wave), during electron transition between n -shell orbitals we find the electron follows a hyperbolic spiral which can be used to derive the transition frequencies, this is significant because periodically the spiral angle components converge giving integer radius values ($360^\circ=4r$, $360+120^\circ=9r$, $360+180^\circ=16r$, $360+216^\circ=25r$... $720^\circ=\infty r$).

As these spiral angles (360° , $360+120^\circ$, $360+180^\circ$, $360+216^\circ$...) are linked directly to pi via this spiral geometry, we may ask if quantization of the atom has a geometrical origin. ^[20].

Theory

Further information: [Fine-structure_constant_\(spiral\)](#)

Hyperbolic spiral

A hyperbolic spiral is a type of spiral with a pitch angle that increases with distance from its center. As this curve widens (radius r increases), it approaches an asymptotic line (the y -axis) with the limit set by a scaling factor a (as r approaches infinity, the y axis approaches a).

For the particular spiral that the electron transition path maps, periodically the spiral angles converge to give integer radius, the general form for this type of spiral (beginning at the outer limit ranging inwards);

$$x = a^2 \frac{\cos(\varphi)}{\varphi^2}, y = a^2 \frac{\sin(\varphi)}{\varphi^2}, 0 < \varphi < 4\pi$$

$$\text{radius} = \sqrt{(x^2 + y^2)}r$$

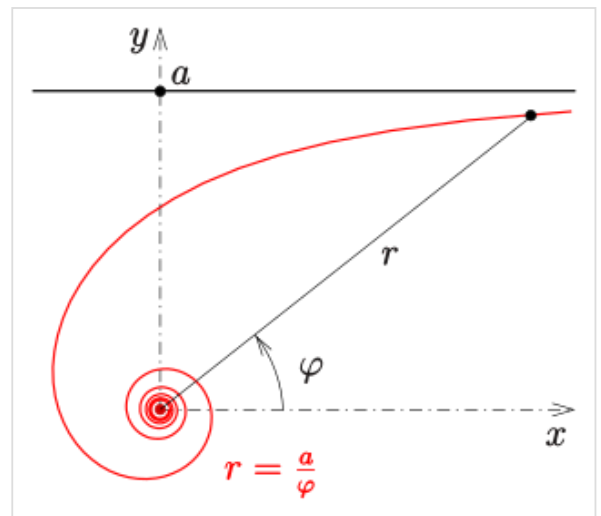
$$\varphi = (2)\pi, 4r (360^\circ)$$

$$\varphi = (4/3)\pi, 9r (240^\circ)$$

$$\varphi = (1)\pi, 16r (180^\circ)$$

$$\varphi = (4/5)\pi, 25r (144^\circ)$$

$$\varphi = (2/3)\pi, 36r (120^\circ)$$

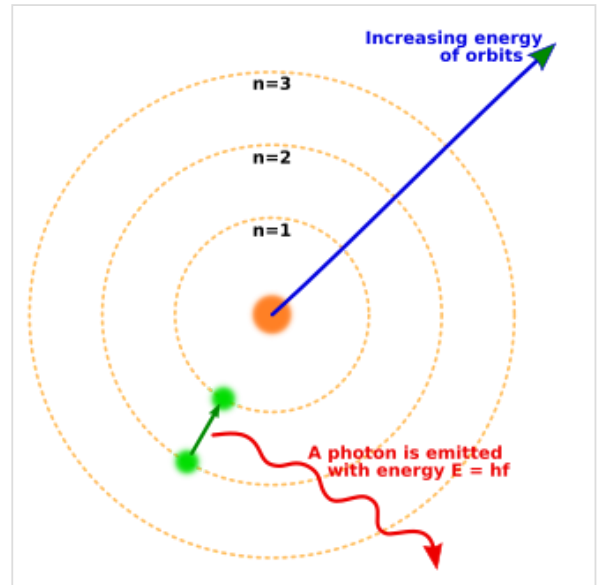


Hyperbolic spiral

Principal quantum number n

The H atom has 1 proton and 1 electron orbiting the proton, in the Bohr model (which approximates a gravitational orbit), the electron can be found at select radius (the Bohr radius) from the proton (nucleus), these radius represent the permitted energy levels (orbital regions) at which the electron may orbit the proton. Electron transition (to a higher energy level) occurs when an incoming photon provides the required energy (momentum). Conversely emission of a photon will result in electron transition to a lower energy level.

The principal quantum number n denotes the energy level for each orbital. As n increases, the electron is at a higher energy level and is therefore less tightly bound to the nucleus (as n increases, the electron orbit is further from the nucleus). Each shell can accommodate up to n^2 (1, 4, 9, 16 ...) electrons. Accounting for two states of spin this becomes $2n^2$ electrons. As these energy levels are fixed according to this integer n , the orbitals may be said to be quantized.



Electron at different n level orbitals

(Bohr) orbital

The basic orbital radius has 2 components, dimensionless (the fine structure constant α) and dimensioned (electron + proton wavelength);

$$\text{wavelength} = \lambda_H = \lambda_p + \lambda_e$$

$$\text{radius} = r_{\text{orbital}} = 2\alpha n^2 (\lambda_H)$$

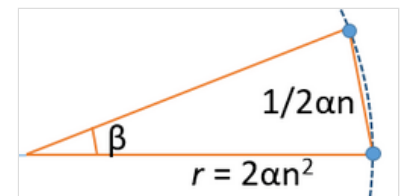
As a mass point, the electron orbits the proton at a fixed radius (the Bohr radius) in a series of steps (the duration of each step corresponds to the wavelength component). The distance travelled per step (per wave-point oscillation) equates to the distance between mass point states and is the inverse of the radius

$$\text{length} = l_{\text{orbital}} = \frac{1}{r_{\text{orbital}}}$$

Duration = 1 step per wavelength and so velocity

$$\text{velocity} = v_{\text{orbital}} = \frac{1}{2\alpha n}$$

Giving period of orbit



electron (blue dot) moving 1 step anti-clockwise along the α orbital circumference

$$\text{period} = t_{\text{orbital}} = \frac{2\pi r_{\text{orbital}}}{v_{\text{orbital}}} = 2\pi 2\alpha 2\alpha n^3 \lambda_H$$

As we are not mapping the wavelength component, a base (reference) orbital ($n=1$)

$$t_{\text{ref}} = 2\pi 4\alpha^2 = 471964.356\dots$$

The angle of rotation depends on the orbital radius

$$\beta = \frac{1}{r_{\text{orbital}} \sqrt{r_{\text{orbital}}} \sqrt{2\alpha}}$$

Photon orbital model

The electron can jump between n energy levels via the absorption or emission of a photon. In the Photon-orbital model^[21], the orbital (Bohr) radius is treated as a 'physical wave' akin to the photon albeit of inverse or reverse phase such that **orbital radius + photon = zero** (cancel).

The photon can be considered as a moving wave, the orbital radius as a standing/rotating wave (trapped between the electron and proton), as such it is the orbital radius that absorbs or emits the photon during transition, in the process the orbital radius is extended or reduced (until the photon is completely absorbed/emitted). The electron itself has a 'passive' role in the transition phase. It is the rotation of the orbital radius that pulls the electron, resulting in the electron orbit around the nucleus (orbital momentum comes from the orbital radius), and this rotation continues during the transition phase resulting in the electron following a spiral path.

The photon is actually 2 photons as per the Rydberg formula (denoted initial and final).

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

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

The wavelength of the (λ_i) photon corresponds to the wavelength of the orbital radius. The $(+\lambda_i)$ will then delete the orbital radius as described above (**orbital + photon = zero**), however the $(-\lambda_f)$, because of the Rydberg minus term, will have the same phase as the orbital radius and so conversely will increase the orbital radius. And so for the duration of the $(+\lambda_i)$ photon wavelength, the orbital radius does not change as the 2 photons cancel each other;

$$r_{\text{orbital}} = r_{\text{orbital}} + (\lambda_i - \lambda_f)$$

However, the (λ_f) has the longer wavelength, and so after the (λ_i) photon has been absorbed, and for the remaining duration of this (λ_f) photon wavelength, the orbital radius will be extended until the (λ_f) is also absorbed. For example, the electron is at the $n = 1$ orbital. To jump from an initial $n_i = 1$ orbital to a final $n_f = 2$ orbital, first the (λ_i) photon is absorbed ($\lambda_i + \lambda_{\text{orbital}} = \text{zero}$ which corresponds to 1 complete $n = 1$ orbit by the electron, the **orbital phase**), then the remaining (λ_f) photon continues until it too is absorbed (the **transition phase**).

$$t_{ref} \sim 2\pi 4\alpha^2$$

$$\lambda_i = 1t_{ref}$$

$$\lambda_f = 4t_{ref} \ (n = 2)$$

After the (λ_i) photon is absorbed, the (λ_f) photon still has $\lambda_f = (n_f^2 - n_i^2)t_{ref} = 3t_{ref}$ steps remaining until it too is absorbed.

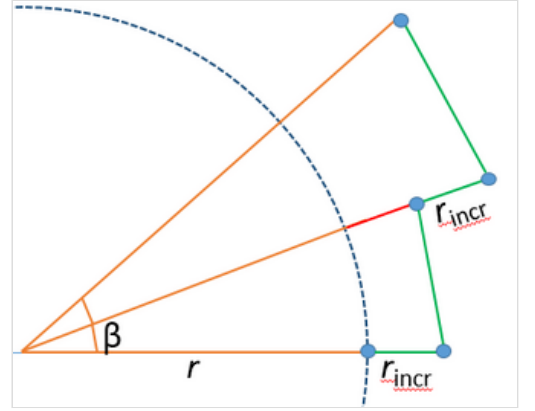
This process does not occur as a single 'jump' between energy levels by the electron, but rather absorption/emission of the photon takes place in discrete steps, each step corresponds to a unit of r_{incr} (both photon and orbital radius may be considered as constructs from multiple units of this geometry);

$$r_{incr} = -\frac{1}{2\pi 2\alpha r_{wavelength}}$$

In summary; the (λ_i) photon, which has the same wavelength as the orbital radius, deletes the orbital radius in steps $r = r_{orbital}$

$$r = r + r_{incr}$$

// λ_i photon



orbital transition during orbital rotation

Conversely, because of its minus term, the (λ_f) photon will simultaneously extend the orbital radius accordingly;

WHILE $(r < 4r_{orbital})$

$$r = r - r_{incr}$$

// λ_f photon

The model assumes orbits also follow along a timeline z-axis

$$t_{orbital} = t_{ref} \sqrt{1 - \frac{1}{(v_{orbital})^2}}$$

The orbital phase has a fixed radius, however at the transition phase this needs to be calculated for each discrete step as the orbital velocity depends on the radius;

$$t_{transition} = t_{ref} \sqrt{1 - \frac{1}{(v_{transition})^2}}$$

AI analysis

AI was used to condense the derivation (summarize the method and give conclusions)^[22]. This presumes familiarity with the Bohr model.

Chat GPT chatgpt.com/share/67ce62fc-8bf8-8012-8622-37a7a4fae6d6 ^[23]

Conclusion : the stability of the n orbital shells (with $m = n^2$) arises because at these levels the spiral's radial and angular increments are in perfect resonance. The electron's semi-classical motion then traces a repeating, closed path. This geometrical resonance, which directly involves π and the circular nature of the motion, naturally leads to the quantized orbital shells without invoking the usual quantum-mechanical postulates.

Deepseek [deepseek-spiral.pdf](#) ^[24]

Conclusion : The levels $m = n^2$ are stable because the spiral's geometry enforces a self-consistent synchronization between radial growth and angular displacement. This resonance prevents dispersion, creating discrete orbital shells without invoking quantum mechanics. The quantization of m into squares is a geometric constraint ensuring constructive interference in the spiral's path, much like how integer multiples of wavelengths stabilize standing waves. The stability of $m = n^2$ levels arises from geometric resonance in the spiral, where radial expansion and angular progression harmonize to form closed or self-reinforcing paths. This ensures discrete, stable orbital shells.

Qwen chat.qwen.ai/s/9fe132a6-91d7-4ec6-8c82-ebf2e1b2b422 ^[25]

Conclusion : The stability of $m = n^2$ orbits is a geometric necessity . The spiral's radial and angular evolution align to create resonant, non-decaying paths at these specific radii. These orbits are "stable" because they satisfy the minimal condition for periodicity and constructive interference, ensuring the electron's motion remains bounded without invoking quantum theory.

Claude claude.ai/share/355e21e4-d623-4810-962a-fb1892c2ef3f ^{[26][27]}

Conclusion : The stability of orbits at $m = n^2$ emerges from the geometric properties of the spiral itself, specifically from resonances in the relationship between angular rotation and radial expansion. This geometric perspective provides a semi-classical explanation for why certain orbital levels are preferred without invoking quantum mechanical principles.

Grok x.com/i/grok/share/2ERWIbPFpB0wlCsaqcGGrGVX2 ^{[28][29]}

Conclusion : The integer (n) introduces a quantization effect, and at these points, the spiral's geometry—through the number of steps and the resulting angular position—creates a resonant or balanced configuration. This allows the electron, moving semi-classically, to occupy stable orbital shells, not because of quantum wavefunctions, but due to the inherent structure and symmetry of the spiral's path at these discrete, integer-squared intervals.

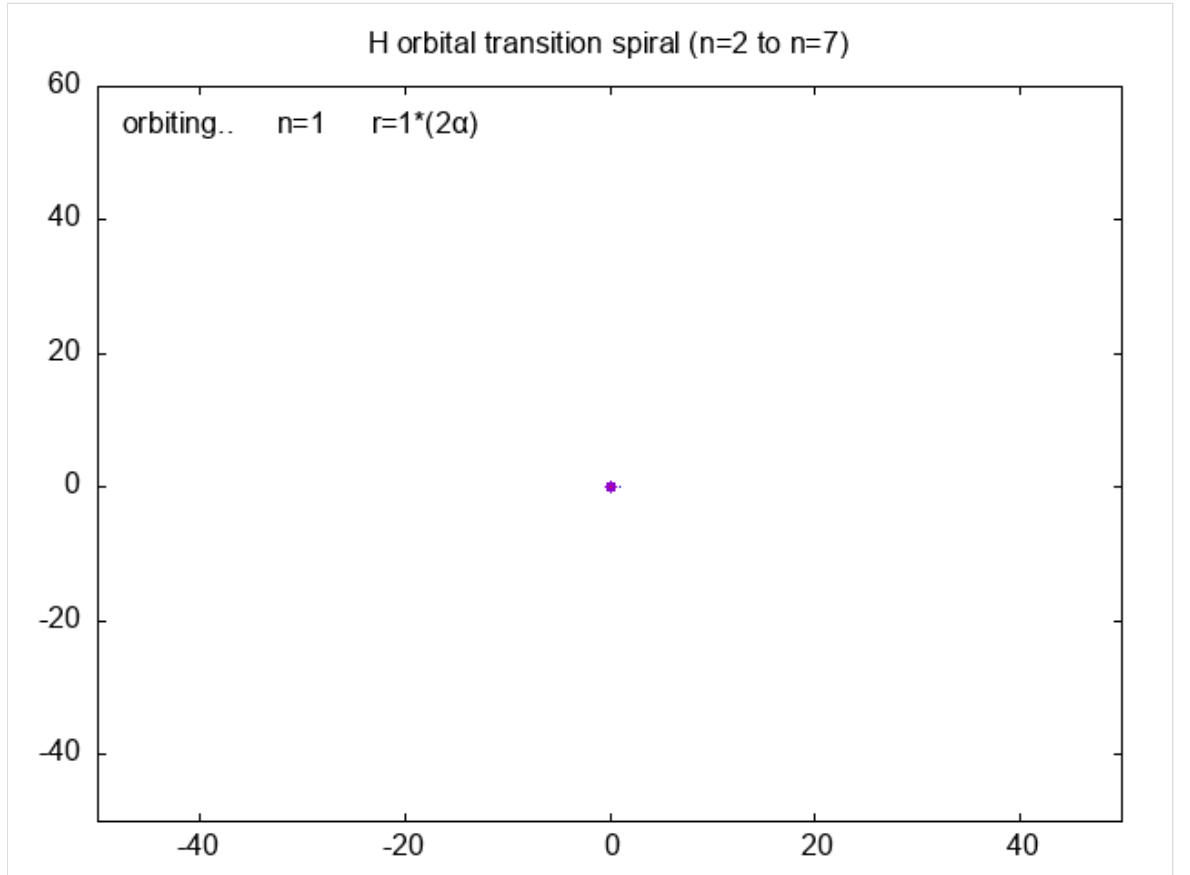
Simulation

The simulation treats the atomic orbital as a 2-body gravitational orbit with the electron (single point) orbiting a central mass - the nucleus. The nucleus is a set of individual points (also orbiting each other) and not a static mass (static entity). The difference between gravitational (between macro objects) and atomic (gravitational) orbits is only in the angle of rotation β' which has an additional r_α term included as the atomic orbital wavelength component is dominated by the particle wave-state (the mass-state is treated as a point), and so velocity along the 2-D (gravitational) plane (we are only mapping the radial component of the orbital) will decrease proportionately.

$$\beta = \frac{1}{r_{\text{orbital}} \sqrt{r_{\text{orbital}}} \sqrt{2\alpha}}$$

Source code for atomic orbital transitions [30]

Spiral angle



Bohr radius during ionization, as the H atom electron reaches each n level, it completes 1 orbit (for illustration) then continues outward (actual velocity will become slower as radius increases according to angle β)

In this example (see simulation $n=2$ to $n=7$), for an idealized Rydberg atom (a nucleus of point size, infinite mass and disregarding wavelength), the electron transition starts at the initial ($n_i = 1$) orbital

$$\varphi = 0, r_{\text{orbital}} = 2\alpha$$

$$x = r_{\text{orbital}}, y = 0$$

For each step during transition, setting $t = \text{step number}$ (FOR $t = 1$ TO ...), we can calculate the radius r and n_f^2 at each step.

$$r = r_{orbital} + \frac{t}{2\pi 2\alpha} \text{ (number of increments } t \text{ of } r_{incr})$$

$$\varphi = \varphi + \beta$$

$$n_f^2 = 1 + \frac{t}{2\pi 4\alpha^2} \text{ (} n_f^2 \text{ as a function of } t)$$

The spiral angle and n_f^2 are interchangeable

$$\varphi = 4\pi \frac{(n_f^2 - n_f)}{n_f^2} \text{ (} \varphi \text{ at any } n_f^2)$$

We can then re-write (n_f is only an integer at prescribed spiral angles);

$$\beta = \frac{1}{r_{orbital}^2 n_f^3}$$

Giving integer values at these spiral angles

$$\varphi = (2)\pi, r = 4r_{orbital} \text{ (360°)}$$

$$\varphi = (8/3)\pi, r = 9r_{orbital} \text{ (360+120°)}$$

$$\varphi = (3)\pi, r = 16r_{orbital} \text{ (360+180°)}$$

$$\varphi = (16/5)\pi, r = 25r_{orbital} \text{ (360+216°)}$$

$$\varphi = (10/3)\pi, r = 36r_{orbital} \text{ (360+240°)}$$

$$\varphi = (7/4)\pi, r = 49r_{orbital}$$

$$\varphi = (7/2)\pi, r = 64r_{orbital} \text{ (360+270°)}$$

Rydberg atom

At the $n = 1$ orbital, 1 complete rotation becomes (the dimensionless terms are measured on a 2-D plane);

$$t_{ref} = \frac{2\pi r_{orbital}}{v_{orbital}} = 2\pi 2\alpha 2\alpha$$

$$1t_{ref} = 471964.3563...$$

$$4t_{ref} = 1887857.4255...$$

$$9t_{ref} = 4247679.2074...$$

$$16t_{ref} = 7551429.7021...$$

H atom

Experimental values for H(1s-ns) transitions (n the principal quantum number).

$$H(1s-2s) = 2466\,061\,413\,187.035 \text{ kHz} \text{ [31]}$$

$$H(1s-3s) = 2922\,743\,278\,665.79 \text{ kHz} \text{ [32]}$$

$$H(1s-4s) = 3082\,581\,563\,822.63 \text{ kHz} \text{ [33]}$$

$$H(1s-\infty s) = 3288\,086\,857\,127.60 \text{ kHz} \text{ [34]} (n = \infty)$$

$$R = 10973731.568157 \text{ [35]} \text{ (Rydberg constant)}$$

$$\alpha = 137.035999177 \text{ (inverse fine structure constant [36])}$$

The wavelength of the H atom, for simplification the respective particle wavelengths are presumed constant irrespective of the vicinity of the electron to the proton.

$$r_{wavelength} = \lambda_H = \frac{2c}{\lambda_e + \lambda_p}$$

Dividing (dimensioned) wavelength ($r_{wavelength}$) by the (dimensioned) transition frequency returns a dimensionless number (the alpha component of the photon).

$$h_{(1s-ns)} = \lambda_H \frac{(n^2 - 1)}{H(1s - ns)}$$

$$h_{(1s-2s)} = 1887839.82626...$$

$$h_{(1s-3s)} = 4247634.04874...$$

$$h_{(1s-4s)} = 7551347.55306...$$

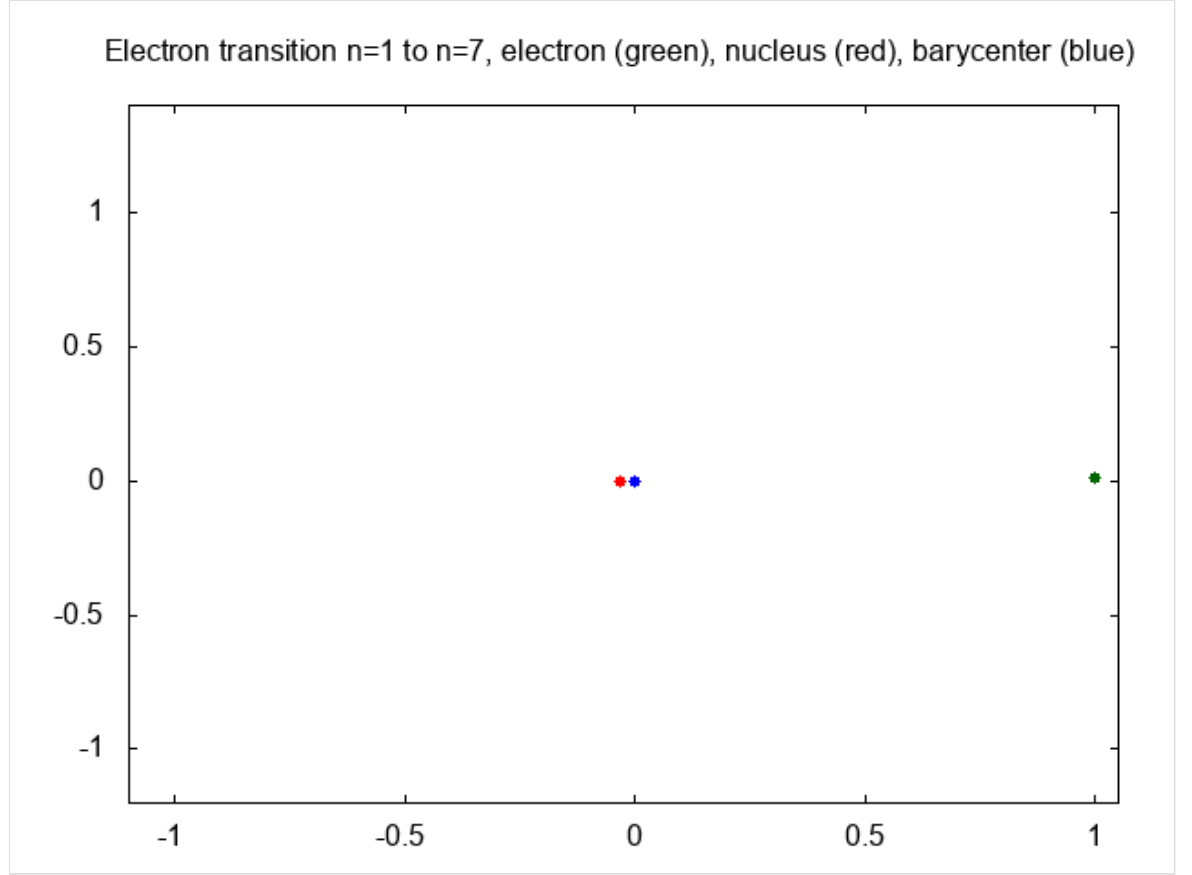
Simulation atom

The following example simulates an electron transition, the electron begins at radius $r = r_{orbital}$ and makes a 360° rotation at orbital radius (the orbital phase) and then moves in incremental steps to higher orbitals (the transition phase) mapping a hyperbolic spiral path (red line) in the process (photon orbital model).

The period t_{sim} and length l_{sim} are measured at integer $n^2 r$ ($n = 1, 2, 3...$) radius. For a Rydberg atom, these radius correspond precisely to the electron path at the (hyperbolic) spiral angles; $(360^\circ(1r), 360^\circ(4r), 360+120^\circ(9r); 360+180^\circ(16r), 360+216^\circ(25r), 360+240^\circ(36r) \dots)$ (the angles converge to give integer values at these radius), and

we find that as the simulation nucleus mass increases, the integer radius values approach these angles (table 2.). The period t_{sim} can then be used to calculate the transition frequencies.

In this example, the nucleus = 249 mass points (start x, y co-ordinates close to 0, 0), the electron = 1 mass point (at radius $x = r, y = 0$), with t_{sim} = period and l_{sim} = distance travelled by the electron ($l_{orbital} = l_{sim}$ at $n=1$), the radius coefficient r_n = radius divided by $r_{orbital}$. As this is a gravitational orbit, although the nucleus comprises 249 points clumped close together, these points are independent of each other (they also rotate around each other), and so the 'nucleus' size and shape is not static (the simulation is not optimised for a nucleus). Table 1. gives the relative values and the x, y co-ordinates for the electron, nucleus center and barycenter.



H atom electron transition spiral plotting the nucleus and barycenter as the electron transitions from $n=1$ to $n=8$

$$j_{atom} = 250 \text{ (atomic mass)}$$

$$i_{nucleus} = j_{atom} - 1 = 249 \text{ (relative nucleus mass)}$$

$$r_{wavelength} = 2 \left(\frac{j_{atom}}{i_{nucleus}} \right)^2 = 2.0160965$$

$$r_{orbital} = 2\alpha * r_{wavelength} \text{ (radius)} = 552.5556$$

$$t_n = \frac{t_{sim}}{r_{wavelength}}$$

$$l_n = \frac{l_{sim}}{l_{orbital}} - l_{orbital}$$

$$r_b = r_{sim} - \frac{r_{sim}}{j_{atom}}$$

$$r_n = \frac{r_b}{r_{orbital}}$$

table 1. Electron transition (mass = 250; r_n = 1 to 5)

r_n	t_{sim}	l_n	angle	x, y (electron)	x, y (nucleus)	x, y (barycenter)
1	471957.072	0.9999897	360°	550.334, 0.0036	-2.2102, -0.00002	-0.00004, -0.00001
4	1887867.293	2.000012	359.952489°	2202.8558, 0.0001	-7.9565, -1.9475	0.8868, -1.9397
9	4247689.502	4.000014	119.92712°	-2473.180, 4296.283	13.558, -10.325	3.611, 6.901
16	7551439.538	6.000014	179.91669°	-8815.254, 12.818	25.636, 13.303	-9.728, 13.301
25	11799118.905	8.000014	215.9122°	-11158.64, -8081.13	16.580, 39.083	-28.118, 6.602

Comparison of the spiral angle at $r_n = 4$ (360°), 9 (360+120°), 16 (360+180°) with different mass ($m = 64, 128, 250, 500$, Rydberg). For the proton:electron mass ratio; $m = 1836.15267...$

table 2. Spiral angle at $r_n = 4, 9, 16$

mass	$r_n = 4$	$r_n = 9$	$r_n = 16$
$m = 64$	359.80318°	119.70323°	179.66239°
$m = 128$	359.90394°	119.85415°	179.83377°
$m = 250$	359.95249°	119.92711°	179.91669°
$m = 500$	359.97706°	119.96501°	
Rydberg	360°	360+120°	360+180°

Geometrically coded universe

- [Simulation_hypothesis_\(Planck\)](#): A geometrical Planck scale simulation universe
- [Electron_\(mathematical\)](#): Mathematical electron from Planck units
- [Planck_units_\(geometrical\)](#): Planck units as geometrical forms
- [Physical_constant_\(anomaly\)](#): Anomalies in the physical constants
- [Quantum_gravity_\(Planck\)](#): Gravity at the Planck scale
- [Fine-structure_constant_\(spiral\)](#): Quantization via pi
- [Relativity_\(Planck\)](#): 4-axis hypersphere as origin of motion
- [Black-hole_\(Planck\)](#): CMB and Planck units
- [Sqrt_Planck_momentum](#): Link between charge and mass

External links

- [Planck scale modelling using geometrical objects \(https://codingthecosmos.com/\)](https://codingthecosmos.com/)
- [Our Mathematical Universe: My Quest for the Ultimate Nature of Reality \(https://www.amazon.com/Our-Mathematical-Universe-Ultimate-Reality/dp/0307599809\)](https://www.amazon.com/Our-Mathematical-Universe-Ultimate-Reality/dp/0307599809) -Max Tegmark (Book)
- [Dirac-Kerr-Newman black-hole electron \(https://link.springer.com/article/10.1134/S0202289308020011/\)](https://link.springer.com/article/10.1134/S0202289308020011/) -Alexander Burinskii (article)
- [Pythagoras "all is number" \(https://plato.stanford.edu/entries/pythagoras/\)](https://plato.stanford.edu/entries/pythagoras/) - Stanford University
- [Mathematical universe hypothesis](#)
- [Philosophy of mathematics](#)
- [Philosophy of physics](#)
- [Platonism](#)

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