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4. Interpreting Planck scale gravitational orbitals via atomic orbital transitions

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An orbital simulation program is described that uses a geometrical approach to emulate gravitational and atomic orbits at the Planck scale. The gravitational orbital approach divides orbiting objects into multiples of Planck mass points to form an n-body complex of discrete point-to-point orbital pairs between the objects. Each orbital pair rotates 1 Planck length per unit of Planck time in a continuous loop such that when mapped over time gravitational orbits emerge. However 1 point may contain 10^{20} or more individual particles, and so to analyze individual particle-particle orbital pairing we can use atomic orbital transitions. For this, the gravitation simulation program is modified to map the orbital of an electron-proton pair (H-atom) by the addition of an alpha (fine structure constant) term. For transitions, the incoming photon is absorbed by (or ejected from) the orbital radius in discrete alpha steps (the orbital radius is assigned photon-like properties), the electron itself has a passive role in the transition process. An orbital radius variable δ; orbital radius = $(2\alpha + \delta)$*λ(electron+proton), was selected to correlate with the Lyman series transition frequencies. A linear relationship was observed between δ and these frequencies with notably at $\delta \sim 0$ (the classical Bohr model), the principal quantum number n = sqrt(2) and the transition energy = half ionization energy.

Table 1	radius δ	$f_{simulation}$ (kHz)	$f_{experimental}$ (kHz)
H(1s)	0.001633397738	0	
H(1s- $\sqrt{2}$ s)	-0.000044356388	1644035417885.869	
H(1s-2s)	-0.000954660863	2466061413187.031	2466061413187.035
H(1s-3s)	-0.001483071027	2922743278665.790	2922743278665.79
H(1s-4s)	-0.001672037031	3082581563822.636	3082581563822.6
H(1s-2^{24}s)	-0.001918147567		
H(1s-∞)			3288087922407.2

1 Introduction

A Planck scale gravitational orbital model [1] has been proposed that divides objects into points where each point represents a discrete unit of Planck mass m_P, which can then be assigned co-ordinates for mapping, for example a 1kg satellite, would sub-divide into 1kg/m_P = 45940509 points.

Each point then forms an orbital pair with all other points resulting in a universe-wide n-body network of rotating (1 Planck length l_p per unit of Planck time t_p) orbital pairs. After each unit of Planck time, the results are averaged and the new co-ordinates for each point calculated. This process occurs in a continuous loop.

The model treats particles as continuous waves that oscillate between an electric wave-state (duration particle frequency in Planck time units) to a Planck mass point-state (duration $1t_p$). An electron has a frequency = $10^{23}t_p$ and so if an object has 10^{23} electrons for example, then on average 1 electron will be in the mass-state at any given unit of Planck time ($1m_P$ per t_p), average mass then = Planck mass and so gravity (orbital pair rotation) can occur at each unit of Planck time.

Although the gravity model operates at unit Planck time, each point is the sum of about 10^{20} particles and these are predominately in the wave-state (gravity interactions can be ignored), and so to study these underlying events, the simulation is modified by the addition of an alpha (fine structure constant) term. This permits to analyze individual particle-particle orbital pairing via the orbit of an electron-proton pair.

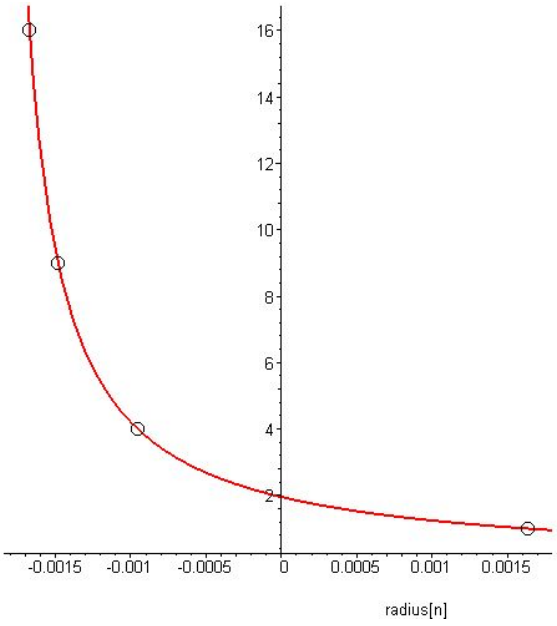

Fig. 1: δ (x-axis) vs n^2 (y-axis), Lyman series

Features;

1. The electron and proton wavelengths are combined $\lambda_H = \lambda_e + \lambda_p$ and then divided into alpha units to form the orbital (Bohr) radius.
2. Orbital rotations occur in λ_H steps. After each step the electron has point (point-state) co-ordinates and so can be mapped.
3. During transition, the orbital radius absorbs (or ejects) the photon in alpha unit steps, the velocity component can then be calculated for each step giving a precise average velocity. The orbital radius is treated as physically analogous to the photon albeit of inverse or reverse phase, the electron itself has a passive role in transition.
4. An orbital radius variable δ is used to correlate radius with observed transition frequencies.

orbital radius = $(2\alpha + \delta)\ \lambda_H$

In fig.1 δ is mapped against the principal quantum number n, in fig.2 δ is mapped against transition energy in eV. Crossover ($\delta = 0$) occurs at $n = \sqrt{2}$ at half ionization energy = 6.7992eV.

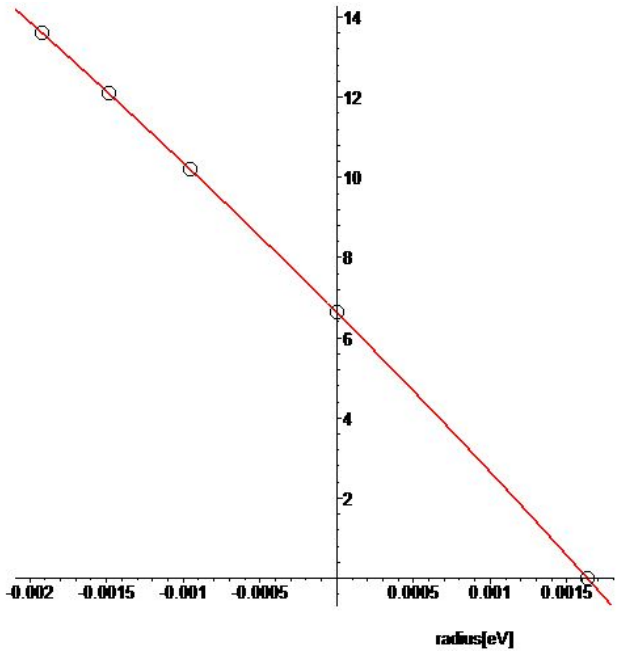

Fig. 2: δ (x-axis) vs eV (y-axis), Lyman series

2 Simulation

The orbital radius is divided into sub-segments (alpha units) joined together in series. The wavelength of the orbital radius is the sum of these segments. To reduce computation, the λ_H component is added later.

$$\alpha_{unit} = \frac{1}{2\pi 2\alpha} \tag{1}$$

The simulation assigns the electron point-state co-ordinates (blue dot, fig.3). After each wave to point oscillation cycle, the electron point jumps (the actual motion of the electron occurs during the electron wave-state) 1 step, plotting over time an orbit around a center.

The angle of rotation is β (see also gravitational orbitals), the β of atomic orbitals include an extra $\sqrt{2\alpha}$ term). The radius of a basic (Bohr) orbital radius $r_{orbital} = 2\alpha n^2$ ($\delta = 0$).

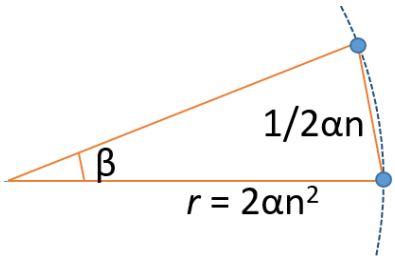

Fig. 3: rotating orbital alpha step

On the 2-D plane

$$r_{orbital} = 2\alpha n^2 \tag{2}$$

$$v_{orbital} = \frac{1}{2\alpha n} \tag{3}$$

$$\beta = \frac{1}{r_{orbital}\sqrt{r_{orbital}}\sqrt{2\alpha}} \tag{4}$$

And so for the basic orbital, where the orbital number n=1 and $\delta = 0$, to complete 1 rotation of the alpha orbital by the electron would require a period approximately 471964 steps, where each step is the duration of 1 wave to point oscillation (measured in Planck time units). However for the purpose of the simulation (to reduce computation), only the alpha units are calculated. The (inverse) alpha = 137.035999177 [7] is used as this is the more familiar. The Bohr radius then becomes a physical construct of these 471964 alpha units added together in series.

$$t_{ref} = 2\pi 4\alpha^2 \sim 471964 \tag{5}$$

3 Transition (theory)

The orbital radius is treated as physically analogous to the photon albeit of inverse or reverse phase, and as such it is the orbital radius that absorbs or ejects the photon during transition, in the process the orbital radius is extended (until the photon is completely absorbed). Conversely the orbital radius may eject a photon, the above in reverse. This process occurs in steps, at each step the orbital radius continues to rotate, the electron, being pulled along by this rotation according to angle β, thereby describes a spiral path (fig.4) as the orbital radius length changes (the electron has a passive role in the transition phase).

The photon is divided into units of r_{incr} which are equivalent to alpha units albeit of reverse or inverse phase such that

$$r_{incr} = \frac{-1}{2\pi 2\alpha} \tag{6}$$

This repeats for the wavelength of the photon λ_{photon}, until the photon has been completely absorbed by, or ejected from, the orbital radius (which in turn has extended or contracted accordingly).

$$r_{orbital} = r_{orbital} - r_{incr} \tag{7}$$

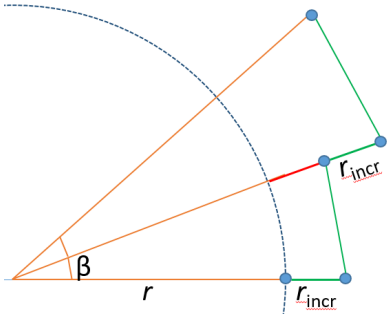

Fig. 4: orbital radius absorbing units from the photon

If the wavelength of λ_{photon} = the wavelength of the orbital radius $\lambda_{orbital}$, and as these waves are of inverse phase, the orbital radius will be deleted. This is defined as ionization.

$$\lambda_{orbital} + \lambda_{photon} = zero \tag{8}$$

However, an incoming photon separates into 2 photons (initial and final) as per the Rydberg formula.

$$\lambda_{photon} = R\,(\frac{1}{n_i^2} - \frac{1}{n_f^2}) = \frac{R}{n_i^2} - \frac{R}{n_f^2} \tag{9}$$

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

The (λ_i) will subtract from the orbital radius as described above, however the (λ_f), because of the Rydberg minus term $-(\lambda_f)$, will have the same phase as the orbital radius and so conversely will increase the orbital radius ($-r_{incr} = \alpha_{unit}$). Therefore, for the duration of the (λ_i) photon wavelength, the orbital radius does not change, as the $+r_{incr}$ $(+\lambda_i)$ and $-r_{incr}$ $(-\lambda_f)$ segments cancel.

$$r_{orbital} = r_{orbital} + (\lambda_i) - (\lambda_f) = r_{orbital} + r_{incr} - r_{incr} \tag{10}$$

The (λ_f) has the longer wavelength, and so after (λ_i) has been absorbed by the orbital radius, and for the remaining duration of this photon wavelength, at each transition step the orbital radius will be extended (fig.4).

At each step, as the orbital radius increases, the orbital rotation angle β will conversely decrease, and as the velocity of orbital rotation depends on β, the velocity will adjust accordingly (for each step), thus we can also calculate the relativistic velocity using the z-axis per step (see Hypersphere) rather than estimating an average velocity for the transition.

For an n_i=1 ($\lambda_i = 1t_{ref}$) to n_f=2 ($\lambda_f = 4t_{ref}$) orbital transition, the (λ_i) photon absorption by the n_i=1 orbital requires $1t_{ref}$ steps, the remaining (λ_f) still has $3t_{ref}$ segments (of r_{incr}) left, and so transition continues for another $3t_{ref}$ steps. A n_i=2 to n_f=3 transition would require $t = 4t_{ref} + (9\text{-}4)t_{ref}$ steps.

In (figs. 5, 6), the electron begins in the n_i=1 orbital rotating anti-clockwise. A photon $\lambda_{photon} = (\lambda_{1s}) - (\lambda_{2s})$ strikes this orbital raising the electron to the $n = 2$ orbital in discrete steps. A 2nd photon $\lambda_{photon} = (\lambda_{2s}) - (\lambda_{3s})$ then strikes this orbital raising the electron to the $n = 3$ orbital. The spiral pattern emerges because the electron is continuously pulled in an anti-clockwise direction by the rotating orbital. During the transition phase, only the orbital radius changes, the electron itself has a passive role.

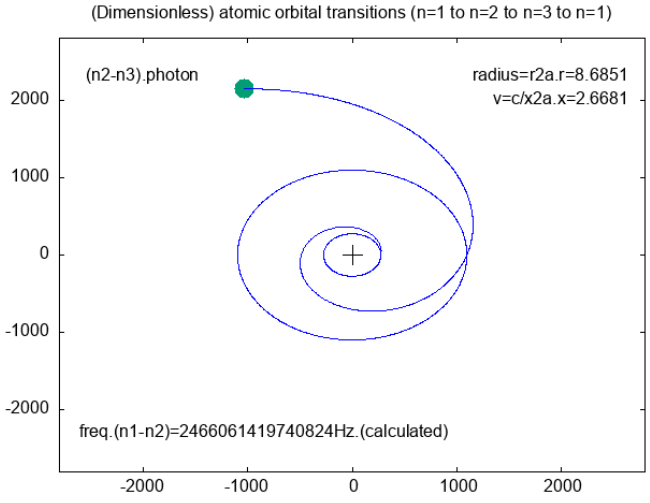

Fig. 5: alpha orbital transition animation 2D [3]

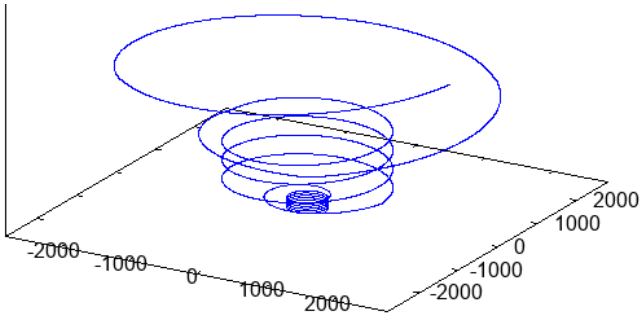

Fig. 6: alpha orbital transition animation 3D [3]

4 Hypersphere

The above is depicted on a 2D plane (in 3D space). If we place the orbital in a 4D expanding hypersphere [4] then we find the orbital is rotating at c in hypersphere co-ordinates [1]. In (fig. 7), while B has a circular orbit period on the 2-axis

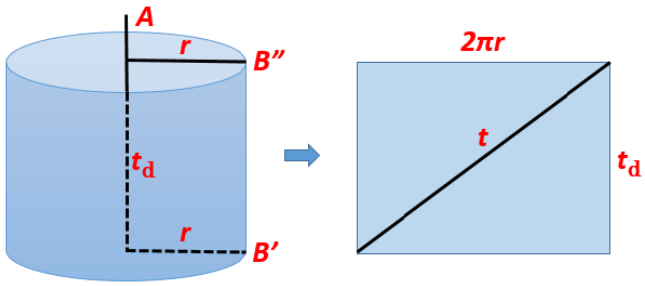

Fig. 7: illustration of B's orbit relative to the A time-line axis

δ-y plane (horizontal axis as 3-D space) around A (center of mass), it also follows a cylindrical orbit (from B' to B'') around the A (vertical) hyper-sphere time-line expansion axis (the z-axis of the simulation). A moves 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 giving the familiar formula [2].

$$t_d = t\sqrt{1 - \frac{v^2}{c^2}} \tag{11}$$

5 Transition (method)

$$r_{orbital} = (2\alpha + \delta) \tag{12}$$

Period of orbit; l_{step} is the distance traveled along the x-y plane (3D space) giving $t_{orbital}$ as the period measured along the orbital timeline (z-axis) in hyper-sphere co-ordinates.

$$t_{orbital} = n_i 2\pi r_{orbital} \frac{\sqrt{1 - l_{step}^2}}{l_{step}} \tag{13}$$

Electron transition, raising the electron to a higher energy level, can occur when a photon strikes. The incoming photon separates, $t_{orbital}$ is the period of the λ_i photon.

$$\lambda_{photon} = (+\lambda_i) + (-\lambda_f) \tag{14}$$

Once λ_i has been absorbed, λ_f continues adding to the orbital radius until it too is absorbed, giving $t_{transition}$. For a transition from an ($n = i$) initial orbital to ($n = f$) final orbital, l_{step} is a function of angle β and thus of radius (β, as a function of radius, reduces as the radius extends), and so an l_{step} value is calculated for each step, $t_{transition}$ then becoming the total period summed (from each l_{step}) over the transition. Periods $t_{orbital}$ and $t_{transition}$ are then added.

$$H_{n_i - n_f} = (n_f - n_i)\,\frac{2c}{(\lambda_e + \lambda_p)}\,\frac{1}{(t_{orbital} + t_{transition})} \tag{15}$$

To calibrate the average radius ($2\alpha + \delta$) over the transition process we can use the following frequencies.

H_{1s-2s} = 2466 061 413 187.035 kHz([5])
H_{1s-3s} = 2922 743 278 665.79 kHz ([6])
H_{1s-4s} = 3082 581 563 822.63 kHz [7])

δ values for each n

$$r_{averaged} = 2\alpha + \delta_{ns} \tag{16}$$

$$\delta_{2s} = -0.000954660863,\ 4r_{1s} - r_{2s} = 0.00124 \tag{17}$$

$$\delta_{3s} = -0.001483071027,\ 9r_{1s} - r_{3s} = 0.00547 \tag{18}$$

$$\delta_{4s} = -0.001672037031,\ 16r_{1s} - r_{2s} = 0.0123 \tag{19}$$

Extrapolating

$$n^2 = 2,\ \delta = -0.000044356388 \tag{20}$$

$$\delta = 0,\ n^2 = 1.951048816 \tag{21}$$

Ionization energy/2

$$eV = 6.79922,\ \delta = -0.00004437128 \tag{22}$$

$$\delta = 0,\ eV = 6.62856911 \tag{23}$$

Ionization energy

$$n = 2^{24},\ \delta = -0.0019181476 \tag{24}$$

$$eV = 13.59843797,\ \delta = -0.0019181479 \tag{25}$$

Measuring transition energy in eV, whereby 0eV would be a state of no-transition (the electron remaining in the n = 1s orbital). See atomic orbitals fig. 1, 2.

$$eV = 0,\ \delta = 0.00163335174 \tag{26}$$

$$\delta = 0.00163335174,\ n = 1.00000723202 \tag{27}$$

For clarity, if we shift our graph by $\delta = -0.00004437128$ then we see an apparent correlation between δ=0 and n=sqrt(2) giving a classical Bohr radius $\lambda_{orbital} = 2\alpha(\lambda_e + \lambda_p)n^2$.

$$eV = 6.79922,\ \delta = 0,\ n^2 = 2.000016823 \tag{28}$$

The Positronium $1s - 2s$ transition
P (f_{1s-2s}) = 1233 607 216.4 MHz [8]

$$r_{orbital} = 2\alpha + 0.01311882852 \tag{29}$$

6 He atom

The above considered a charge equivalence, 1 electron to 1 proton. If we expose the electron to more charge, then we can speculate on further changes to the orbital radius. To illustrate this, in this example t_{ref} = 471964 represents the ionization energy of H = 13.59844 eV, we then divide this into 4 parts each of $t_{ref}/4$ = 117986, with each part equivalent to 13.59844 eV. Under this scenario, if an electron orbits at a radius where t_{orbit} = 117986, then it will require 3*13.59844eV to reach a base H orbital (t_{ref} = 117986 + 3*117986) and then a further 13.59844eV to ionize from there. Total ionization energy = 4*13.59844eV = 54.4eV.

Ionization energies (1H = 13.59844 eV)

$$\lambda_{He} = \frac{l_p m_P}{6.64465723010^{-27} kg} = 0.529399491\ 10^{-16} m \quad (30)$$

The ionization energy of e_2 = 4.00018*H (54.417760 eV, 43890887.89 1/m). Measured in orbital radius units;

$$t_{e_2} = \frac{2}{(\lambda_{He} + \lambda_e)43890887.89} = t_{ref} H/e_2 = 117986 \quad (31)$$

e_1 = 24.587387 eV (19831066.9 1/m)
$t_{e_1} = t_{ref} H/e_1$ = 261027

As the first He electron e_1 is ionized (absorbing momentum), the remaining He electron e_2 drops to a lower orbital (ejecting momentum), thus subsidizing the ionization of e_1.

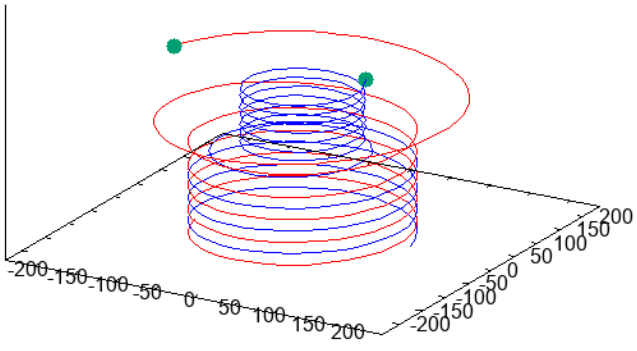

Fig. 8: He ionization; red electron dissociates forcing reduction in blue electron radius (to the new n=1 orbital) [3]

What this means is that e_1 can be at a lower orbital radius (than for the 261027). For example, both electrons are orbiting at a reduced radius whereby $t_{orbit} \sim$ 247310. From there for e_1 to reach t_{ref} requires 1.904H, but as e_2 simultaneously drops to 117986 (-1.096H), it transfers momentum in the process to e_1 (1.904-1.096 = 0.8081). From t_{ref}, e_1 then requires

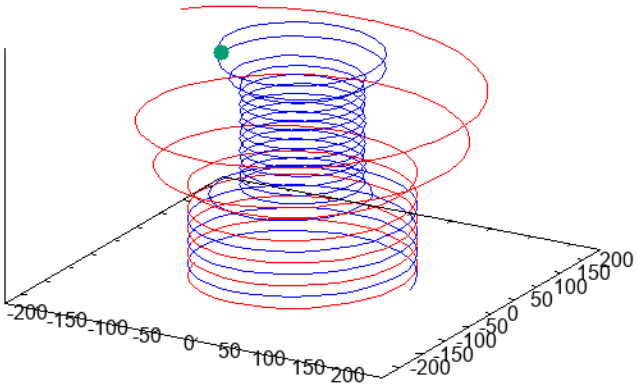

Fig. 9: subsequent He transition n=1 to n=2 (blue electron) [3]

1H to ionize; He -> He^+ = 1.8081H = 24.58 eV. Note, if we were to simultaneously ionize both electrons (He -> He^{2+}), then we would require 2.904H*2 = 78.98 eV. With only 1 electron remaining, the He atom is now treated as in the H atom example albeit the orbital radius is $(1/2)\alpha$.

7 Molecular bonding

Diatomic H2 atomic radius = 37pm. The orbital radius for the H atom was calculated at 2α (the base orbital) * (λ_e + λ_p) = 105.89pm. To simulate as a 'gravitational' orbit (anti-clockwise rotation with no allowance for charge); electrons (mass=1 point), protons (mass=1836 points), number of point to point orbitals = 6747301 [1]. We then adjust the distance between the protons while maintaining the distance from each electron to each proton = 105.89 respectively.

10.1. Proton start co-ordinates (0, 37) blue and (0, -37) red. Electron start co-ordinates (-99, 0) and (99, 0). Orbit center (0, 0). The electrons, although still 105.89pm from each proton, are now closer to each other at 2*99.46pm.

The H2 ionization energy (15.426eV) is 1.1344x greater than for the H atom (13.59844eV). Likewise combining the 2 electrons 105.89/99.46 = 1.06727 gives 1.13454.

Electrons 1/2 orbit, protons 1x orbit (fig.10), electrons 1x orbit, protons 2x orbit (fig.11). Period of electron orbit (r = 99.46) = 174230 = 2.8*($2\pi r^2$).

10.2. Protons (0, 33) and (0, -33), electrons (-100.6, 0) and (100.6, 0). At this radius the 2 protons act as a single center mass resulting in a circular orbit (fig.12).

10.3. Protons (0, 75) and (0, -75), electrons (-75, 0) and (75, 0), (fig.13). Although the electrons begin at 105.89pm from the protons, the electron path goes around the protons and the orbital radius increases proportionately.

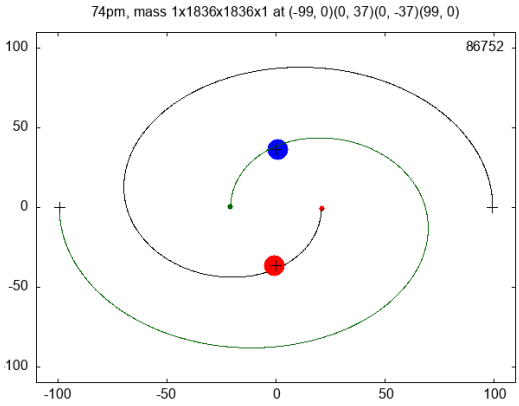

Fig. 10: 74pm proton-proton separation; protons 1x orbit [3]

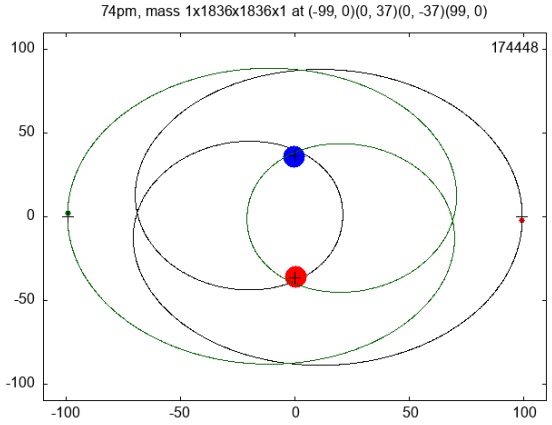

Fig. 11: 74pm proton-proton separation; protons 2x orbit [3]

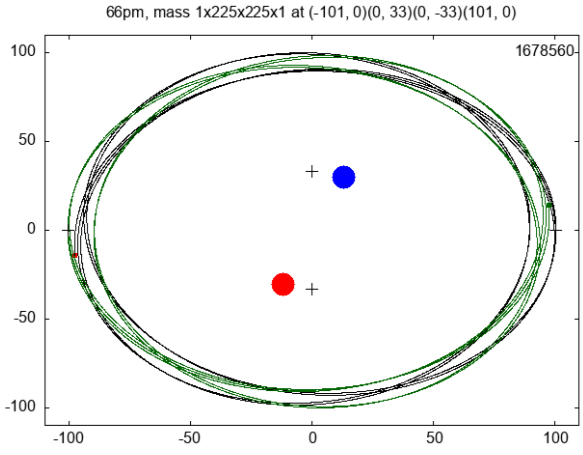

Fig. 12: 66pm proton-proton separation; start (0, 33), (101, 0) [3]

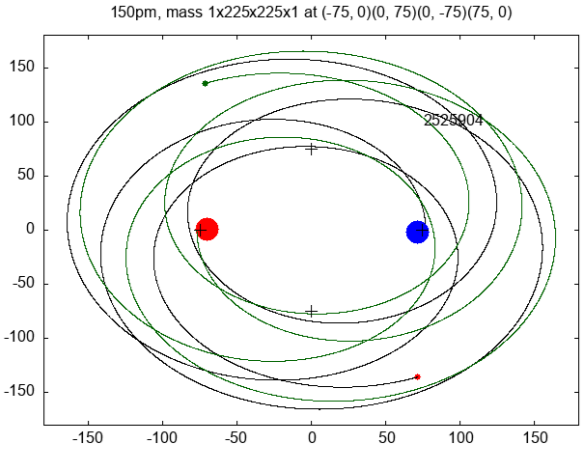

Fig. 13: 150pm proton-proton separation; start (0, 75), (75, 0) [3]

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