THE ECE2 LAW OF PRECESSION

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ABSTRACT

An ECE2 covariant universal law of precession is developed by rotating the infinitesimal line element at a given angular velocity. The resulting phase change explains all observable precessions in terms of the angular velocity of clockwise or anticlockwise frame rotation. The law of precessions is applied to planetary precessions in the solar system, the Hulse Taylor binary pulsar and the S2 star orbiting the centre of the Milky Way.

Keywords: The universal law of precession, ECE theory.

UFT410

1. INTRODUCTION

Recently in this series {1 - 41} the Einsteinian theory of general relativity (EGR) has been refuted in many new ways, so there nearly a hundred refutations of EGR in the UFT series of papers on www.aias.us and www.upitec.org. These complement many more refutations by scholars such as Stephen Crothers and Myles Mathis. Some of these refutations, such as that in UFT406, are very simple, and require no mathematics for their understanding. UFT406 shows that EGR erroneously describes planetary precession in terms of only one component, the Einsteinian precession, while inconsistently omitting from consideration the geodetic and Lense Thirring precessions, and any other EGR precession which may be present. So the fabled precision of EGR cannot be true. The inconsistency is shown up vividly through the fact that EGR applied to Gravity Probe B claims to have observed the geodetic and Lense Thirring precessions of the satellite. When EGR is applied to planets it completely omits consideration of the geodetic and Lense Thirring precessions. So even within the deeply flawed context of EGR, even if we accept its obsolete claims, the way in which it has been applied is clearly incorrect and completely self inconsistent. The total EGR precession of planets, Gravity Probe B, and all orbiting objects must always be the sum of the Einsteinian precession, geodetic or de Sitter precession and Lens Thirring precession, plus any other precessions that EGR itself predicts. In view of this simple reasoning the claim that the data are explained precisely by the Einsteinian precession alone is clearly false, and in this paper an entirely new law of precession is proposed.

This paper is a short synopsis of detailed calculations given in the notes accompanying UFT410 on www.aias.us. Note 410(1) shows that the EGR theory of geodetic precession, given dogmatically by wikipedia, is very obscure, and corrects it straightforwardly using simple algebra. Clearly, the claim that Gravity Probe B has detected EGR geodetic precession cannot be true, and geodetic precession could not have been isolated experimentally from the other precessions that always accompany it in EGR: the Einsteinian and Lense Thirring and so on. The only thing that can ever be observed experimentally is the total precession, the rest is theory. Note 410(2) gives details of the relation between precession, time dilatation and length contraction. It is shown that the latter can only be interpreted in one way, otherwise the ideas behind them produce diametrically self inconsistent results. This is a fundamental and well known problem of special relativity itself. Note 410(3) discusses invariance under four rotation. Note 410(4) is the derivation of the phase equation at the root of the new law of precession, a new phase equation that clarifies the obscure treatment of Thomas precession usually found with difficulty in the literature. Note 410(5) applies the new law of precession to the Hulse Taylor binary pulsar and Note 410(6) applies the new law to the planets. Note 410(7) applies the new law to the S2 star system, in which the rotation of the infinitesimal line element must be in the opposite sense to that of some of the planets and the Hulse Taylor binary pulsar.

Section 2 derives the new phase law and universal law of precessions and corrects the standard model derivation of geodetic precession. Section 3 gives tables of results and graphical analysis.

2. DERIVATION OF THE UNIVERSAL LAW OF PRECESSION

Consider the invariance of phase under four rotation:

$$\phi = \kappa^{\mu} x_{\mu} = \kappa^{\mu\prime} x_{\mu}^{\prime} \qquad (1)$$

where

$$\kappa^{\mu} = \left(\frac{\omega}{c}, \underline{\kappa} \right) \qquad (2)$$

is the wave four vector and

$$x^\mu = (ct, \underline{r}) \quad -(3)$$

the position four vector. The invariance of phase can therefore be described as:

$$\phi = \omega dt - \underline{\kappa} \cdot d\underline{r} = \omega' dt' - \underline{\kappa}' \cdot d\underline{r}' \quad -(4)$$

where ω is the angular frequency $\underline{\kappa}$ the wave vector. A particle in frame K' does not move with respect to the frame K', so:

$$d\underline{r}' = \underline{0} \quad -(5)$$

The infinitesimal dt is the infinitesimal of proper time $d\tau$, so

$$\phi = \omega dt - \underline{\kappa} \cdot d\underline{r} = \omega_0 d\tau \quad -(6)$$

where ω_0 is the rest frequency of the particle. The de Broglie / Einstein equations are:

$$E = \hbar\omega = \gamma mc^2 \quad -(7)$$

$$\underline{p} = \hbar\underline{\kappa} = \gamma m \underline{v}_N \quad -(8)$$

where γ is the Lorentz factor, $\hbar$ is the reduced Planck constant and m the particle mass. Here E is the relativistic total energy, $\underline{p}$ is the relativistic momentum and $\underline{v}_N$ is the Newtonian velocity. The rest angular frequency of a particle in frame K' is the angular frequency in a frame K' which is at rest with respect to the particle. The angular frequency in frame K, the laboratory or observer frame in which the particle is moving with respect to K is:

$$\omega = \gamma\omega_0 \quad -(9)$$

Note that the particle is fixed in frame K', which moves with respect to frame K. So the particle moves with respect to frame K.

It follows that the phase change between frame K and frame K' is:

$$\Delta\phi = \omega t - \omega_0 \tau = \omega t\left(1 - \frac{1}{\gamma^2}\right) = \underline{\kappa} \cdot \underline{r}. \quad -(10)$$

For one revolution or orbit:

$$\omega t = 2\pi \quad -(11)$$

so:

$$\Delta\phi = 2\pi\left(1 - \frac{1}{\gamma^2}\right) = \underline{\kappa} \cdot \underline{r}. \quad -(12)$$

The universal law of precession is therefore based on the phase change:

$$\Delta\phi = 2\pi\left(1 - \frac{1}{\gamma^2}\right) \quad -(13)$$

For all γ and v:

$$\Delta\phi = 2\pi\frac{v^2}{c^2}. \quad -(14)$$

In Cartesian and plane polar coordinates:

$$d\underline{r} \cdot d\underline{r} = dX^2 + dY^2 = dr^2 + r^2 d\phi^2 \quad -(15)$$

so

$$v_N^2 = \left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\phi}{dt}\right)^2 = \left(\frac{dX}{dt}\right)^2 + \left(\frac{dY}{dt}\right)^2. \quad -(16)$$

From these equations:

$$d\underline{r} \cdot d\underline{r} = dr^2 + r^2 d\phi^2 = dX^2 + dY^2 = v_N^2 dt^2 \quad -(17)$$

and the invariance under four rotation can be expressed as:

$$ds^2 = (c^2 - v_N^2)\,dt^2 = c^2 d\tau^2 \quad (18)$$

By definition:

$$c^2 dt_1^2 := (c^2 - v_N^2)\,dt^2 \quad (19)$$

It follows that:

$$dt = \gamma\, dt_1 = \gamma\, d\tau \quad (20)$$

where the Lorentz factor is:

$$\gamma = \left(1 - \frac{v_N^2}{c^2}\right)^{-1/2}. \quad (21)$$

Note carefully that frame rotation has not yet been considered. The correct method of applying the theory of frame rotation is to consider the rotated infinitesimal line element:

$$ds^2 = c^2 dt^2 - dr^2 - r^2 d\phi'^2 \quad (22)$$

where:

$$d\phi' = d\phi + \omega\, dt. \quad (23)$$

Here ω is the angular velocity of frame rotation defined by:

$$\omega = \frac{d\phi}{dt} \quad (24)$$

for a positive sense of rotation and by:

$$d\phi' = d\phi - \omega\, dt \quad (25)$$

for a negative sense of rotation. In both cases the angular velocity is defined by:

$$v_\phi = \omega r. \quad -(26)$$

For the positive sense of rotation:

$$ds^2 = c^2 dt^2 - dr^2 - r^2 d\phi^2 - 2\omega r^2 d\phi\, dt - \omega^2 r^2 dt^2$$
$$= (c^2 - v_\phi^2)\, dt^2 - 2\omega r^2 d\phi\, dt - dr^2 - r^2 d\phi^2 \quad -(27)$$

Using:

$$d\phi = \omega\, dt \quad -(28)$$

it follows that:

$$2\omega r^2 d\phi\, dt = 2\omega^2 r^2 dt^2 = 2 v_\phi^2 dt^2 \quad -(29)$$

and the infinitesimal line element is:

$$ds^2 = (c^2 - 3 v_\phi^2)\, dt^2 - (dr^2 + r^2 d\phi^2). \quad -(30)$$

Finally using:

$$dr^2 + r^2 d\phi^2 = v_N^2 dt^2 \quad -(31)$$

invariance under four rotation reduces to:

$$ds^2 = (c^2 - v_N^2 - 3 v_\phi^2)\, dt^2. \quad -(32)$$

This can be written as:

$$ds^2 = \left(1 - \frac{v^2}{c^2}\right) c^2 dt^2 \quad -(33)$$

where:

$$v^2 = v_N^2 + 3v_\phi^2 . \quad -(34)$$

Defining:

$$dt_2^2 = \left(1 - \frac{v^2}{c^2}\right) dt^2 \quad -(35)$$

it follows that invariance under four rotation can be expressed as the following invariance of infinitesimal time elements:

$$dt_2^2 = d\tau^2 . \quad -(36)$$

The Lorentz factor is generalized under rotation to:

$$\gamma_1 = \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \quad -(37)$$

and the universal law of precession is:

$$\Delta\phi = 2\pi \frac{v^2}{c^2} = 2\pi \left(v_N^2 + 3v_\phi^2\right). \quad -(38)$$

For a negative sense of frame rotation Eq. (23) becomes:

$$d\phi' = d\phi - \omega\, dt \quad -(39)$$

and it follows that:

$$\begin{aligned} ds^2 &= c^2 dt^2 - dr^2 - r^2 d\phi'^2 \\ &= c^2 dt^2 - dr^2 - r^2 d\phi^2 + 2\omega r^2 d\phi\, dt - \omega^2 r^2 dt^2 \end{aligned} \quad -(40)$$

Defining:

$$dr^2 + r^2 d\phi^2 = v_N^2 dt^2 \quad -(41)$$

and using:

$$d\phi = \omega\, dt \quad -(42)$$

it follows that:

$$ds^2 = \left(1 - \frac{v^2}{c^2}\right) c^2 dt^2 \quad -(43)$$

in which:

$$v^2 = v_N^2 - \omega^2 r^2 \quad -(44)$$

In this case:

$$v_N^2 > v^2 \quad -(45)$$

For the positive rotation (23):

$$v^2 > v_N^2 \quad -(46)$$

and

$$v_N^2 - \omega^2 r^2 > 0. \quad -(47)$$

Using these methods it becomes possible to calculate the EGR de Sitter or geodetic precession simply and correctly. The de Sitter precession of 1916 rotates the so called Schwarzschild line element:

$$ds^2 = m(r,t)\, c^2 dt^2 - \frac{dr^2}{m(r,t)} - r^2 d\phi^2 \quad -(48)$$

where:

$$m(r,t) = 1 - \frac{2MG}{rc^2} = 1 - \frac{r_0}{r}. \quad -(49)$$

Note carefully that Eq. (48) is a solution of the incorrect Einstein field equation and so Eq. (48) can never give physically meaningful results. Using Eq. (23), the rotated

Schwarzschild line element is:

$$ds^2 = \left(m(r,t)c^2 - \omega^2 r^2\right)dt^2 - \frac{dr^2}{m(r,t)} - r^2 d\phi^2 - 2\omega r^2 d\phi dt \quad -(50)$$

and it follows that:

$$ds^2 = \left(m(r,t)c^2 - 3\omega^2 r^2\right)dt^2 - \left(\frac{dr^2}{m(r,t)} + r^2 d\phi^2\right). \quad -(51)$$

Define:

$$v_1^2 = \frac{1}{m(r,t)}\left(\frac{dr}{dt}\right)^2 + r^2\left(\frac{d\phi}{dt}\right)^2 \quad -(52)$$

to find that:

$$ds^2 = c^2 d\tau^2 = \left(m(r,t) - \frac{\left(3v_\phi^2 + v_1^2\right)}{c^2}\right)c^2 dt^2 \quad -(53)$$

where:

$$v_2^2 := v_1^2 + 3v_\phi^2. \quad -(54)$$

The Lorentz factor for de Sitter rotation is generalized to:

$$\gamma_1 = \frac{dt}{d\tau} = \left(m(r,t) - \frac{v^2}{c^2}\right)^{-1/2} \quad -(55)$$

and the phase change of de Sitter rotation is given by:

$$\Delta\phi = 2\pi \frac{v_2^2}{c^2}. \quad -(56)$$

The wikipedia article on de Sitter rotation is very obscure and does not resemble the above simple algebra.

The next section applies the universal law of precession to planets of the solar system, the Hulse Taylor binary pulsar and S2 star.

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3 Numerical results and graphics

3.1 Solar system

We extend the calculations done in UFT 306, section 3.1. First we compare experiental and calculated values of planetary precession. Experimental orbit data and measured precessions of planets are listed in Table 1. Only the total precession angle $\Delta\phi_T$ can be measured directly. Therein the impact of other planets is contained. As discussed earlier, each small or moderate distortion of an elliptic orbit leads to a precession. Subtracting the contributions of the other planets can only be done by theory, and this procedure is only available for the first three planets of the solar system. To obtain these "pure orbital precession data" for all planets, we assume that the formula of the obsolete Einstein theory, which describes this value for the first three planets sufficiently well, is also useable for the other planets. So this precession is

$$\Delta\phi_R = \frac{6\pi MG}{c^2 a(1-\epsilon^2)}, \tag{57}$$

where we have inserted a mean orbital radius

$$\langle r\rangle = a(1-\epsilon^2) \tag{58}$$

which is computed from the semi major axis a and orbital eccentricity ϵ. Conveniently, these data are given in angle (arc seconds or radians) per earth year. Then they span five orders of magnitude, see Table 1. When relating this quantity to one orbit, it becomes better geometrically feasible. Formula (57) gives these units directly. For $\Delta\phi_T$, the recalculation has first to relate the precession to one second, then the result has to be multiplied with the respective orbital period:

$$\Delta\phi_T(\text{per sec}) = \frac{\Delta\phi_T(\text{per earth year})}{365.25\cdot 24\cdot 3600}, \tag{59}$$

$$\Delta\phi_T(\text{per orbit}) = \Delta\phi_T(\text{per sec})\cdot T(\text{planetary orbit in sec}). \tag{60}$$

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The difference between Mercury and Pluto makes only two orders of magnitude. We have the surprising result, that originary precession is present in all planetary orbits in a similar way. This fact is covered by the totally measured precession $\Delta\phi_T$. The latter has a tendency to become larger for the outer planets so that it is larger up to seven orders of magnitude compared to $\Delta\phi_R$, see last column of Table 1.

As described in section 2, characteristic velocities can be derived from

$$v_R^2 = \frac{c^2}{2\pi}\Delta\phi_R, \tag{61}$$

$$v_T^2 = \frac{c^2}{2\pi}\Delta\phi_T. \tag{62}$$

For a near circular Newtonian orbit the radial component should be nearly zero so that

$$v_N \approx \omega r \tag{63}$$

where ω is the angular velocity of the planet. According to the relativistic line element (43) we then had

$$v_{R,T}^2 = v_N^2 - \omega^2 r^2 \approx 0. \tag{64}$$

All three velocities are listed in Table 2. Compared to v_N, which is the measured orbial velocity in very good approximation, v_R is in the order of magnitude of v_N, so all planet can be considered as “relativistic”. The velocity v_T, derived from the totally measured precession, is much larger and becomes even bigger with the planets being farther away from the sun.

It is seen from Table 2 that the cases

$$v_R > v_N \quad \text{and} \quad v_R < v_N \tag{65}$$

Nr.	Name	a[m]	ϵ	$\Delta\phi_R$ per earth year	$\Delta\phi_R$ per orbit	$\Delta\phi_T$ per orbit
1	Mercury	5.787E+10	0.2056	2.085E-6	5.022E-7	6.713E-5
2	Venus	1.081E+11	0.0068	4.184E-7	2.574E-7	6.114E-5
3	Earth	1.495E+11	0.0167	1.862E-7	1.862E-7	5.551E-4
4	Mars	2.278E+11	0.0934	6.553E-8	1.233E-7	1.485E-3
5	Jupiter	7.778E+11	0.0483	3.024E-9	3.587E-8	3.767E-3
6	Saturn	1.426E+12	0.056	6.647E-10	1.958E-8	2.785E-2
7	Uranus	2.869E+12	0.0461	1.156E-10	9.722E-9	1.361E-2
8	Neptune	4.494E+12	0.01	3.758E-11	6.194E-9	2.876E-3
9	Pluto	5.910E+12	0.2484	2.020E-11	5.020E-9	

Table 1: Experimental planetary data and precession data[1]; precessions in radians per earth year and per single orbit.

Nr.	Name	$v_N[m/s]$	$v_R[m/s]$	$v_T[m/s]$
1	Mercury	4.740E+4	1.727E+5	9.799E+5
2	Venus	3.500E+4	7.736E+4	9.352E+5
3	Earth	2.980E+4	5.161E+4	2.818E+6
4	Mars	2.410E+4	3.062E+4	4.608E+6
5	Jupiter	1.310E+4	6.577E+3	7.340E+6
6	Saturn	9.700E+3	3.084E+3	1.996E+7
7	Uranus	6.800E+3	1.286E+3	1.395E+7
8	Neptune	5.400E+3	7.332E+2	6.414E+6
9	Pluto	4.700E+3	5.375E+2	

Table 2: Newtonian orbital velocity v_N, and velocities v_R, v_T derived from precession data.

Nr.	Name	$\omega[rad/s]$	$\omega_+[rad/s]$	$\omega_-[rad/s]$
1	Mercury	8.552E-7	1.730E-6	
2	Venus	3.237E-7	3.684E-7	
3	Earth	1.994E-7	1.628E-7	
4	Mars	1.067E-7	4.828E-8	
5	Jupiter	1.688E-8		1.460E-8
6	Saturn	6.823E-9		6.469E-9
7	Uranus	2.375E-9		2.332E-9
8	Neptune	1.202E-9		1.191E-9
9	Pluto	8.476E-10		8.421E-10

Table 3: Angular frequencies ω, ω_+ and ω_- of the planets.

both occur. According to Eq. (34), v_R can be written as

$$v_R^2 = v_N^2 + 3\,v_\phi^2 \quad \text{(positive rotation)} \tag{66}$$

or

$$v_R^2 = v_N^2 - v_\phi^2 \quad \text{(negative rotation)} \tag{67}$$

where v_ϕ is a "relativistic" angular velocity different from the orbital angular velocity. Which form is valid, depends on the direction of frame rotation. Therefore we can write

$$v_\phi = \omega_{(+,-)} \cdot r \tag{68}$$

[1]see https://nssdc.gsfc.nasa.gov/planetary/factsheet/;
http://farside.ph.utexas.edu/teaching/336k/Newtonhtml/node115.html

with additional frequencies ω_+ and ω_- for both signs of rotation. These can be determined from the experimental precession data. From (61) and (66) follows for positive frame rotation:

$$\Delta\phi_R = \frac{2\pi}{c^2}(v_N^2 + 3\omega_+^2 r^2) \tag{69}$$

with solution

$$\omega_+ = \frac{\sqrt{\Delta\phi_R\, c^2 - 2\pi {v_N}^2}}{\sqrt{6\pi}\ r}, \tag{70}$$

and for negative frame rotation from (61) and (67):

$$\Delta\phi_R = \frac{2\pi}{c^2}(v_N^2 - \omega_-^2 r^2) \tag{71}$$

with solution

$$\omega_- = \frac{\sqrt{2\pi {v_N}^2 - \Delta\phi_R\, c^2}}{\sqrt{2\pi}\ r}. \tag{72}$$

Notice the different factor in the denominator between Eqs. (70) and (72). The results for the planetary system are given in Table 3, together with the "standard" frame rotation frequency

$$\omega = \frac{v_N}{r}. \tag{73}$$

Interestingly, the first four planets have positive frame rotation while the outer planets have negative rotation. The modulus of universal precessions ω_+ and ω_- is nearly identical to ω for the most planets, with exception of Mercury and Mars. For Mercury this may be due to stronger relativistic effects. Between Mars and Jupiter there is the asteroid belt which seems to distort the geometry. As explained in earlier papers, the frequencies ω_+ and ω_- may be interpreted as spin connections so they can be considered as a measure of the torsional structure of the solar system. Obviously, the direction of spacetime rotation changes in the asteroid belt. This supports the older astronomical view of speaking of inner and outer planets.

The three frequencies of spin connections are graphed in Fig. 1 on a linear scale. It is seen that for Mercury there is a great discrepancy between ω and ω_+. For the outer planets the frequencies are quite small. An alternative view is given by the double-logarithmic graph in Fig. 2. On this scale, the deviations for Mercury and Mars are the same but inverted. For the outer planets, ω and ω_- are hardly distinguishable.

3.2 Hulse-Taylor pulsar and S2 star system

For the Hulse-Taylor double star system we have orbital data mainly available for the point of closest approach. Therefore we use these data. With masses m_1 and m_2 we have for the Newtonian velocity

$$v_N^2 = \frac{k}{\mu}\left(\frac{2}{r} - \frac{1}{a}\right) \tag{74}$$

with

$$\mu = \frac{m_1 m_2}{m_1 + m_2} \tag{75}$$

(reduced mass) and

$$k = m_1 m_2 G. \tag{76}$$

Experimental and derived universal precession values are listed in Table 4. Obviously we have $v_R < v_N$ and therefore negative frame rotation, at least when using the data of closest approach which is a rough approximation due to the high eccentricity of the orbit. The shrinking of the orbit which conventionally is attributed to sending out gravitational waves, will be addressed in the next paper.

$m_1 \approx m_2$	2.804E30 kg
α	5.3671E8 m
ϵ	0.6171334
T	7.75 hours
$r = \frac{\alpha}{1+\epsilon}$	3.3189E8 m
$a = \frac{\alpha}{1-\epsilon^2}$	8.6685E8 m
$\Delta\phi_R$	4.226 degrees per earth year
	= 6.521 rad per orbit
v_N	1.3504E6 m/s
v_R	9.6579E5 m/s
ω	0.0040689 rad/s
ω_-	0.0028439 rad/s

Table 4: Orbital data and universal precession data of Hulse-Taylor double star system.

The S2 star is moving around the centre of the galaxy in a few years. Experimental data and results of universal precession are presented in Table 5. The orbital velocity is

$$v_N^2 = MG\left(\frac{2}{r} - \frac{1}{a}\right) = \frac{MG}{a}\left(\frac{2}{1-\epsilon} - 1\right). \tag{77}$$

We have again $v_R < v_N$ and negative frame rotation. ω_- is roughly half the value of ω which is also the case for the Hulse-Taylor double star, although the orbital parameters are quite different between both star systems.

M	7.956E36 kg
a	1.4253E14 m
ϵ	0.8831
T	15.56 earth years
$r = a(1-\epsilon)$	1.6662E13 m
$\Delta\phi_R$	3.549E-3 rad per orbit
v_N	7.7466E6 m/s
v_R	7.1250E6 m/s
ω	4.6493E-7 rad/s
ω_-	1.8248E-7 rad/s

Table 5: Orbital data and universal precession data of S2 star.

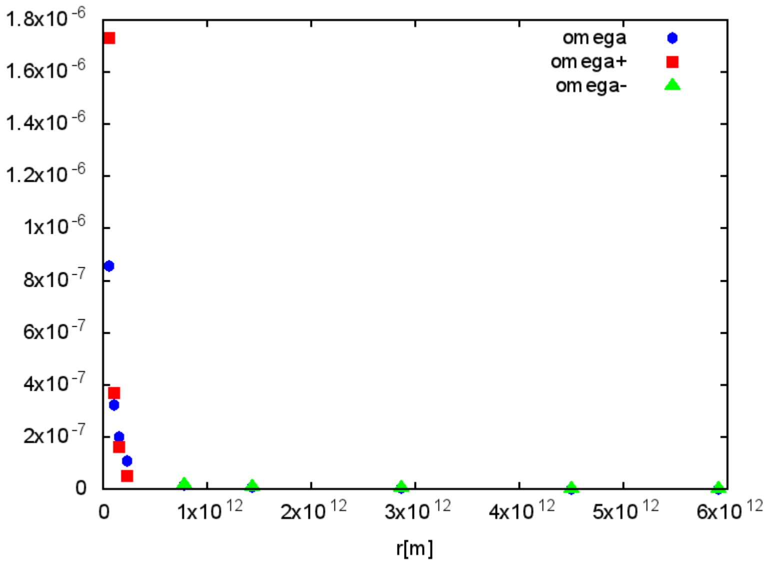

Figure 1: Universal angular freqeuncies of planets.

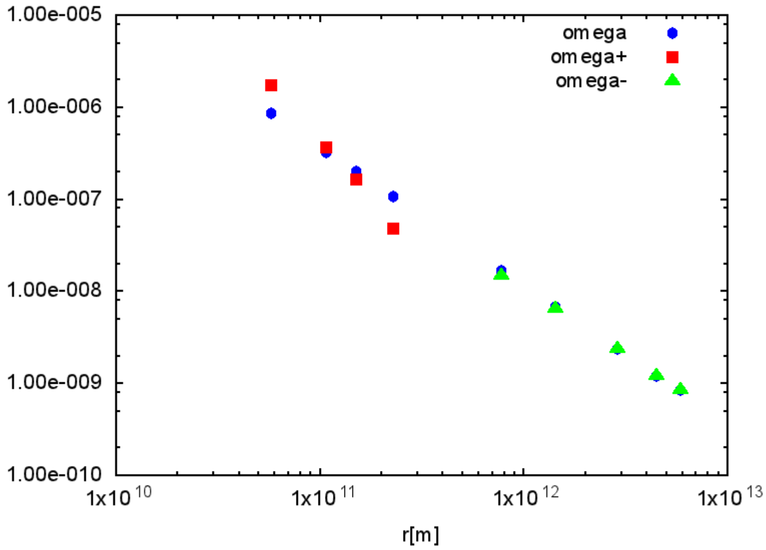

Figure 2: Universal angular freqeuncies of planets, logarithmic scales.

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