Orbiting explains Gravity

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Abstract

This manuscript identifies the cause of gravity. Based on this cause the gravitational force is quantified. This leads to a correction of Newton's gravitational equation for the (very) short distance: instead of an ever growing strength –up to infinity when the distance between two objects approaches 0- we will actually find a finite repelling force instead.
This manuscript concludes with 2 case studies that support the here presented outcome for gravity, and with a third case study that may allow verification.
The reason why gravity puzzled scientists is found in the S.I. system. This system imposes a framework for describinhg and analyzing nature/physics. However, it is -historically- based on observing human perceptions and has its flaws. For this reason this manuscript starts with pinpointing these flaws, and comes up with a more transparent alternative. Thereby no more than two physical properties are introduced: *content* and *whereabouts*.

Keywords: Physics, Gravity

1. Units of Measurement

Physics describes nature in terms of units of measurement. These are typically based on the 'International System', abbreviated as '*S.I*'. However, the *S.I.* is not '**normalized**'. This which complicates physics.

For example in defining *mass* as base unit, one would presume that simple mathematical rules would apply to it, such as: the total *mass* of two objects m_1 and m_2 equals m_1+m_2. However, e.g. the mass of an iron is about 1% less than the total mass of its constituents: protons, neutrons and electrons. Also, when heating up a piece of iron, we increase its *mass*.

These examples demonstrate that *mass* depends on other physical properties. This would not be so if *mass* were an independent property. More in general: if the *S.I.* were normalized.

Using the *S.I.* does not lead to false results as long as we are aware of the mutual dependencies between physical properties. Nevertheless: these dependencies complicate physics.

To avoid this, we will develop a normalized system of units of measurement by introducing no more than two alternate physical properties. Our system thereby is not complete, but it is adequate for the purpose at hand: explaining gravity.

As will be discussed in the following, analysing orbiting systems gives us a good starting point.

a) *Orbiting systems stretch distances and slow time.*

We envision an object 'A' that is propagating forward in an otherwise empty space. At some point the object is suddenly attached to the end of a stretched rope whereof the other end is tightly connected to some fixed point 'X' in space. This forces 'A' into a circular orbit:

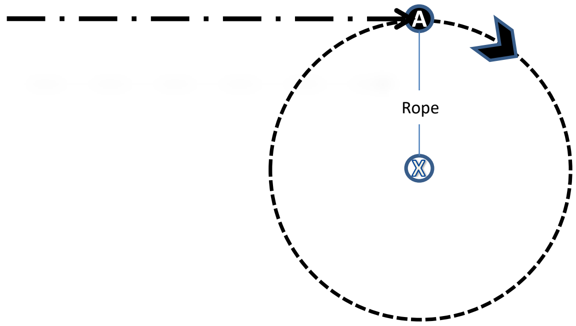

Fig.1.1: Object 'A' is forced into a circular orbit.

The now imposed orbiting causes an orbiting *frequency* 'υ' which did not exist before. Regardless the nature of object 'A', per Planck's equation $E = h.\upsilon$ this frequency is to be associated with a gain in embedded *energy*. We will refer to this as a gain in *content*, here specifically: '*Planck content*' since Planck's equation quantifies it. (The term *content* will be addressed later). Where did that '*Planck content*' come from? How is the conservation principle obeyed?

To answer these questions we analyse two equal point objects 'A' and 'B', keeping each other in a gravitational orbit around their centre of gravity 'X'. We position ourselves at some remote point on the axis of the orbiting system, thereby observing:

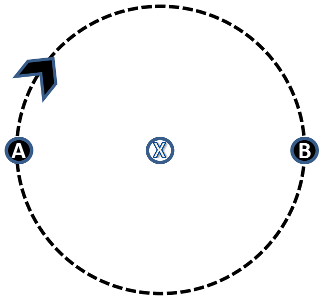

Fig. 1.2: equal objects 'A' and 'B' orbiting (clockwise) around their shared centre of gravity 'X'.

Next we decide to measure the *distance* between object 'A' and object 'B'.

Distance measuring is a personal effort (the method is consistent within the *S.I.*): one uses a local clock (a clock that one holds in his hands) and the velocity of light *c* (in vacuum). One measures Δt_{local} as the time needed for light to travel that distance (through vacuum). With *c* being a universal natural constant, this unambiguously delivers the *distance*:

$$Distance = \Delta t_{local}.c \qquad (1.1)$$

Since we are at a remote position, we ask a person residing on object 'A' to measure his distance to object 'B' for us. We will name the result '*LOD*' (the Locally Observed Distance):

$$LOD = \Delta t_{local}.c \qquad (1.2)$$

Thereby, due to the orbiting, object 'B' isn't where it is seen. As the Moon isn't where we see it from Earth. We see the Moon where it resided about 1.3 seconds ago because the distance between Earth and Moon is about 400,000 *km*, and the velocity of light is about 300,000 *km/s*. During those 1.3 seconds the Moon has progressed in its orbit.

We review the situation from the perspective of our remote observation location on the orbit axis. We define the '*ROD*' as the Remotely Observed Distance between objects 'A' and 'B'. The *ROD* is the distance as *we* see it. That is: the diameter of the orbit as shown in figure (1.2).

The following figure illustrates the challenge:

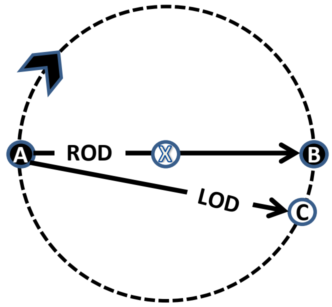

Fig.1.3: the Remotely Observed Distance '*ROD*' and Locally Observed Distance '*LOD*'

Location 'C' is the anticipated location where object 'B' (from our remote perspective) will reside by the time a light flash as sent by our helper on location 'A' will arrive at 'B'.

The line '*LOD*' therefore represents the direction as well as the path that light will follow from the perspective of our remote observation point.

As figure (1.3) shows:

$$LOD < ROD$$

The difference between *LOD* and *ROD* depends on the orbit velocity v_{orbit} .We use the following figure:

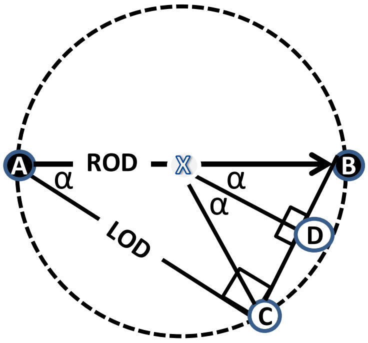

Fig. 1.4: *LOD/ROD.*

Given an orbit velocity v_{orbit}, angle BXC (which equals 2.α) is calculated as:

$$2.\alpha = \frac{v_{orbit}.ROD/c}{\pi.ROD} \times 2.\pi = \frac{2.v_{orbit}}{c}\ (radials)$$

Thus:

$\alpha = \frac{\mathrm{v_{orbit}}}{c}\ (radials)$

Figure 1.4 shows:

$\frac{LOD}{ROD} = \cos(\alpha) = \cos\left(\frac{\mathrm{v_{orbit}}}{c}\right)$

Or:

$$LOD = ROD \times \cos\left(\frac{\mathrm{v_{orbit}}}{c}\right) \qquad (1.3)$$

Note that the ratio LOD/ROD does not depend on the diameter of the orbit.

With different line lengths for *ROD* and *LOD* in above figure, the question comes up what the 'real' distance between object 'A' and 'B' will be.

Relative to both observers, the region of the orbiting system is not moving. Therefore -per Theory of Relativity- they must find an equal value for the orbiting system's embedded *content*, thus for the aforementioned orbiting induced '*Planck content*'. This implicitly demands that both observers must find the same orbiting *frequency* when applying Planck's equation $E = h.\upsilon$. The latter demand can only be met when *time* stretches proportionally to *distance*.

Therefore, when seen from our remote position (from where we see the longer distance *ROD* between 'A' and 'B'), we must require the clock at the orbiting system to appear running at a proportionally slower pace. Equation (1.3) therefore not only specifies *distance* stretching, but also *time* stretching:

$$Time_{Local} = Time_{Remote} \times \cos\left(\frac{\mathrm{v_{orbit}}}{c}\right) \qquad (1.4)$$

Thus the local observer on 'A' as well as the remote observer will find that the *time* it takes light to travel the distance from 'A' to 'B' is equal between them. And when both observers multiply this time with light velocity 'c', they therefore will come up with an equal value for the *distance* between 'A' and 'B'.

b) Whereabouts

Given the proportional relationship between *distance* and *time*, these two apparently different physical properties can mutually be expressed in one another, and therefore both can be expressed by using one single unit of measurement. Or: in nature *distance* and *time* jointly specify one single physical property.

To avoid confusion with existing terminology, we will give that property a unique name: *whereabouts*.

And we give the unit of measurement thereof also a unique name: the *C̲renel (symbol C̲)*:

The physical property *whereabouts* is measured in *C̲(renel).*

Fig. (1.5): Memory aid: *Crenels* on top of a castle wall. Their shape can be associated with *time* and with *distance*.

Distance and *time* then are different *appearances* of the property *whereabouts*. (We will later justify the term *appearance*, as opposed to the commonly used term *dimension*.)

We can specify the property *whereabouts* by spanning a Cartesian frame of reference, e.g. by using 4 *appearances*: X, Y, Z and T (also known as '*Minkowski spacetime*'). By using a Cartesian frame we ensure that *whereabouts appearance* values (=coordinates) are normalized: a change in e.g. the X coordinate does not impact any of the other coordinates. These 4 coordinates then jointly define the *whereabouts* of an object. Should in some experiment all 4 coordinates be found equal between two objects, we have a collision.

From a mathematical perspective there is no requirement with regards to the number of *whereabouts appearances* that span a *whereabouts* frame of reference, thus fully define the *whereabouts* property. Human visual observations are however restricted to a 3 dimensional spatial space, so in many cases that will do.

c) Velocity

Velocity is expressed in *distance/time*. Per the above *distance* and *time* were found two different *appearances* of one and the same physical property: *whereabouts*. Thus the ratio *distance/time* is dimensionless and thereby *velocity* is dimensionless.

A measured *velocity* can therefore not be subject to e.g. the Theory of Relativity. This theory only makes *dimensions* relative. But dimensionless properties are not affected. Other examples thereof are π, *e*, and the *bit*, which also are dimensionless and therefore equal to all.

This explains why light velocity '*c*' -as any other velocity- is found equal between all observers.

d) Light velocity 'c'

It is a practical choice to then set a numerical value of 1 to light velocity '*c*'. Therefore we now define:

$$\boldsymbol{c = 1}$$

In doing so, *velocity* ranges from 0 to 1.

e) Content

The finding that velocity is a dimensionless property shines light on Einstein's equation: $E = m.c^2$. With velocity '*c*' being dimensionless, '*E*' and '*m*' in this equation must be of same dimension and therefore both represent a shared -more fundamental- physical property underneath.

Again, to avoid confusion in terminology, we give that property a unique name: *content* (which term we already used on page 2). And we will give the unit of measurement thereof also a unique name: the *Package* (symbol *P*).

The physical property *content* is measured in *P(ackages).*

Energy and *mass* are two different *appearances* of the property *content*. (As said: we will later justify the term *appearance*, as opposed to the commonly used term *dimension*.)

At this point we have completed the introduction of alternate physical properties

f) Planck's constant 'h'

In Planck's equation:

$E = h.\upsilon$

Energy '*E*' is expressed in *Packages*.

In the *S.I.* frequency 'ʋ' is expressed in *seconds*$^{-1}$. The counterpart for *seconds*$^{-1}$ is *Crenel*$^{-1}$. Thus, in our system of units of measurement we find for Planck's constant '*h*':

$$\boldsymbol{h = 1\ C.P}$$

g) Gravitational constant 'G'

Within the *S.I. acceleration* is expressed in m/s^2. In our system *acceleration* therefore is to be expressed in C/C^2 or C^{-1}. Using Newton's equation $F = m.a$ we find that *force* is to be expressed in *P/C*.

When we substitute the new units of measurement into Newton's gravitational equation:

$$F = G.\frac{M_1.M_2}{d^2}$$

We find for the Gravitational constant *G*:

$$\boldsymbol{G \equiv 1\ \frac{C}{P}}$$

h) Conversion factors (Planck Units)

With three natural constants *c, G* and *h* now being defined, we can explore the following three forthcoming equations:

For light velocity *c*:

$1\ (\text{dimensionless}) = c\ (m.s^{-1})$ (1.5)

For Planck's constant *h*:

$1\ P.C = h\ (N.m.s)$ (1.6)

For the gravitational constant *G*:

$1\ C.P^{-1} = G\ (N.m^2.kg^{-2})$ (1.7)

The left side in these three equations expresses the universal natural constants (*c*, *h* and *G* respectively) in the newly defined fundamental units of measurement *Crenel* and *Package*, whereas the right side expresses these per the *S.I.*.

Using 3 preparation steps, we can extract *P* and *C*, and express these in *S.I.* units of measurement as follows:

Preparation step 1:

Equation (1.5) can be rewritten as: $1\ (s) = c\ (m)$.

Preparation step 2:

Based on the above, in equation (1.6), '*s*' can be replaced by *c meter*.

This results in:

$1.P.C = h.c\ (N.m^2)$ (1.8)

Preparation step 3:

Based on Einstein's $E = m.c^2$ 1 *kg* is equal to c^2 *Joule* or c^2 *(N.m)*. In equation (1.7) the kg^{-2} can therefore be replaced by $c^{-4}\ (N^{-2}.m^{-2})$:

$1\ C.P^{-1} = G.c^{-4}\ (N.m^2.N^{-2}m^{-2}) = G.c^{-4}\ (N^{-1})$ (1.9)

We divide equation (1.8) by equation (1.9):

$$P^2 = \frac{h.c^5}{G}\ (N^2.m^2) = \frac{h.c^5}{G}\ (Joule^2)$$

Or:

$$\boldsymbol{1\ Package} = \sqrt{\frac{h.c^5}{G}}\ (\boldsymbol{Joules}) \quad (1.10)$$

$=4.9033\text{x}10^9$ J

From here onwards some other conversion factors can be derived. Because 1 *Joule* equals c^{-2} *kg*:

$$\boldsymbol{1\ Package} = \sqrt{\frac{h.c}{G}}\ (\boldsymbol{kilograms}) \quad (1.11)$$

$=5.4557\text{x}10^{-8}$ kg

Based on Planck's $E = h.\upsilon$, equation (1.10) can likewise be converted to *frequency* (in *seconds*$^{-1}$):

$$1\,Package = \sqrt{\frac{h.c^5}{G}} \times \frac{1}{h}\,(s^{-1}) = \sqrt{\frac{c^5}{h.G}}\,(s^{-1})$$

or:

$$\mathbf{1\,Package} = \sqrt{\frac{c^5}{h.G}}\ (\mathbf{Hertz}) \qquad (1.12)$$

=7.4001x10^{42} Hz

Equation (1.12) delivers *frequency* as the third *appearance* in the *content* arena, besides the already defined *appearances mass* and *energy*.

The step from the *content* arena towards the *whereabouts* arena is found by multiplying equation (1.8) with equation (1.9):

$$C^2 = \frac{h.G}{c^3}\ (meter^2)$$

Or:

$$\mathbf{1\,Crenel} = \sqrt{\frac{h.G}{c^3}}\ (\mathbf{meter}) \qquad (1.13)$$

=4.0512x10^{-35}m

And, because one *meter* corresponds to c^{-1} *seconds*:

$$\mathbf{1\,Crenel} = \sqrt{\frac{h.G}{c^5}}\ (\mathbf{seconds}) \qquad (1.14)$$

=1.3513x10^{-43}s

Our limited system of only two physical properties - *content* (in *Packages*) and *whereabouts* (in *Crenel*)- thus delivered a set of yardsticks for *energy, mass* and *frequency* in the *content* arena, and *time, distance* in the *whereabouts* arena.

These yardsticks are consistent with the historically known 'Planck units', albeit that the above equations hold Planck's constant '*h*', whereas the 'Planck units' hold the *reduced* Planck constant '*h/2.π*' ('$\hbar$'). Had for Planck's equation $\mathrm{E} = h.\upsilon$ the alternate and equally valid version $\mathrm{E} = \hbar\omega$ been used in the above, this would have resulted in full consistency with the 'Planck units'.

When we now express an object's *content* in *Packages*, the numerical value thereof will be found equal regardless one expresses this in the *mass*, the *energy* or the *frequency appearance*. For example: the *content* of an electron equals $1.6697\mathrm{x}10^{-23}$ *Packages*, regardless one is measuring or expressing this as *mass*, as *energy*, or as *frequency*. This feature of numerical equality justifies our usage of the term '*appearance*' of *content*, rather than '*dimension*' of *content*. One can freely swap between appearances without numerical impact. In comparison, in the *S.I.* for example one *kg* of *mass* does not equal 1 *Joule* of *energy* or 1 *Hertz*.

With *c* being normalized to the dimensionless 1, within our system of units of measurement we can simplify the found conversion factors:

$$\mathbf{1\,P} = \sqrt{\frac{h}{G}} \quad \textit{Energy appearance} \qquad (1.15)$$

$$\mathbf{1\,P} = \sqrt{\frac{h}{G}} \quad \textit{Mass appearance} \qquad (1.16)$$

$$\mathbf{1\,P} = \sqrt{\frac{1}{h.G}} \quad \textit{Frequency appearance} \qquad (1.17)$$

$$\mathbf{1\,C} = \sqrt{\mathbf{h.G}} \quad \textit{Distance appearance} \qquad (1.18)$$

$$\mathbf{1\,C} = \sqrt{\mathbf{h.G}} \quad \textit{Time appearance} \qquad (1.19)$$

Equation (1.17) is of key relevance: it shows how *content* (in *Packages*) can appear as *frequency*, which is expressed in *Crenel*$^{-1}$, that is: in the inverse of *whereabouts*.

This conversion option implies that the two base physical properties *content* and *whereabouts* are related to one another. And thus these properties are not necessarily **normalized**. We need to explore that.

i) Normalization

For that, we start with reviewing the mathematical (and thus universal) steps to convert *content* into *whereabouts*:

1. INVERT the conversion factor for *content* (per either equation (1.15) or (1.16)).
   This results in:
   $\sqrt{\frac{G}{h}}$
2. MULTIPLY the result with Planck's constant '*h*'. This results in:
   $\sqrt{h.G}$
   which matches equations (1.18) and (1.19).

The exact same steps can be used to reconvert *whereabouts* into *content*:

1. INVERT the conversion factor for *whereabouts* (per either equation (1.18) or (1.19).
   This results in:
   $\sqrt{\frac{1}{h.G}}$
2. MULTIPLY the result with Planck's constant '*h*'. This results in:
   $\sqrt{\frac{h}{G}}$
   which matches equations (1.15) and (1.16).

The equality between the conversion and reconversion steps is remarkable. The failsafe approach to reconvert to the original is to undo each conversion step in reverse order. In this case however, each of the following statements hold true:

a. Applying the conversion procedure twice results in the original value, regardless of whether one starts with the *Package* or with the *Crenel*.
b. Applying the conversion procedure twice has the same impact as a multiplication with dimensionless 1.

From a mathematical perspective it is exclusively the 'multiplicative inverse' operation which has this property. We apply this mathematical insight to the above two equal conversion procedures. Mathematics says that:

Content **(in *Packages*) <u>is equal to</u>**
inverted *whereabouts* (in *Crenel*)

And vice versa:

Whereabouts **(in *Crenel*) <u>is equal to</u>**
inverted *content* (in *Packages*)

However, the conversion/reconversion procedure that we found consists of two mathematical steps rather than one single step. This does not contradict the above mathematical conclusion. To verify this, we take a closer look at the second step of the procedure.

Given the above mathematical perspective that the *Package* and *Crenel* are found reciprocal, their product ***C.P*** must equal a dimensionless 1. This implies that Planck's constant:

$$\boldsymbol{h = 1\, C.P \equiv 1}$$

Within our model Planck's constant *h* (mathematically) therefore equals the dimensionless 1, and a multiplication with Planck's constant (step 2 of the procedure) has no mathematical impact on the outcome. Yet we found that such multiplication nevertheless results in a physical property swap between *Crenel* and *Package*.

This gives a deeper insight into the conversion procedure**.** From a mathematical perspective, the first step (the inversion step) **is** the swap between *Crenel* and *Package***.** The second step (multiply with Planck's constant '*h*') only ensures that this swap is processed dimensionally without impacting the result. After all, from a mathematical perspective this second step is indeed no more than a multiplication by 1.

Planck's constant is the 'inner product' (also referred to as 'scalar product') '*P.C*' of the two physical properties '*P*' and '*C*' respectively. This inner product '*P.C*' must equal dimensionless 1. If not, the sequential applying of the conversion and reconversion procedures would not result in the original result, as demanded by mathematical rules. From a physical perspective it would violate the conservation principle should the original result not materialize.

The inner product of '*P(ackage)*' and '*C(renel)*' being equal to dimensionless 1 implies that these properties are perpendicular (independent) relative to one another.

In conclusion:

The currently defined system of units of measurement with two fundamental physical properties (*content* and *whereabouts*) is indeed normalized.

j) The conservation principle's bottom line.

By revealing that *content* (in *Packages*) is inverted *whereabouts* (in *Crenel*), and vice versa, our model gives the deepest view on the conservation principle.

The exchange rate between *whereabouts* and *content* can be found by rewriting the definition of the gravitational constant *G=1 C/P* as:

$$C = G \times P \tag{1.20}$$

Or: whereabouts (in <u>*C*</u>*renel*) equals the gravitational constant (*G*) multiplied with *content* (in <u>*P*</u>*ackages*). This finding is our first glimpse of the physical meaning of the gravitational constant *G*.

2. Gravity.

We found why at orbiting systems *distances* appear stretched when remotely observed (see equation (1.3)). And we concluded that -based on the conservation principle- *time* must appear to run proportionally slower (see equation (1.4)).

Thus at the orbiting system we see an apparent widening of *whereabouts* gridlines relative to these same gridlines in empty deep space, and also relative to our own Cartesian frame of reference. Apparently *whereabouts* embed a physical property that can be compared to e.g. a pressure in the Earth's atmosphere. In this comparison we would describe the widening of gridlines as a *whereabouts* **depression** at the orbiting system.

And as air moves from high pressure regions to low pressure regions whereby the (local) gradient in air pressure is the driving force, we can explain the gravitational force in that *content* will be likewise pulled towards a *whereabouts* depression, whereby the driving force is the gradient in the widening of gridlines.

At the same time, we associated orbiting systems with 'Planck *content*'.

If now we hypothesize that the orbiting objects had zero *content* prior to the start of the orbiting so that there is no bias to take into account, and that thus all embedded *content* is orbiting induced 'Planck *content*', we have a case to test this hypothesis for its consistency and outcome.

a) A Photon's Path curving

In the previous paragraph we found that we see orbiting systems magnified:

$$LOD = ROD \times \cos\left(\frac{v_{\text{orbit}}}{c}\right) \quad (2.1)$$

Although we see the photon incoming from an orbit with diameter *ROD*, within our own Cartesian frame of reference we must reckon that it was locally emitted from an orbit with the shorter diameter *LOD*.

The difference between *ROD* and *LOD* tells us how the photon changed course within our own Cartesian frame of reference. We will name the angle of the course change $d\alpha$.

Within our Cartesian frame of reference, this angle $d\alpha$ equals the total curving of the photon's path, which curving implicitly equals the total curving of the *whereabouts* gridline which connects the reckoned local emission point to our remote observation point.

We use the following figure to calculate aforementioned angle $d\alpha$. As the figure makes clear, this angle depends on the distance x towards the centre of the orbiting system:

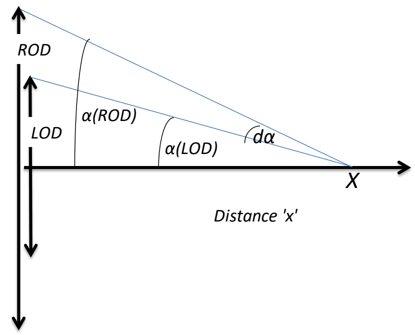

Fig. 2.1: photon course change $d\alpha$.

In figure (2.1):

- Angle $\alpha_{(ROD)}$ is the angle relative to the orbit axis, at which we actually see the photon incoming.
- Angle $\alpha_{(LOD)}$ is the angle towards the reckoned emission point.
- Angle $d\alpha$ is the difference between both.

We define R_R as the remotely observed orbit radius:

$R_R = ROD/2$ (2.2)

And we define R_L as the locally observed orbit radius:

$R_L = LOD/2$ (2.3)

The tangent of $\alpha_{(ROD)}$ then equals:

$$\tan(\alpha_{ROD}) = \frac{R_R}{x} \quad (2.4)$$

And the tangent of $\alpha_{(LOD)}$ equals:

$$\tan(\alpha_{LOD}) = \frac{R_L}{x} \quad (2.5)$$

Per equation (2.1): $LOD = \cos\left(\frac{v_{orbit}}{c}\right).ROD$

Or: $\frac{LOD}{2} = \cos\left(\frac{v_{orbit}}{c}\right).\frac{ROD}{2}$

Or: $R_L = \cos\left(\frac{v_{orbit}}{c}\right).R_R$

We substitute this in equation (2.5):

$$\tan(\alpha_{LOD}) = \frac{\cos\left(\frac{v_{orbit}}{c}\right).R_R}{x} \quad (2.6)$$

The angle $d\alpha$ equals:

$$d\alpha = tan^{-1}\left\{\frac{R_R}{x}\right\} - tan^{-1}\left\{\frac{\cos\left(\frac{v_{orbit}}{c}\right).R_R}{x}\right\} \quad (2.7)$$

This equation can be normalized by expressing distance x in number of R_R's. This makes R_R the new measure for distance. To achieve this, we define a new distance unit of measurement named x_R, whereby $x_R = x/R_R$.

Equation (2.7) then normalizes to:

$$d\alpha = tan^{-1}\left\{\frac{1}{x_R}\right\} - tan^{-1}\left\{\frac{\cos\left(\frac{v_{orbit}}{c}\right)}{x_R}\right\} \quad (2.8)$$

(x_R expressed in orbit radiuses R_R)

Figure (2.3) shows $d\alpha$ per this equation as a function of distance x_R from the orbit centre.

We thereby opted for the maximum possible orbit velocity case whereby $v_{orbit}=c$.

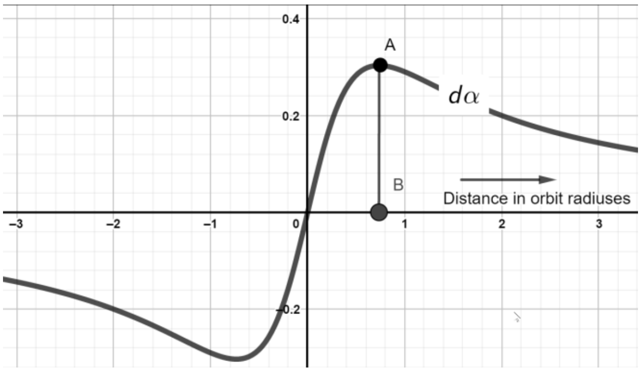

Fig. 2.2: $d\alpha$ as a function of distance x_R (x_R expressed in number of R_R's from the orbit centre, whereby the orbit velocity $v_{orbit}=c$).

The gradient in *whereabouts* is quantified by the steepness and direction of the slope in the above shown curve of $d\alpha$. It equals:

$$\frac{d\alpha}{dx_R}=\frac{x_R{}^2.\left(\cos\left(\frac{v_{orbit}}{c}\right)-1\right)+\left(\cos\left(\frac{v_{orbit}}{c}\right)-\cos^2\left(\frac{v_{orbit}}{c}\right)\right)}{x_R{}^2.\left(\cos^2\left(\frac{v_{orbit}}{c}\right)+1\right)+x_R{}^4+\cos^2\left(\frac{v_{orbit}}{c}\right)}$$

(x_R expressed in remotely observed orbit radiuses R_R) (2.9)

The following figure embeds the value thereof, again based on the maximum possible orbit velocity case whereby $v_{orbit}=c$:

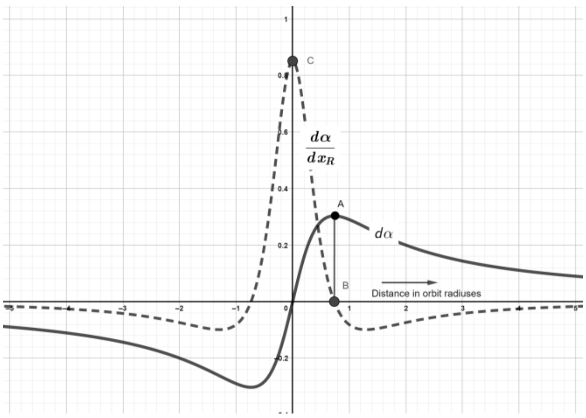

Figure 2.3: Gradient $\frac{d\alpha}{dx_R}$
(as a function of distance x_R expressed in R_R's, based on an orbit velocity $v_{orbit}=c$).

The *whereabouts* gradient curve $\frac{d\alpha}{dx_R}$ was previously identified as the **cause** of gravity, not necessarily representing the **strength** of the gravitational force. We will explore that later. Yet, at this point and based on above figure we find a change of sign at the point marked B (at either side of the orbiting centre).
This indicates that at this point B the gravitational force changes from attracting towards repelling.

This is a major finding. It explains why objects -when approaching the centre of orbiting induced *content*- will not gravitate under ever growing gravitational force, as would be the case per Newton's gravitational equation. Instead, figure (2.3) shows a finite maximum repelling force at the *content* centre (that is: the centre of the orbiting system, the point marked C).

The exact location of point B is found where the nominator in equation (2.9) equals 0:

$$x_R{}^2.\left(\cos\left(\frac{v_{orbit}}{c}\right)-1\right)+\left(\cos\left(\frac{v_{orbit}}{c}\right)-\cos^2\left(\frac{v_{orbit}}{c}\right)\right)=0 \qquad (2.10)$$

Equation (2.10) gives the following two values for distance x_R:

$$x_R=\pm\frac{\sqrt{-4.\left(\cos\left(\frac{v_{orbit}}{c}\right)-1\right).\left(\cos\left(\frac{v_{orbit}}{c}\right)-\cos^2\left(\frac{v_{orbit}}{c}\right)\right)}}{2.\left(\cos\left(\frac{v_{orbit}}{c}\right)-1\right)} \qquad (2.11)$$

b) Distance x.

Rather than normalizing equation (2.7), we can also specify the gradient $\frac{d\alpha}{dx}$ thereof:

$$\frac{d\alpha}{dx}=\frac{R_R.x^2.\left(\cos\left(\frac{v_{orbit}}{c}\right)-1\right)+R_R{}^3.\left(\cos\left(\frac{v_{orbit}}{c}\right)-\cos^2\left(\frac{v_{orbit}}{c}\right)\right)}{R_R{}^2.x^2.\left(\cos^2\left(\frac{v_{orbit}}{c}\right)+1\right)+x^4+R_R{}^4.\cos^2\left(\frac{v_{orbit}}{c}\right)} \qquad (2.12)$$

For very large values of distance x as well as for very small values of R_R, equation (2.12) is estimated by:

$$\frac{d\alpha}{dx}\approx\left(1-\cos\left(\frac{v_{orbit}}{c}\right)\right)\times\frac{ROD}{x^2} \qquad \text{(large } x\text{) (2.13)}$$

Per equation (2.1) the term '$\cos\left(\frac{v_{orbit}}{c}\right)$' can be replaced by *LOD/ROD*:

$$\frac{d\alpha}{dx}_{large\ x\ or\ small\ R}\approx\left(1-\frac{LOD}{ROD}\right)\times\frac{ROD}{x^2}$$

Or:

$$\frac{d\alpha}{dx}_{large\ x\ or\ small\ R}\approx(ROD-LOD)\times\frac{1}{x^2} \qquad (2.14)$$

In the above equation the term *(ROD-LOD)* reflects the amount of 'fake' *whereabouts*: from a remote perspective we 'see' an orbit diameter equal to the *ROD*, but we know that we see it stretched, as if looking through a magnifying glass.

The difference *(ROD-LOD)*, being 'fake' *whereabouts*, is to be interpreted as *whereabouts* that has been converted into *content*. Thereby, our model demands that one unit of *whereabouts* converts one-on-one into one unit of *content*.

We can therefore write equation (2.14) as:

$$\frac{d\alpha}{dx}_{large\ x\ or\ small\ R} \approx \frac{Content}{x^2} \tag{2.15}$$

With -per our model- the gradient $\frac{d\alpha}{dx}$ being identified as the **cause** of the gravitational force, we can now make a direct comparison with Newton's gravitational equation:

$$F_G = G \times \frac{Content_1 \times Content_2}{x^2} \tag{2.16}$$

Newton's equation says that if we place a *content₂* at a distance *x* from a *content₁*, the gravitational force is given by equation (2.16). Newton's equation is a fundamental equation that must hold within any system of *UoM*, thus also within our model. Here, the equation holds, even though our model demonstrates that it is no more than a good approximation of the gravitational force at large distances (large, relative to the orbit diameter of orbiting induced *content*).

To verify Newton's equation within our model, we rename *content* in equation (2.15) to *content₁*, and we substitute this in Newton's equation (2.16):

$$F_G = G \times \frac{d\alpha}{dx}_{large\ x\ or\ small\ R} \times Content_2 \tag{2.17}$$

Prior to interpreting the physical meaning of this equation, let's check its dimensional integrity within our model:

F_G is to be expressed in P/C (see chapter 1)
G equals 1 C/P
$\frac{d\alpha}{dx}_{large\ x\ or\ small\ R}$ is in $^{P}/_{C^2}$
$Content_2$ is in P

Substituting these dimensions into equation (CP9.23) gives:

$$\frac{P}{C} = \frac{C}{P} \times \frac{P}{C^2} \times P = \frac{P}{C} \tag{2.18}$$

Thus we confirm the dimensional integrity of equation (2.17).

As said, per our model the term $\frac{d\alpha}{dx}_{large\ x\ or\ small\ R}$ in equation (2.17), being the local gradient in *whereabouts* pressure, was introduced as the **cause** of the gravitational force. Based on equation (2.17) we can now upgrade the meaning of this gradient: per our model the gradient in *whereabouts pressure* exactly **represents** gravity at large distances, without demanding a weight factor. Or: for the term *G* in equation (2.17) we can indeed substitute the gravitational constant per our model: *G* (being equal to 1 *C/P*).

In conclusion:
The following equation quantifies the exact gravitational force between an orbiting induced *content* and some remote *content* at distance *x*:

$$\boldsymbol{F_g} = \frac{R_R.x^2.\left(\cos\left(\frac{V_{orbit}}{c}\right)-1\right)+{R_R}^3.\left(cos\left(\frac{V_{orbit}}{c}\right)-cos^2(1)\right)}{{R_R}^2.x^2.\left(cos^2\left(\frac{V_{orbit}}{c}\right)+1\right)+x^4+{R_R}^4.cos^2\left(\frac{V_{orbit}}{c}\right)} \times \boldsymbol{Content} \tag{2.19}$$

c) *Case studies.*

1. Imagine an orbiting galactic system, consisting of numerous and homogeneously distributed masses. Per Newtonian laws the net gravitational force at the centre of this system would be equal to 0, since the added gravitational forces of all surrounding masses would compensate each other. And in the vicinity of this centre any object would be pulled towards this centre, so that such system should ultimately take the shape of a perfectly flat disc. In fact we see galactic systems not completely flattened, despite their age.
   Per our model, an object which is located near the centre of such galactic system would experience a gravitational repelling force, directed away from the centre. In the regional absence of any other forces (which would virtually be valid near the centre of such a galactic system) this orbiting induced gravitational repelling force would prevent the system to ultimately flatten completely. This fits the actual observations.
2. Imagine a proton and an electron in orbit around their centre of gravity. Per our model an approaching electrically neutral particle would not settle itself at that centre. Here, it would be subject to a repelling gravitational force.
   We observe atoms as 3-dimensional objects, not being flat. This observation conceptually fits our model.

3. Imagine a space ship on its way from the Earth towards the Moon. It would thereby pass the centre of gravity of the Earth/Moon orbiting system at relatively close range.
   Per our model it would thereby experience a (small) non-Newtonian gravitational force which is directed away from the centre of gravity. Such space ship would -on its way- therefore experience a minor force away from the targeted Moon.
   It is not known if such (small) deviation can be confirmed by actual data.