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3. Simulating gravity via Planck scale n-body particle-particle orbital pairs

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An orbital simulation program is described that uses a geometrical approach to modeling gravitational and atomic orbits at the Planck scale. Orbiting objects A, B, C... are sub-divided into points, each point representing 1 unit of Planck mass, for example, a 1kg satellite would divide into 1kg/Planck mass = 45940509 points. Each point in object A then forms a rotating orbital pair with every corresponding 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 Planck length per unit of Planck time at velocity c in hypersphere space co-ordinates, the results are then summed and averaged to give the new co-ordinates, the program then repeats. When these rotations are mapped over time on a 2-D plane (representing 3D space), objects A, B, C... appear to be orbiting each other. The basic simulation uses the fine structure constant alpha as an orbital constant to simulate gravitational orbit parameters. As each orbital comprises only 2 points, 1 at each orbital pole, information regarding the objects A, B, C... ; momentum, size, center of mass, barycenter etc ... is not required, instead only the start (x, y, z) co-ordinates of each point are defined. Each point, by having a mass of Planck mass, is itself a construct of multiple particles, and so we can also form individual particle to particle orbital pairs. The simulation uses only geometry, no dimensioned constants (G, h, c ...) are required, although the results can be measured in Planck units for comparison. Points are physically linked together by a unit of momentum (a graviton), the rationale for this is described in a subsequent article on atomic orbitals.

1 Gravitational orbitals

The following describes an orbital simulation program that uses a geometrical approach to emulate atomic and gravitational orbits at the Planck scale. For gravity, all orbiting objects in the 'simulation universe' are sub-divided into discrete points, each point corresponding to 1 unit of Planck mass m_P, for example a 1kg satellite would divide into 1kg/mP =45940509 points. All 45940509 points would then form orbital pairs with every other point in the simulation creating a universe-wide n-body complex of point-to-point orbital pairs with the points located at each pole of the orbital.

Each orbital rotates 1 unit of length per increment to the time variable. This would be analogous to 1 unit of Planck length l_p per unit of Planck time t_p at velocity $v = c = l_p/t_p$ in a 4-axis hypersphere coordinate system [1]. As the orbitals are circular (on a 2D plane) with the points located at each orbital 'pole', the barycenter for each orbital is the orbital center. After 1 (Planck unit) rotation step of all orbitals, the results are summed and averaged giving the new co-ordinates for each point. As such the program can be run on a serial processor. When mapped over time, orbits emerge between the objects.

To emulate observed gravitational orbital parameters, the fine structure constant alpha is included in the orbital radius as an orbital constant (note: for the program to emulate atomic orbitals, an extra alpha term is required as atomic orbital rotations are slower than gravitational [4]). As gravitational orbits between objects is a time-emergent property, information regarding the objects themselves; momentum, size, center of mass, barycenter etc ... is not required at any unit time.

Gravitational potential and kinetic energies become measures of orbital alignment, if the orbitals are all aligned a lateral movement (a circular orbit) occurs, if they are unaligned the object will 'fall' (straight line orbit). Elliptical orbits reflect the degree of nonalignment.

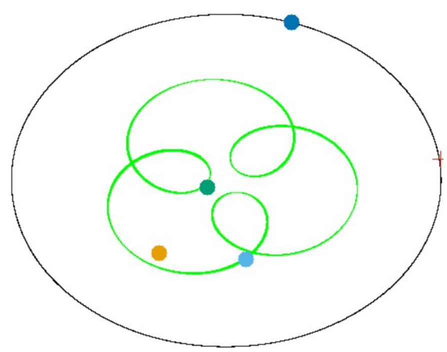

Fig. 1: 4-body orbit; 1 outer point, 3 center points, 6 orbitals [2]

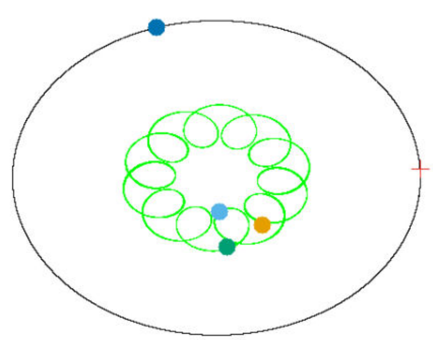

Fig. 2: 4-body orbit; 1 outer point, 3 center points, 6 orbitals [2]

2 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 an 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 is given in the mathematical electron model [5].

As an illustration, if the electron 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 an object composed only of electrons to have 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 (although actually this is the average object mass over time). For the simulation program, this object can now be defined as a point (it will have point co-ordinate's at each unit of Planck time and so can be mapped). As the simulation is dividing the mass of objects into Planck mass points and then rotating these points around each other as point-to-point orbital pairs, then by definition gravity becomes 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 particle to particle orbitals for which both particles are in the wave-state, the H atom is a well-researched particle-to-particle orbital pair (electron orbiting a proton) and so is used as reference [4].

In summary, both gravitational and atomic orbitals reflect the same particle-to-particle orbital pairing, the distinction being the state of the particles; mass to mass or 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).

3 N-body orbitals

The simulation universe is a 4-axis hypersphere expanding in increments [1], with 3-axis (the hypersphere surface) representing 3-D space 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 geometries. To translate to dimensioned gravitational or atomic orbits, we can use the Planck units (mass m_P, length l_p, 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 $c = l_p/t_p$). These rotations are then all summed and averaged to give new point co-ordinates.

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

$$\beta = \frac{1}{r_{orbital}\sqrt{r_{orbital}}} \tag{1}$$

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.

4 2-body orbits (x, y plane)

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) ... 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

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

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 reduces to 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 (Planck) length unit (in 3-axis), the new co-ordinates after each orbital rotation are averaged and summed, the process then repeats. After 1 complete orbit (return to the start position by the orbiting point on the x, y plane), the period t (as the number of increments to the simulation clock) and the orbit length l (distance as measured on the x, y plane) are noted.

4.1. Initialize

i) $r_s = i$ = number of center points in the orbit (center mass)

ii) j = total number of points (for simple 2 body orbits with only 1 orbiting point; $j = i + 1$)

iii) j_{max} = mass to radius co-efficient

iv) x, y start co-ordinates for each point ($z = 0$)

v) r_α = radius constant. To emulate gravitational orbits, this constant is assigned $\sqrt{2\alpha}$ where α (inverse fine structure constant) = 137.035 999 084 (CODATA 2018)

$$r_\alpha = \sqrt{2\alpha} = 16.55512 \tag{3}$$

$$r_{orbital} = {r_\alpha}^2 r_{wavelength} \tag{4}$$

4.2. Orbital formulas (2-D plane)

$$r_{wavelength} = 2(\frac{j_{max}}{i})^2 \tag{5}$$

radius of orbiting point (from center)

$$r_{outer} = r_\alpha^2 r_{wavelength} = 4\alpha(\frac{j_{max}}{i})^2 \tag{6}$$

barycenter

$$r_{barycenter} = \frac{r_{outer}}{j} \tag{7}$$

velocity of orbiting point

$$v_{outer} = \frac{j}{j_{max} r_\alpha} \tag{8}$$

velocity of center points

$$v_{inner} = \frac{1}{j_{max} r_\alpha} \tag{9}$$

period of orbit

$$t_{outer} = \frac{2\pi r_{outer}}{v_{outer}} = 4\pi(\frac{j_{max} r_\alpha}{i})^3 \tag{10}$$

distance travelled

$$l_{outer} = 2\pi(r_{outer} - r_{barycenter}) \tag{11}$$

4.3. Simulation data

1. t = orbital period
2. l = orbital length

$$l_{sim} = t\frac{i}{j_{max} r_\alpha} \tag{12}$$

$$r_{sim} = \frac{l}{2\pi} \tag{13}$$

$$v_{sim} = \frac{l}{t} = \frac{i}{j_{max} r_\alpha} \tag{14}$$

$$b_{sim} = \frac{x_{max} + x_{min}}{2} \tag{15}$$

4.4. Examples.

4.4.1. 8 mass points (28 orbitals) divided into j = 8 (total points), $i = j$ - 1 (7 center mass points). After 1 complete orbit, period t and length l are noted.

1) j_{max} = i+1 = 8
period t = 74465.0516, t_{outer} = 74471.6125
length $l = l_{sim}$ = 3935.7664, l_{outer} = 3936.1032
radius r_{sim} = 626.3951
velocity v_{sim} = 1/18.920137
barycenter b_{sim} = 89.5241, $r_{barycenter}$ = 89.4929

1)j_{max} = 32*i+1 = 225
period t = 1656793370.3483, t_{outer} = 1656793381.3051
length $l = l_{sim}$ = 3113519.1259, l_{outer} = 3113519.1385
radius r_{sim} = 495531.959
velocity v_{sim} = 1/532.128856
barycenter b_{sim} = 70790.283, $r_{barycenter}$ = 70790.280

4.4.2. From the standard gravitational parameters, the earth to moon mass ratio approximates 81:1 and so we can reduce to 1 point orbiting a center of mass comprising i = 81 points, $j = i + 1 = 82$;

$$\frac{3.986004418\ x10^{14}}{4.9048695\ x10^{12}} = 81.2663 \tag{16}$$

$$r_{earth-moon} = 384400km \tag{17}$$

$$M_{earth} = 0.59737810^{25}kg \tag{18}$$

Solving j_{max}

$$r_{outer} = {r_\alpha}^2 * 2(\frac{j_{max}}{i})^2 = \frac{2 r_{earth-moon} m_P}{M_{earth} l_p} \tag{19}$$

$$j_{max} = 1440443 \tag{20}$$

Gives

$$t_{outer} = 4\pi(\frac{j_{max} r_\alpha}{i})^3 (\frac{l_p}{c}) = 0.8643\ 10^{-26}s \tag{21}$$

$$t_{outer}\frac{M_{earth}}{m_P} = 2371844s = 27.452days \tag{22}$$

$$v_{Moon} = (c)\frac{i}{j_{max} r_\alpha} = 1018.3m/s \tag{23}$$

$$v_{Earth} = (c)\frac{1}{j_{max} r_\alpha} = 12.57m/s \tag{24}$$

$$r_{barycenter} = \frac{r_{earth-moon}}{j} = 4688km \tag{25}$$

5 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;

$$\alpha_G = \frac{Gm_e^2}{\hbar c} = \frac{m_e^2}{m_P^2} = 1.75...x10^{-45} \tag{26}$$

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). The (inverse) α_G then represents the probability that any 2 electrons will be in the mass point-state at any unit of Planck time.

$$\alpha_G{}^{-1} = \frac{m_P^2}{m_e^2} = 0.57...x10^{45} \tag{27}$$

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. 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.

$$\frac{\alpha_G{}^{-1}}{t_p} \tag{28}$$

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.

For example a 1kg satellite orbits the earth, for any unit of (Planck) time satellite (A) will have $1kg/m_P = 45.9\ x10^6$ particles in the point-state.

The earth (B) will have $5.97\ x10^{24} kg/m_P = 0.274\ x10^{33}$ particles in the point-state, and so the number of links (rotating orbital pairs for any unit time) between the earth and the satellite will sum to;

$$N_{orbitals} = (\frac{m_A}{m_P})(\frac{m_B}{m_P}) = 0.126\ x10^{41} \tag{29}$$

With each increment to the simulation clock *age*, the rotating orbital pairs will change as different particles enter/leave the mass-point state, nevertheless the average number of orbitals remains the same. A gravitational orbit of the satellite around the earth emerges as a natural consequence.

Examples (i = earth as center mass):

$$i = \frac{M_{earth}}{m_P} = 0.27444\ x10^{33} \tag{30}$$

$$r_s = i2l_p = 0.00887m \tag{31}$$

$$s = \frac{1kg}{m_P} = 45940509 \tag{32}$$

$$j = N_{orbitals} = i * s = 0.1261\ x10^{41} \tag{33}$$

5.1.1. 1kg satellite at earth surface orbit, 6371 km

$$r_o = 6371000m \tag{34}$$

$$j_{max} = \frac{j}{r_a}\sqrt{\frac{r_o}{il_p}} = 0.288645\ x10^{44} \tag{35}$$

$$n_g = \frac{j_{max}}{j} = 2289.41 \tag{36}$$

$$r_o = r_\alpha^2 n_g^2 il_p \tag{37}$$

$$v = \frac{c}{n_g r_\alpha} = 7909.7924m/s \tag{38}$$

$$t = 2\pi\frac{r_{outer}}{v_{outer}} = 5060.8374s \tag{39}$$

5.1.2. 1kg satellite at synchronous orbit, 42164.17 km

$$r_o = 42164170m \tag{40}$$

$$j_{max} = \frac{j}{r_a}\sqrt{\frac{r_o}{il_p}} = 0.74256\ x10^{44} \tag{41}$$

$$n_g = \frac{j_{max}}{j} = 5889.674 \tag{42}$$

$$r_o = r_\alpha^2 n_g^2 il_p \tag{43}$$

$$v = \frac{c}{n_g r_\alpha} = 3074.66m/s \tag{44}$$

$$t = 2\pi\frac{r_{outer}}{v_{outer}} = 86164.092s \tag{45}$$

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

$$E_{orbital} = \frac{hc}{2\pi r_{6371}} - \frac{hc}{2\pi r_{42164}} = 0.412\ 10^{-32}J \tag{46}$$

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

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

5.3. The orbital angular momentum of the planets derives from the angular momentum of the respective orbital pairs.

$$N_{sun} = \frac{M_{sun}}{m_P} \tag{47}$$

$$N_{planet} = \frac{M_{planet}}{m_P} \tag{48}$$

$$N_{orbitals} = N_{sun} N_{planet} \tag{49}$$

$$n_g = \sqrt{\frac{R_{radius} m_P}{2\alpha l_p M_{sun}}} \tag{50}$$

Orbital angular momentum L_{oam}

$$L_{oam} = 2\pi \frac{Mr^2}{T} = N_{orbitals}\ n_g \frac{h}{2\pi} \sqrt{2\alpha},\ \frac{kgm^2}{s} \tag{51}$$

mercury = 0.9153 x10^{39}
venus = 0.1844 x10^{41}
earth = 0.2662 x10^{41}
mars = 0.3530 x10^{40}
jupiter = 0.1929 x10^{44}
pluto = 0.365 x10^{39}

Orbital angular momentum combined with orbit velocity cancels n_g giving an orbit constant.

$$L_{oam} v_g = N_{orbitals}\ \hbar c,\ \frac{kgm^3}{s^2} \tag{52}$$

6 Orbital trajectory (circular vs. straight)

Orbital trajectory is a measure of alignment of the orbitals; if all orbitals rotate in the same direction = aligned = circular orbit, if all orbitals are unaligned there will be no net lateral motion and the object will appear to 'fall'. The degree of orbit eccentricity reflects the ratio of orbital alignments.

In this example (fig. 3), for comparison, onto a regular 8-body orbit (blue circle), is imposed a single point (yellow dot) with a ratio of 1 orbital (left rotation) to 2 orbitals (right rotation) giving an elliptical orbit around the center or mass (green circle). The change in orbit velocity (acceleration towards the center and deceleration from the center) derives automatically from the change in the orbital radius (see also electron transition between orbitals [4]).

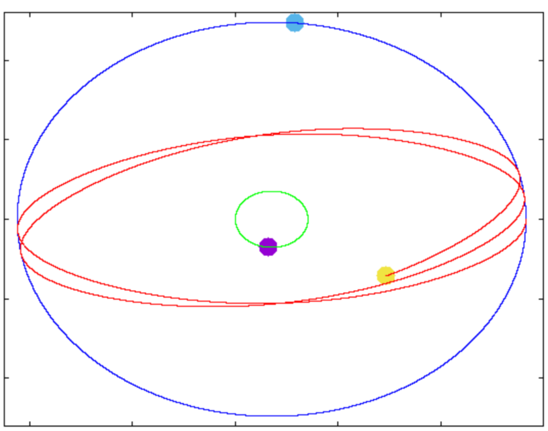

Fig. 3: Circular orbit with opposing orbitals ratio 1:2 [2]

7 Precision

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

radius of curvature L

$$L = \frac{b^2}{a} = \frac{\alpha l^4 \lambda_{sun}}{n^2} \tag{53}$$

$$\frac{3\lambda_{sun}}{2L} = \frac{3n^2}{2\alpha l^4} \tag{54}$$

arc seconds per 100 years (drift)

$$\frac{3n^2}{2\alpha l^4}.1296000.(\frac{100T_{earth}}{T_{planet}}) \tag{55}$$

Mercury = 42.98 (eccentricity = 0.205630)
a = 57909050 km (n = 378.2734)
b = 56671523 km (l = 374.2096)
Venus = 8.62
Earth = 3.84
Mars = 1.35
Jupiter = 0.06

8 Hyper-sphere

Each point moves 1 unit of (Planck) length per 1 unit of (Planck) time in x, y, z hyper-sphere co-ordinates [1] (the angle β determines the proportion of that length unit along the x, y plane) [3].

In (fig. 4), 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.

$$d = r_\alpha n_g \tag{56}$$

$$t_0 = 2\pi r = 2\pi \frac{2}{2\pi d} \tag{57}$$

$$v_{outer} = \frac{1}{d} \tag{58}$$

$$(B) \quad t_d = \sqrt{t^2 - {t_0}^2} = t\sqrt{1 - {v_{outer}}^2} \tag{59}$$

$$(A) \quad t_d = t\sqrt{1 - v_{inner}^2} \tag{60}$$

9 Atomic orbitals

The simulation presumes that for any unit of (Planck) time there are 2 particles in the mass point state forming a gravitational orbital, and rotates these accordingly. Nevertheless each orbital comprises 2 particles, and so if we retain the orbital when the 2 particles are both in the wave-state, then we can classify as atomic orbitals. The wave-state is defined by a

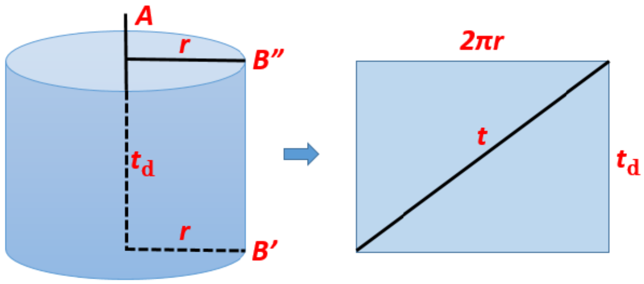

Fig. 4: illustration of B's orbit relative to the A time-line axis

wave-function, we can however map (assign co-ordinates to) the mass point-states (as the particles oscillate between wave and point) and so follow the electron orbit around the atomic nucleus.

Of particular note, the orbital radius (Bohr radius) is treated as a physical unit of momentum (standing wave) analogous to the photon (moving wave) albeit of inverse or opposite phase such that photon + radius = zero. Transition of the electron between energy levels is via absorption (or reverse) of the photon by the orbital radius. The electron has a passive role. By extension, the gravitational orbital is similarly linked, we may define this radius link by convention as a graviton. This is looked at in the article on the atom [4].

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