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Notes on Gravitons, Gravitational waves and Bohr

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In this essay, I outline a simple model based on a premise that wave-particle duality reflects a correspondent electric-gravity duality. It is the wave-state that characterizes the electric force interaction and the particle-state which characterizes the gravitational force interaction. Gravitons become waves mathematically equivalent to gravitational waves, differing only in phase. The counterparts for the atom are photons and atomic orbitals. The function is the same. A gravitational Rydberg formula is proposed, it suggests that gravitational waves are standing waves delineating the orbital path.

Outline:
The Bohr model[1] depicts the atom as a small, positively charged nucleus surrounded by electrons that travel in circular orbits around the nucleus—similar in structure to the solar system, but with electrostatic forces providing attraction, rather than gravity. Although considered incorrect by physicists; it does give correct results for selected systems. It was later replaced with a more useful wave model (depicting the electron and proton as waves).

Nevertheless, for certain simple orbits, the Bohr model was extremely accurate and still no one knows why.

The basic Bohr model uses –*c* (speed of light), –λ (wavelength), –*n* (principal quantum number; n = 1, 2, 3, 4…) and –α (Sommerfeld fine structure constant[2], $\alpha \approx 137.036$).

The basic formulas:
a) Radius:

$$R = \alpha\, n^2\, \lambda$$

For a simple 2 body system such as the earth and the moon, or an electron and a proton, we just add the wavelengths (this addition of 2 wavelengths ($\lambda = \lambda_1 + \lambda_2$) is commonly referred to as the reduced mass).

$$R = \alpha\, n^2\, (\lambda_1 + \lambda_2)$$

1. Hydrogen atom (radius electron + radius proton);

$$R_H = \alpha\, n^2\, (\lambda_e + \lambda_p)$$

$$R_e = \alpha\, n^2\, \lambda_e$$

$$R_p = \alpha\, n^2\, \lambda_p$$

2. Sun and earth (λ = Schwarzschild radius[3]);

$$R_{sun\ earth} = \alpha\ n^2\ (\lambda_{sun} + \lambda_{earth})$$

b) Velocity:

$$v_{electric} = \frac{c}{\alpha\ n}$$

$$v_{gravity}{}^2 = \frac{c^2}{2\ \alpha\ n^2}$$

c) Acceleration ($a = v^2/R$):

$$a_{electric} = \frac{c^2}{\alpha^3\ n^4\ \lambda}$$

$$a_{gravity} = \frac{c^2}{2\ \alpha^2\ n^4\ \lambda}$$

d) Period ($T = 2.\pi.R/v$):

$$T_{electric} = \frac{2\ \pi\ \alpha^2\ n^3\ \lambda}{c}$$

$$T_{gravity}{}^2 = \frac{8\ \pi^2\ \alpha^3\ n^6\ \lambda^2}{c^2}$$

Example; satellite orbiting earth surface
$\lambda_{earth} \approx .00887$m (Earth mass = 5.9742×10^{24}kg)[4]
$\lambda_{satellite} \approx 0$m
At n = 2290,
$R_g = \alpha * 2290^2 * (.00887 + 0) = 6374$km
$a_g = 9.81\text{m/s}^2$
$T_g = 5064.8$s
$v_g = 7907$m/s.
At n = 2291,
$R_g = 6380$km
$a_g = 9.79\text{m/s}^2$
$T_g = 5071.4$s
$v_g = 7904$m/s.

To calculate the semi-major axis R_a of an elliptical orbit, if we know period T, then we can use this approximation;

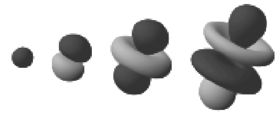
$$R_v = \frac{1}{2}\frac{T\ v_g}{\pi}$$

$$R_a = \frac{2}{3}R_v + \frac{1}{3}R_g$$

Example:
Semi-major axis for Mercury's orbit[9] around the Sun:
T = 87.9691days * 86400
a_o = 57 909 100km (observed)
a_K = 57 909 066km (Kepler's formula)
a_n = 57 909 096km (n = 378)

The Atom:

The basic model of the atom depicts quantized orbits[5]. For example;



For the purposes of this model, these orbitals are not regions where the electron may be found but instead physical standing waves which provide the boundary conditions for the electron orbit. I conjecture that they are mathematically identical to photons but of opposite phase, and so I have defined them as anti-photons. If we add 2 waves which are identical but of opposite phase then they cancel each other; therefore photon + anti-photon (atomic orbital) = 0.

The Rydberg formula[6]:

According to the incoming photon, the electron goes from the $n_{initial}$ orbital to the n_{final} orbital.

$$\lambda = R\,c\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)$$

Photon frequency (Hydrogen 1s to 2s)

Experimental: 2466061413 MHz[10]

If we calculate using only the above Rydberg formula (not including other effects[11])

Calculated: 2466038424 MHz (Rydberg formula)

For atoms where the nucleus is sufficiently massive as to ignore the mass of the electron, the Rydberg constant[7] is the most accurate of all the natural constants.

R = 10973731.568539(55) m^{-1}

The Rydberg formula may be re-written;

$$\lambda_{i-f} = \frac{R\,c}{n_i^2} - \frac{R\,c}{n_f^2}$$

We consider now the incoming photon λ_{i-f} as comprising 2 individual waves;

$$\lambda_{i-f} = \lambda_i - \lambda_f$$

$$\lambda_i = \frac{R\,c}{n_i^2}$$

$$\lambda_f = \frac{R\,c}{n_f^2}$$

The incoming λ_{i-f} photon hits the n_i orbital. The λ_i wave is equivalent to the n_i orbital (anti-photon) but of opposite phase. Likewise the λ_f wave is equivalent to the n_f orbital (anti-photon) but of opposite phase.

Initially the 'i' waves are added together such that $\lambda_i + n_i$ = '0' (both waves cancel each other).

Then, from the Rydberg formula; '0' + ($-\lambda_f$) = n_f. The phase of the λ_f wave is inverted thereby becoming automatically the n_f orbital.

By means of this simple wave addition, the electron orbit has been changed from n_i to n_f. The electron itself has not moved, however its boundary condition (the orbital) has changed.

Gravity:

Gravitational potential energy between 2 orbits:

$$\delta.\mu_{GPE} = \frac{G.M.m}{r_1} - \frac{G.M.m}{r_2}$$

Radius r_1 and r_2;

$$r_1 = \alpha.n_1^2.\lambda_g$$

$$r_2 = \alpha.n_2^2.\lambda_g$$

As Planck units;

$$\frac{G.M.m}{r_n} = \frac{l_p.c^2}{m_P} . M.m . \frac{1}{\alpha.n^2.\lambda_{M+m}}$$

$$\frac{G.M.m}{r_n} = \frac{h.c}{2.\pi.\alpha.n^2.\lambda_{M+m}} . \frac{M.m}{m_P^2}$$

Gives;

$$R = \frac{1}{2.\pi.r}.(\frac{1}{n_1^2} - \frac{1}{n_2^2})$$

$$R = \frac{1}{2.\pi.\alpha.\lambda_{M+m}}.(\frac{1}{n_1^2} - \frac{1}{n_2^2})$$

$$f = R.c.(\frac{1}{n_1^2} - \frac{1}{n_2^2})$$

$$E_{tot} = h.f. \frac{M.m}{m_P^2}$$

$$E_{graviton} = (\frac{h.R.c}{n_1^2} - \frac{h.R.c}{n_2^2})$$

$$E_{tot} = E_{graviton} . \frac{M.m}{m_P^2}$$

Example: Hitting a baseball into a geosynchronous orbit.
M = earth mass = 5.97×10^{24} kg
m = baseball mass = 1kg
The 2nd term gives the total number of gravitons N required to lift the baseball.

$f_{graviton} = n_{2290}$ orbit – n_{5890} orbit
$f_{graviton}$ = 7.485 - 1.132 = 6.354Hz

$$E_{graviton} = .421\times10^{-32}\ J$$
$$N_{gravitons} = M.m/m_P{}^2 = .126\times10^{41}$$
$$E_{total} = E_{graviton} \times N_{gravitons} = .53\times10^{8}\ (J/kg)$$

If analogous to the atom, the n = 2290 orbit would correspond to n = 2290 anti-gravitons, with 1 anti-graviton between each unit of (Planck) mass in both the earth and the baseball. The n = 5890 orbit would correspond to n = 5890 anti-gravitons. Applying the same principle as occurs in the atom, the baseball bat momentum generates gravitons that replace the n = 2290 orbit anti-gravitons with n = 5890 orbit anti-gravitons by the same process of wave addition.

We may note that, according to the 2nd term, every unit of Planck mass in the baseball is linked, via these anti-gravitons (gravitational orbits), to every unit of Planck mass in the earth; in other words, every single particle that comprises that baseball is linked to every single particle that comprises the earth… and so, by extrapolation, to every single particle in the universe.

The frequency of the anti-gravitons corresponds to our notion of gravitational waves, 7.48Hz corresponds to the circumference of the earth (c/7.48Hz = 40050km). Earth gravitational waves are merely standing waves around the earth, they delineate the orbit boundary, and this neatly corresponds with the model of the atomic orbitals.

Summary:

This paper was constructed upon these assumptions[12];

1. That atomic orbitals are standing waves that are mathematically identical to photons albeit an inverse of phase, hence the designation anti-photons.

2. That gravitational waves are standing waves that are mathematically identical to gravitons albeit an inverse of phase, hence the designation anti-gravitons.

3. That the Rydberg formula describes 2 waves that mathematically correspond to 2 different orbits (or orbitals) albeit for inverse of phase.

4. That ‘movement’ between 2 ‘n’ orbits (or orbitals) occurs via a process of wave addition and subtraction.

5. That anti-photons and anti-gravitons delineate their respective orbital paths.

6. That it is the momentum of the gravitons that forces (drags) the object along the orbital path, the object itself has no inherent momentum.

7. That wave-particle duality reflects a wave-state (electromagnetic state) to point-state (mass state) oscillation.

8. That these waves are units of Planck momentum[8].

References:

1. Bohr model, (last revision Dec 2008)
   http://en.wikipedia.org/wiki/Bohr_model

2. Fine Structure Constant, (last revision 3, Jun 2011)
   http://en.wikipedia.org/wiki/Fine-structure_constant

3. Schwarzschild radius, (last revision 19, Sept 2011)
   http://en.wikipedia.org/wiki/ Schwarzschild_radius

4. Earth mass, (last revision 6, May 2011)
   http://en.wikipedia.org/wiki/ Earth_mass

5. Atomic Orbits, (last revision 25, Oct 2011)
   http://en.wikipedia.org/wiki/Atomic_orbital

6. Rydberg formula, (last revision 11, May 2011)
   http://en.wikipedia.org/wiki/Rydberg_formula

7. {Rydberg} http://physics.nist.gov/cgi-bin/cuu/Value?ryd (CODATA 2010)

8. Natural units as Planck momentum, online calculator (last revision 25, Oct 2011)
   http://www.planckmomentum.com/calculator.html

9. Mercury, (last revision 14, Oct 2011)
   http://en.wikipedia.org/wiki/Mercury_%28planet%29

10. Physical Review Letters 84(24), 5496 (2000))

11. Atomic Hydrogen
    http://www.mpq.mpg.de/~haensch/hydrogen/research.html

12. Plato's Code: Geometry of Planck Momentum (2011 online edition)
    http://www.platoscode.com